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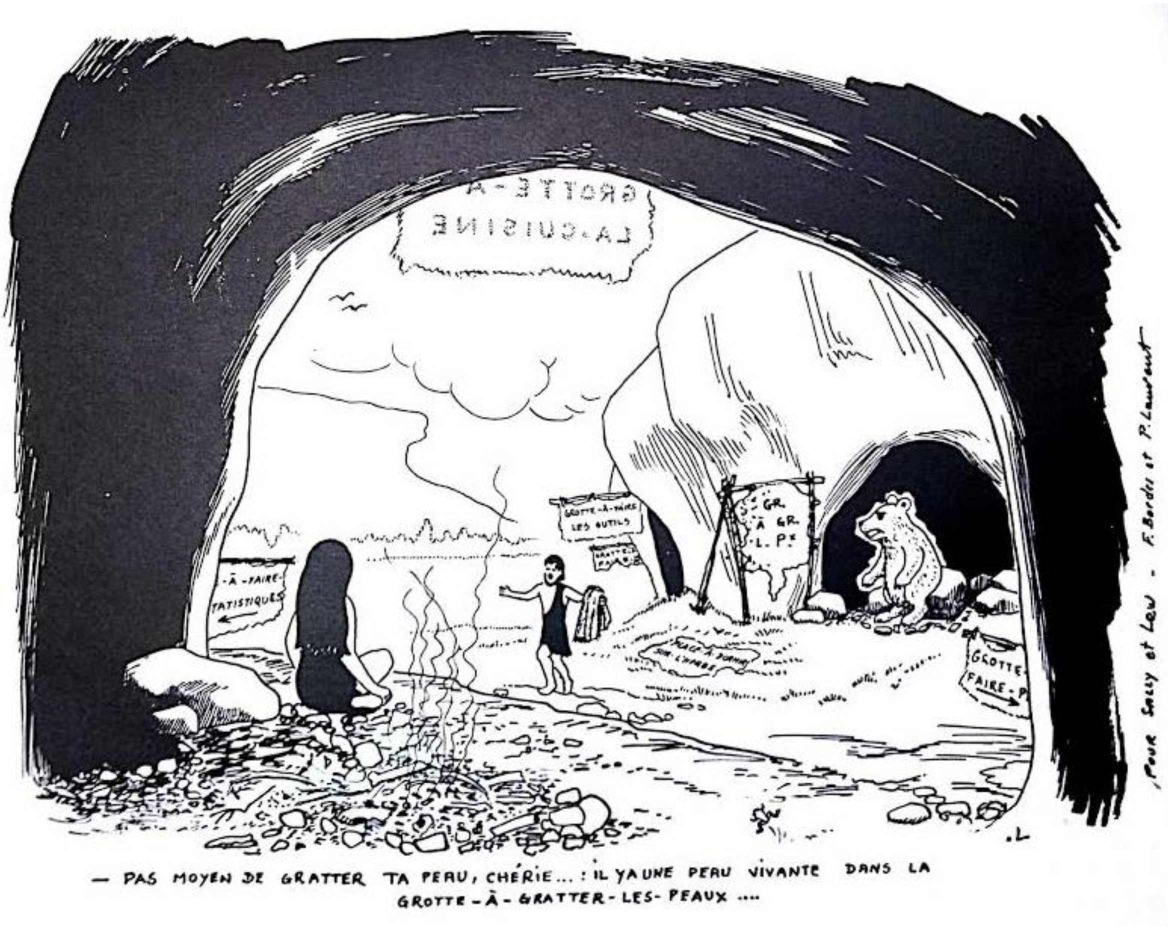
Assessing the Role of Artefact Design within the Middle Palaeolithic Repertoire: Determining the Behavioural Potential of Blade Production Strategies

by

Christian Steven Hoggard



A comical perspective of Binfordian ideas by François Bordes (Renfrew, 1973)

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<u>ABSTRACT</u>

FACULTY OF HUMANITIES

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ASSESSING THE ROLE OF ARTEFACT DESIGN WITHIN THE MIDDLE PALAEOLITHIC REPERTOIRE: DETERMINING THE BEHAVIOURAL POTENTIAL OF BLADE PRODUCTION STRATEGIES

By Christian Steven Hoggard

The Middle Palaeolithic of Europe has long been characterised by its rich technological diversity, with an array of core volume management strategies exhibited. In understanding and accounting for this diversity, interpretations of consistent behaviour and technological change have stressed the importance of three factors: social transmission and cultural tradition (Bordian-centric models), site-function and adaptation (Binfordian-centric models), and diachronic change andchronology. In many of these investigations and analyses into the Middle Palaeolithic, little emphasis is placed on commonalities and differences in blank-type, product desirability and their behavioural potential given their morphology. While function may not account for all aspects of technological variability, analyses of functional performance may explain chronological changes in various core volume management strategies which appear, at face value, to produce similar blanks. Undertaking such provides an entry-point into the nature and behaviour of Neanderthal tool-makers and tool-users, and a platform for discussing the role of other factors (e.g. ecological adaptation).

This thesis investigates the behavioural potential of the main methods of 'technological blade production', the specific proceduralised sequence of producing stereotyped elongated blanks from a homothetic core morphology: Levallois (unidirectional/bidirectional) elongated recurrent and Laminar *sensu stricto* systems of blade manufacturing. A thorough technological analysis of blade production systems from eleven Middle Palaeolithic contexts were first undertaken to characterise technological variability of blade production systems throughout the Middle Palaeolithic. Traditional and geometric morphometric analyses of an experimental (n = 499) and archaeological (n = 908) dataset were then undertaken in order to understand differences in: 1) blank shape and form (size *plus* shape), 2) economisation and efficiency, and 3) product regularity and standardisation. Analyses from the technological framework were then assessed alongside findings from the functional analysis through a goodness-of-fit test, to explain whether a working hypothesis grounded on 'performance attributes' (Skibo and Schiffer, 2001) and artefact design could explain the change from a predominantly Levallois method of blade production in the Early Middle Palaeolithic, to a predominantly Laminar method in the Late Middle Palaeolithic, in addition to on-site concurrency (equifinality vs. activity-specific behaviours).

The thesis highlights the expansive evidence for technological blade strategies within the Middle Palaeolithic and highlights the 'retouch potential' of Levallois technological blade strategies, given a higher flattening index, increased width and size, and an increased amount of edge per blank, while Laminar blades produce more cutting edge per weight of stone, and blades per core, representing a more portable, economic and expedient technological blade strategy. This is supported through archaeological evidence for extensive preparation and invasive continuous retouch featured on Levallois products, and the lack of retouch observed on Laminar products.

This research also provides a thorough account into the role of raw material in the shape and form of blades produced from both methods, details a quantitative framework suggestive of spatio-temporal relationships of social learning within MOIS 5, supports arguments for a 'Northwest Technocomplex' (Depaepe, 2007), and queries the archaeological integrity of the Le Rissori sequence.

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Academic Thesis: Declaration Of Authorship

I, Christian Steven Hoggard declare that this thesis (Assessing the Role of Artefact Design within the Middle Palaeolithic Repertoire: Determining the Behavioural Potential of Blade Production Strategies) and the work presented in it are my own and has been generated by me as the result of my own original research.

I confirm that:

1. This work was done wholly or mainly while in candidature for a research degree at this University;

2. Where any part of this thesis has previously been submitted for a degree or any other qualification at this University or any other institution, this has been clearly stated;

3. Where I have consulted the published work of others, this is always clearly attributed;

4. Where I have quoted from the work of others, the source is always given. With the exception of such quotations, this thesis is entirely my own work;

5. I have acknowledged all main sources of help;

6. Where the thesis is based on work done by myself jointly with others, I have made clear exactly what was done by others and what I have contributed myself;

7. Either none of this work has been published before submission, or parts of this work have been published as: [please list references below]:

Signed: ....

Date: ....

Acknowledgements

Behind every researcher is an extensive emotional and academic support network, during the best and hardest of times, and I could not achieve this thesis alone. Despite this, all errors contained within the thesis remain the responsibility of my own.

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Chapter One
Introduction to the Research Topic and Thesis

1.1. Introductory Remarks

Humans make things, and make things with some proficiency. We compose music scores, build skyscrapers in the desert, generate electricity, democratic institutions, toast, and prose. At the heart of everything we have ever done, and everything we will ever do, is our ability to transform our world and the objects within. Whether this be tangible or intangible, within our immediate or extended landscapes, or within our very own behaviours and mindset, our ability to transform things is exclusive to ourselves and our hominin ancestors. In this, technology (i.e. the material culture produced with specific knowledge and observed within a social environment) has long been integral to archaeologists wanting to understand various elements of hominin cultural and social behaviour within a spatio-temporal framework. This is the very core of what defines archaeology. In understanding technology and technological change, it is essential to determine, classify and understand technological variability; that is, to quantify differing technologies and knowledge, understand precisely the commonalities and differences in their use and form, and explain why technologies occur in conjunction or isolation of one another. This thesis focuses on a period which is characterised by an influx of technological variability from its onset: the European Middle Palaeolithic.

The period is generally agreed to begin with the earliest widespread evidence of Neanderthals and Neanderthal behaviours around c. 300,000 BP, and ending with the demise of the 'Classic Neanderthals' c. 41,000-39,000 BP (Higham et al., 2014). In material culture, the Middle Palaeolithic is commonly defined by the widespread adoption of Levallois-based flintknapping strategies in conjunction with other (prepared/unprepared) flake-based methods of lithic production (Böeda, 1984, 1986; Delagnes et al., 2007; Meignen et al., 2009). Despite issues and debates concerning the temporal parameters and archaeological proxies for defining the Middle Palaeolithic (Kuhn, 2013; Richter, 2011), these two notions (its periodisation and archaeological manifestation) have general consensus among most researchers (Richter, 2011). In recent decades, methodological frameworks grounded on chaîne opératoire methodologies (Geneste, 1985; Bar-Yosef and Van Peer, 2009; Soressi and Geneste, 2011) have shifted the technological character of the Middle Palaeolithic, challenging the traditional Middle Palaeolithic binary opposition of 'Levallois' and 'non-Levallois' methods of stone tool production. These frameworks, in conjunction with refined excavation strategies, re-evaluations of previously known material, and discoveries which highlight the use of a variety of non-lithic and non-utilitarian materialities (Peresani et al., 2011; Moncel et al., 2012; Morin and Laroulandie, 2012; Hardy et al., 2013) now demonstrate a picture of technological fluidity, plasticity and diversity within the European Middle Palaeolithic, one where the category of 'non-Levallois' artefacts is no longer suitable (see Table 1.1 for more information on the variety of core volume management strategies utilised by Neanderthals throughout the Middle Palaeolithic).

Strategy	Technological overview	Reference(s)
Levallois (recurrent)	Oriented towards the production of multiple flakes (non-/elongated) from a centripetally prepared core surface. Can be unidirectional, bidirectional or centripetal in nature (see Chapter 2).	Böeda (1988a, 1988b, 1995); Inizan et al. (1999); Scott (2011)
Levallois (preferential)	Oriented towards the production of a single major flake removal from a centripetally prepared core surface (see Chapter 2).	Böeda (1988a, 1988b, 1994); Inizan et al. (1999); Scott (2011)
Laminar	Method of producing stereotyped elongated products utilising the core's longitudinal circumference. Laminar strategies are initiated through the creation or utilisation of a longitudinal ridge, and are continued through various management systems. Can be unidirectional and/or bidirectional in nature (see Chapter 2).	Böeda (1995); Inizan et al. (1999); Delagnes (2000)
Discoid	Non-hierarchical recurrent method featuring two highly convex surfaces which are alternately flaked. Cores are often bipyramidal in morphology (see Chapter 3).	Böeda (1993, 1995); Peresani (2003); Brenet et al. (2013)
Quina	Non-hierarchical recurrent exploitation of two surfaces intersecting at a low angle. Synonymous with 'Quina retouch'. Two methods of Quina production: *débitage en tranche de saucisson*, and a second more complex unnamed variant (see Chapter 3).	Rolland (1981); Turq (1989, 1992); Bourguignon (1996, 1997); Mellars (1996)
Pucheuil-type	Recurrent unidirectional method with minimal preparation with each flake superposed from the previous flake (see Chapter 3).	Hahn (1989); Delagnes (1993); Lazuén and Delagnes (2014)
Bifacial	Working of material on both sides of the raw material to produce a large chopping tool (LCT). Of varying size, shape and material (see Chapter 3).	Inizan et al. (1999); Wragg Sykes (2009); Ruebens (2012)
Débitage des Tares	Unidirectional and centripetal in nature; similarities drawn with the African Kombewa (Marks, 1968) and Clactonian (McNabb, 2011). Thick cutting edges with extensive retouch. Four different types of product are manufactured (see Chapter 3).	Geneste and Plisson (1996)
Migrating platform	Cores which feature no fixed plane of intersection and no hierachically organised surface, with little control for the shape and form of flakes produced.	White and Pettitt (1995); White and Ashton (2003)

Table 1.1. Different technological strategies observed in the European Middle Palaeolithic

While there are now numerous publications which account for technological variability within the Middle Palaeolithic (see Chapter 4), these are typically top-down, generalised approaches, explaining broad patterns of many technologies with little primary analysis. Publications often fail to acknowledge or investigate the *chaîne opératoire* of the end-products produced, i.e.

the specifics of how artefacts are made, and changes in the *chaîne opératoire* of a core volume management system throughout the Middle Palaeolithic. Furthermore, methodologies fail to explain and account for the existence of differing strategies which produce artefacts which appear, at first glance, to be similar in nature. These can include, but are not limited to: Levallois centripetal and discoidal flakes, handaxe typologies, and blade production methods. Methodologies which focus on differences in the shape, form, and the function and desirability of these end-products, given their morphology, are lacking and underemphasised. Addressing these issues through the creation, function and shape-based hypotheses, in conjunction with the technological record, forms the crux of this thesis.

1.2. Addressing and Understanding Middle Palaeolithic Technological Variability

In addressing the issues noted above, a thorough understanding of how materialities vary and why materialities vary is essential to construct a method for testing reasons of variability. Investigations into Middle Palaeolithic technological variability have progressed from the binary cultural/stylistic vs. functional/site-specific debates of the mid-twentieth century (Bordes, 1947, 1950a, 1950b, 1953a, 1953b; Binford and Binford, 1966, 1969; Freeman, 1966), and onto challenging assumptions of artefact type, assemblage composition, and singularity. Initially, this was through the investigation and appreciation of models incorporating, for example, tool-making and tool-rejuvenation, stylistic drift, the role of immediate ecologies, and the diachronic relationship of assemblage composition (Mellars, 1965, 1969, 1986; Dibble, 1987, 1988; Rolland and Dibble, 1990; Dibble and Rolland, 1992; Rolland 1992). More recently, notions of variability continue to be categorised and defined with respect to the Bordian/Binfordian debate (e.g. Bourguignon et al., 2006; Delagnes and Meignen, 2006; Delagnes and Rendu, 2011), in addition to notions of chronology and social transmission (Guibert et al., 2008; Vieillevigne et al., 2008), and the provisioning of peoples and landscapes (Kuhn, 1995).

From these models, explanations of technological variability can be grouped into three categories: 1) social transmission (incorporating notions of style, e.g. Sackett 1982), 2) short- and long-term diachronic change, and 3) variability attributed to aspects of function (on an inter-/intra-context scale). In these, social transmission can include *symmetric vs. asymmetric transmission* (Boyd and Richerson, 1985), transmission method designated by levels of intentionality (Stade and Hoggard, submitted), and notions of technological acculturation, innovation, and convergence, i.e. where parallel technological and behavioural changes occur, whether through random, or through environmental constraints such as ecology or raw material. Short- and long-term diachronic change can include changes through time on an immediate context level, e.g. *differential reduction intensity* (Dibble, 1987, 1988; Dibble and Rolland, 1992; Dibble, 1995), and long-term chronologies over multiple contexts (Mellars, 1986; Guibert et al., 2008). Finally, there are functional interpretations, including all aspects of variability which relate to the notion of adaptation, such as climatic and ecological adaptation, environmental determinism, economisation and *technological provisioning* (Kuhn, 1995), equifinal behaviour (i.e. the use of various technologies for the same behaviour), and changes in the function of artefacts (e.g. *competence transfer*, Slimak, 2008). Also incorporated into aspects of function are notions of *curated vs. expedient* technologies (Binford, 1979) and the symbolic function of artefacts (e.g. concluding remarks in Eren et al., 2008 with respect to blade technology; see Figure 1.1 for a schematic overview of these different categories). It is essential to stress that these categories, and the three-fold schematic, serve as a framework for understanding variability, and are not mutually exclusive; for example, the notion of convergence can incorporate all three categories. As Rolland and Dibble (1990: 493) emphasise, "…the correct interpretation of assemblage variability must consider a wide range of possible causes that interact simultaneously" (for more information on aspects of categorising technological variability see Chapter 4). In attributing and identifying the degree of technological variability, archaeologists have used a wide variety of different methodologies and data types. These include methodologies focussing on raw material selection and distributions (Geneste, 1985; Moncel and Daujeard, 2012; Rolland, 1981), zooarchaeological evidence (Discamps et al., 2011; Moncel and Daujeard, 2012; Morin et al., 2014), radiometric data (Guibert et al., 2008; Mellars, 1969, 1986; Richter et al., 2013a, 2013b; Vieillevigne et al., 2008), technological analyses (Ruebens, 2012) and qualitative evaluations (Bourguignon et al., 2006; Meignen et al., 2009).

If Middle Palaeolithic technological variability, best known for the 'Mousterian debate' (see Chapter 4), has extensively rumbled on for over half a century, then why should this thesis be another to focus on such? In how the artefacts have been interpreted, studies lack research which focusses on shape, form (size *plus* shape), and the functional/physical characteristics of the technological sequence (and specifically their end-products). While two artefacts may appear similar, they may perform differently given their efficiency, effectiveness and robustness resulting from differences in shape and form. This may be because of differences in the product's edge angle, the overall blank morphology and shape (e.g. degree of standardisation), and the ramifications of producing these artefacts (e.g. the amount of usable cutting edge per weight of stone and the technological efficiency). For example, *artefact X* may be better placed for heavy butchery, whereas *Artefact Y* may be better for breaking into bone; this may hold true for two groups of artefacts which appear, at face value, morphologically similar. It is the author's belief that the 'performance attributes' (Skibo and Schiffer, 2001), the behavioural capabilities of an artefact to fulfil a given task, can explain: 1) why Neanderthals utilised certain technological strategies, 2) why certain strategies were favoured over others, 3) why certain strategies may have been used in isolation or in conjunction, and 4) why certain strategies decreased, or increased over time.

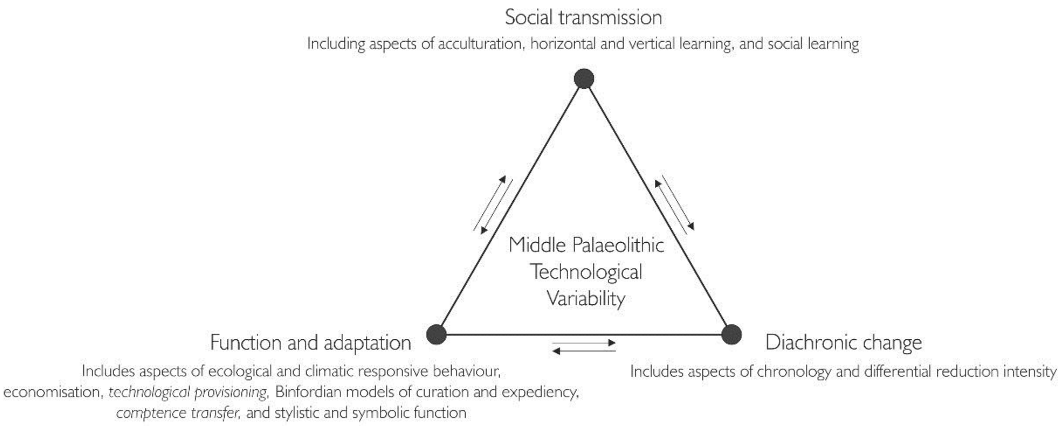


Figure 1.1. A schematic representation of Middle Palaeolithic technological variability highlighting the interchangeable role of the three concepts discussed within the thesis (for specific terminology refer to Chapter 4)

These function-centric methodologies are often based on differences in the artefact's form, (both two- and three-dimension), and commonalities and differences in form interpreted through archaeological and experimental data. In the 1950s, this data came in the form of Cartesian coordinates and linear distances between points of reference, dictated within a geometric framework (e.g. Roe, 1968; Bordes, 1961; Monnier, 2006a). With the advent of geometric morphometric methods in the 1980s and 1990s, methods of understanding the nature of shape variability within landmark and non-landmark based configurations were transformed under a unified geometric framework. This geometric morphometric framework which now incorporates techniques including Fourier-based (Elliptical Fourier and Fast Fourier), Eigenshape and allometric analyses, coupled with the use of powerful high-order statistical methodologies based on ordination and discriminant techniques (Principal

Components Analysis, Lineal Discriminant/Canonical Variates Analysis, etc.), provide an opportunity for lithicists to understand the nature of technological variability and aspects of function with a higher resolution than previously possible. Only in the last decade have geometric morphometric methodologies been adopted within the Palaeolithic record (e.g. Buchanan and Collard, 2010; Costa, 2010; Picin et al., 2014), with Picin et al. (2014) representing the sole application of geometric morphometrics within the analysis of multiple Middle Palaeolithic technological strategies. The concurrent application of both traditional and geometric frameworks can therefore provide a starting point into investigating artefact desirability, and the thorough testing of function-based hypotheses in conjunction with the Middle Palaeolithic technological record.

1.3. Introducing the Case Study: Laminar and Levallois Methods of Blade Production

One aspect of Middle Palaeolithic technological variability where geometric and traditional morphometric methodologies coupled with extensive technological analyses can be investigated is in methods of blade production, and what this thesis terms 'technological blade strategies'. These are formal methods of core volume management designed to produce stereotyped elongated material within a homothetic core configuration. These are documented throughout the European Early and Late Middle Palaeolithic, and can even be recorded towards the end of the European Lower Palaeolithic (Fontana et al., 2009), and in Africa as early as half a million years ago (Beaumont and Vogel, 2006; Johnson and McBrearty, 2010; Wilkins and Chazan, 2012). In their manufacture, technological blade strategies can generally be categorised into two distinct core volume management strategies: Levallois recurrent (unidirectional/bidirectional) and Laminar technological blade methods (see Chapter 2). These Middle Palaeolithic strategies have been documented over the last forty years (relatively young, given the history of Palaeolithic studies). From such comes a robust spatio-temporal framework, with many contexts featuring absolute dates throughout both the Early and Late Middle Palaeolithic. This framework (see Chapter 2), provides a case study to test whether an approach based on the morphological attributes of an artefact can provide a better understanding hominin technological and social behaviour, and the nature of these tools' use and manufacture from the beginning of the European Middle Palaeolithic onwards.

More generally, the analysis of these strategies provides a valuable contribution to a developing corpus of literature on Levallois and Laminar technological blade strategies. While there is now an abundance of literature documenting the nature of Levallois and Laminar blade strategies (Révillion and Tuffreau, 1994; Delagnes, 2000; Kozlowski, 2001; Koehler, 2009, 2011a, 2011b; Koehler et al., 2014; Wiśniewski, 2014) their existence and co-existence throughout both periods of the Middle Palaeolithic is poorly understood. Publications have often three ideas: 1) the nature and stratigraphic positioning of both types of blade strategy throughout the Middle Palaeolithic in its entirety (Révillion, 1993a, 1993b; Révillion and Tuffreau, 1994), 2) their existence with respect to the wider Middle Palaeolithic technological repertoire (Meignen et al., 2009; Delagnes and Rendu, 2011; Locht et al., 2010a), and 3) the relationship of Laminar industries within the Late Middle Palaeolithic (Depaepe, 2007; Koehler, 2011a; Koehler et al., 2014). Despite this, there are many issues with respect to both technological strategies. The true nature and representation of Laminar and Levallois technological blade strategies is unknown, with differences between each technique poorly understood. While the *Technocomplexe du Nord-Ouest* (Depaepe, 2007) has been conceptualised, its relationship with earlier blade strategies in the Early Middle Palaeolithic is unclear, and its assessment as a technocomplex requires scrutiny. Besides issues with the use of the term 'technocomplex' in comparison to its original definition (Clark, 1968), can sites such as Therdonne (Locht et al., 2010b) or Rocourt (Otte et al., 1990, Otte, 1994) be included into this category, given similarities in their blade technique despite their temporal and spatial dissimilarity? How large is the actual 'technocomplex', and how is it categorised? Is it the abundance of blade strategies which categorises a context as belonging to the technocomplex, or is it the specific Laminar strategy utilised? And how appropriate is the term 'technocomplex'?

Through a review of the relevant literature (Chapter 4), it is evident that there is a noted pattern and relationship between the two technological blade strategies, with Levallois-rich blade sites in the Early Middle Palaeolithic, Laminar-rich blade strategies in the Late Middle Palaeolithic, and a selection of sites which seem to suggest co-existence of both strategies throughout. While there have been attempts to question the nature of the contemporaneity between these strategies (see the 'Colluvial Deposition Hypothesis' in Chapter 4), the model cannot be tested, and the arguments remain unconvincing. Given the temporal range, and existence of deposits not typical of the hypothesis, an alternative explanation is needed. Why do we see this change throughout the Middle Palaeolithic? Why do we see the existence of both blade strategies in certain contexts, and the preference of a specific type of blade strategy in other sites? Can concurrency be explained through differing functions, or do they represent equifinal behaviour? While studies highlight the differences in 'sophistication' between the two technological blade strategies (Bourguignon et al., 2006; Delagnes and

Meignen, 2006; Delagnes et al., 2007; Meignen et al., 2009), these are with respect to the greater technological repertoire, and appear to contradict suggestions by Delagnes and Rendu (2011). Figure 1.2. exemplifies this problem of how the strategies are understood. Delagnes and Rendu (2011) homogenise between Levallois and Laminar end-products in terms of their versatility, whereas Bourguignon et al. (2006) and Meignen et al. (2009) note, to some degree, differences in their strategies. Perhaps the main issue is in the nature that these conclusions were created, through qualitative evaluations, with no description on their advantages and disadvantages. If qualitative assessments conclude that the two strategies are parallel in the products manufactured, then why do they exist together? In both examples, a rigorous, testable, and replicable quantitative method of analysis (utilising methods noted above) is essential to assess this relationship.

Technique	Core shaping and/or maintenance	Predetermination of desired end-products	Normalisation of desired end-products	Potential for resharpening	Ramification	Productivity
Levallois preferential	+++	+++	+++	+++	---	---
Levallois recurrent (uni-/bi-directional)	++	++	++	+--	++	++
Levallois recurrent (centripetal)	+	+--	+--	+--	+--	+++
Discoidal	+--	+--	+	+--	++	+++
Quina	---	+	+--	+++	+++	+++
Laminar	+	+	++	+--	---	++

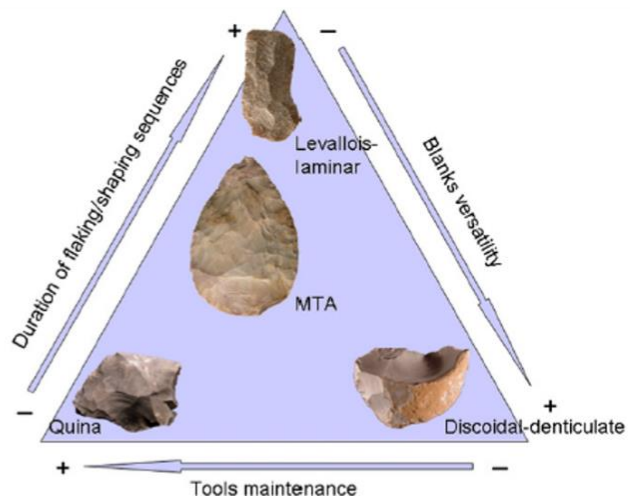


Figure 1.2. Aspects of Middle Palaeolithic technological systems discussed with reference to Laminar technology. Top: qualitative evaluation of various technological systems (Meignen et al. 2009). Bottom: qualitative evaluation of systems through a triadic categorisation as interpreted by Delagnes and Rendu (2011)

This case study also tests hypothesised advantages in Laminar blade technology which have been documented, including efficiency and standardisation (Bordaz, 1970; Clark, 1987; Eren et al., 2008) and provides a Middle Palaeolithic comparison. In every instance, the suggested advantages are based on Upper Palaeolithic soft-hammer and punch strategies of blade production, and not direct hard hammer percussion. To what extent can these be treated as a direct parallel for hard hammer technological blade strategies, given differences in the fracture mechanics of each technique? And to what extent does raw material choice influence the morphology of blades produced?

For any study on the applicability of a functional hypothesis or desirability within a lithic dataset, a methodology grounded in robust technological analyses must be utilised. While the November 1991 ERA37 and CRA/CNRS-led conference, and doctoral thesis by Révillion (1993b), represented the first attempts to synthesise and analyse Middle Palaeolithic blade technology, formal technological analyses played a minor role. To understand similarities and differences between the different technological blade strategies, *chaîne opératoire* frameworks are necessary. Localised inter-site analyses in MOIS 5 have already been undertaken with this approach (Locht et al., 2010a; Koehler, 2011b; Koehler et al., 2014); however, with the existence of Early Middle Palaeolithic Laminar sites (as highlighted in Koehler 2011b), technological analysis must be undertaken to be deemed credible for any analysis of long-term stasis or change, studies of shape and form of end-products, and for hypotheses based on function and the behavioural potential of artefacts.

One final aspect to consider is the nature of the dataset itself, and its role in understanding differences between the two blade strategies. It has been noted (Bordes, 1961; Révillion, 1993) that there are many problems in differentiating between Laminar and Levallois end-products, particularly where refit analyses are limited. Many of the criteria (see Chapter 4) used to identify Levallois and Laminar blades are not exclusive to a particular blade type, particularly given how similar the shape-based characteristics of each technique appear (identifying blade end-products in this thesis is based on *technology* and not *shape*). Experimental studies therefore provide a controlled dataset in order to examine the properties of each technology, such as the role raw material and size influence the physical properties of both technological blade strategies, and provide a method of assessing how well morphometric and technological criteria can be used when discriminating between Levallois and Laminar technological blade end-products. Ortega et al. (2013) represents the only experiment to look at both blade strategies and the physical properties of each technique. Sadly, this experiment only considered three aspects (elongation, flattening and curvature), and not aspects of edge angle, or usable edge (per weight of stone and on average, both important when considering the performance and economisation of each technique).

The above paragraphs highlight a significant gap in our knowledge of different Middle Palaeolithic blade production methods, and the potential of new analyses and methods. The adoption of a technological and morphometric analysis of both archaeological and experimental materials provides an opportunity to better understand the role of these strategies, the nature of blade variability, and notions of cultural transmission and continuity throughout the Middle Palaeolithic. A more extensive review on literature pertaining to technological variability, technological blade strategies, and the role of an experimental data is presented in Chapters 2, 4 and 5. Text box 1.1. also introduces the basic concepts applied throughout this thesis.

1.4. Research Questions Investigated Throughout the Thesis

The research questions under investigation in this thesis are as follows. Operating with the assumption that aspects of hominin technological and social behaviour can be reflected and understood through lithic artefacts and their analysis, and with the Null Hypotheses (H_0) being that contexts which feature either/both technological blade strategies are random and not linked within a spatio-temporal framework:

1. What are the differences or commonalities in the *chaîne opératoire*, use, and modification of Laminar and Levallois blade *débitage* are observed throughout the Early and Late Middle Palaeolithic of north-west Europe?

2. How do Levallois and Laminar technological blade end-products differ in terms of their artefact design, behavioural potential and desirability? What is the role of raw material variation in shape and in the nature of Levallois and Laminar technological blade end-products?

3. Can an explanation, grounded in hypotheses of function and artefact design, explain the use of Levallois and Laminar technological blade strategies in isolation and in conjunction, and the shift from Levallois-rich blade contexts in the Early Middle Palaeolithic to Laminar-rich contexts in the Late Middle Palaeolithic?

Question one and two, when considered with other literature on technological blade strategies, provide the framework for the third question, as these test the strength of statistical analyses undertaken throughout the morphometric and technological methodology. Thus, statistical significance can be tested against the archaeological data to infer archaeological significance. When synthesised, the overall question of this thesis can therefore be presented as:

To what extent do aspects of artefact design and the behavioural potential of artefacts provide a better understanding of Neanderthal technological variability, diachronic change, and social behaviour in the European Middle Palaeolithic?

Through addressing these questions, one further issue can begin to be addressed, which can help shed light on the nature of Neanderthal technological and social behaviour:

1. Does primary recording of each context's taphonomic history support or hinder arguments made by Locht et al. (2010a) and Antoine (2002) regarding the 'Colluvial Deposition Hypothesis'?

1.5. A Brief Chapter Outline

To present the various components of this research, the thesis is divided up as follows:

Chapter 2 (Talking Technology: An Introduction to Laminar and Levallois Technological Blade Strategies and Technological Blade Production): this chapter introduces Laminar and Levallois blade production, defining the notion of technological blade production, the different categorical frameworks for blade technology, and differences between the two techniques examined.

Chapter 3 (The Period in Question: An Overview of the Chronological, Palaeoenvironmental, Pedosedimentary and Archaeological Framework for the Middle Palaeolithic): this chapter provides a fundamental overview of the Middle Palaeolithic in terms of its chronology, its climate and environment, the pedosedimentary record, and the archaeological (lithic and non-lithic) evidence.

Chapter 4 (The Theoretical Framework: Contextualising Middle Palaeolithic Technological Blade Strategies and Technological Variability): this chapter documents the archaeological evidence for Laminar and Levallois technological blade strategies, and the theoretical framework underpinning the thesis.

Chapter 5 (The Methodological Framework for this Thesis): this chapter outlines the exact technological and morphometric methodologies used, in addition to information regarding the experimental and archaeological dataset used, and how these address the main research questions.

Chapter 6 (Understanding Technological Blade Production through an Experimental Approach): this chapter outlines analyses and findings from the experimental replication of Levallois and Laminar technological blade strategies.

Chapter 7 (Technological Blade Strategies in France: Selected Contexts): this chapter outlines technological analyses and findings from the analysis of Saint-Valery-sur-Somme (Moulin de la Veuve Rignon), Therdonne (N3), Fresnoy-au-Val (Série 1) and Bettencourt-Saint-Ouen (N2B).

Chapter 8 (Technological Blade Strategies in Belgium: Selected Contexts): this chapter outlines technological analyses and findings from the analysis of Rissori (IV/IIIB/IIIA), Mesvin (IV) and Rocourt.

Chapter 9 (Technological Blade Strategies in the UK: Selected Contexts): this chapter outlines technological analyses and findings from the analysis of various collections at Baker's Hole and Crayford.

Chapter 10 (Comparative Analyses of the Archaeological Evidence: A Consideration of Morphometric and Technological Variability): this chapter analyses all the sites investigated in conjunction, using the previously noted technological data, other technological data, and extended traditional and geometric methodologies. The experimental analyses and data from existing literature are also discussed here.

Chapter 11 (Discussion: Understanding Middle Palaeolithic Blade Strategies): This chapter discusses the analyses undertaken throughout the thesis, outlines the role of function in the transition of technological blade strategies, and notes the implications of the analysis for our understanding of Middle Palaeolithic technological variability and Neanderthal technological and social behaviour, through the questions above. This chapter also notes further research agendas for our understanding of technological blade production and Middle Palaeolithic technological variability.

Chapter 12 (Conclusion): This chapter concludes the thesis, outlining findings from the research.

An appendix, featuring analyses touched upon throughout the thesis but not discussed at length, is featured at the end of this thesis.

Middle Palaeolithic - A temporal sub-division of early prehistory starting around 300,000 BP, with the widespread use of prepared core technologies (with emphasis on Levalloisian technological strategies), and concluding with the demise of Neanderthals around c. 43,000-41,000 BP. Traditionally divided into two further divisions: the *Early Middle Palaeolithic* (c. 300,000-130,000 BP), and the *Late Middle Palaeolithic* (c. 130,000-41,000 BP). See Mellars and Stringer (1989) and Richter (2011) for more information on this sub-division.

Technological strategy - The accumulation of choices, actions and decisions undertaken by the hominin before and during flint-knapping; this is reflected in lithic the analysis of end products and through refit analyses.

Chaîne opératoire - A term to describe how material is transformed and manufactured. Derives from the work of French social anthropologists including André Leroi-Gourhan (Leroi-Gourhan, 1964, 1993), Robert Cresswell (Cresswell, 1983) and Pierre Lemonnier (Lemonnier, 1992). This was first applied by French prehistorians for lithic analysis (Geneste 1985; Boëda 1988a; Boëda et al., 1990) and, thus, is now synonymous with lithic reduction sequences. Sometimes known as *work-chain* (Cresswell 1990) or *operational sequences* (Dibble and Bar-Yosef, 1995). See Bar-Yosef and Van Peer (2009) for an extensive definition, and Soressi and Geneste (2011) for a history of its adoption.

Non-Levallois - A category typically adopted for all technological strategies which do not conform to the Levallois technique. Strategies not pertaining to a Levallois technique are defined as *Non-Levalloisian*, however the pertinence of such categorisation is now under question given the diversity and abundance of techniques (see Chapter 3).

Levallois - A technological strategy first documented in the mid-nineteenth century (Reboux, 1867; de Mortillet, 1883), characterised by distinct core hierarchy (flaking surface vs. striking platform surface), predetermination of overall shape and size of products, and removal of lithic material parallel to the plane of intersection. Typical diagnostic features can include a *chapeau de gendarme* preparation and the occurrence of *éclats débordants* (core-edge flakes). Strategies pertaining to the Levallois technique are defined as *Levalloisian*. See Bordes (1950, 1953b), Boëda (1986, 1988a, 1994, 1995), Bradley (1977), Perpère (1986), Van Peer (1991, 1992) and Schlanger (1996) for more information on the Levallois technique. See Chapter 2 for a more extensive discussion on the Levallois recurrent technique.

Laminar technology* - A non-Levallois technological strategy for producing elongated stereotyped products from a homothetic morphology (technological blade strategy). Blades are extracted from around the greater volume of the core's circumference, in contrast to a single flaking surface (Levallois). See Chapter 2 for a more extensive discussion and Figure 1.3.

Mousterian - A term first coined by de Mortillet (de Mortillet 1869a, 1869b, 1883) to define assemblages which are characterised by the presence of points and side-scrapers, the absence of end-scrapers, the unifacial treatment of tools and handaxes which were thinner than those in the Acheulean. The term is now commonplace for European flake-based assemblages within the Middle Palaeolithic.

Technocomplex - First defined by Clarke (1968: 323) as a "huge system of networking culture groups, cultures, assemblages and artefact types", typically c. 750-3000 miles in radius. Deemed a term with "interpretive baggage' (Gamble *et al.*, 2005), similarly to terms including "culture", "industry", and "assemblage". The concept of Archaeological Taxonomic Units (ATUs), and in this case ATU 2, is preferred by some researchers (Trinkaus, 1990; Gamble, 2001; Gamble et al., 2005).

Technocomplexe du Nord-Ouest - Translated from the French as the 'North-west Technocomplex', this term originates from Depaepe (2007) for a group of sites dating just after the onset of the Late Middle Palaeolithic. See Chapter 4 for more information.

North-west Europe - A geographic expanse, north of the Alps and the Pyrenees, covering western Germany, Netherlands, Belgium, Luxembourg, the United Kingdom and parts of France (Figure 1.4). These includes contexts along rivers stemming from the English Channel/*la Manche* including the northern stretch of the Loire, the Seine, Rhine and the Thames.

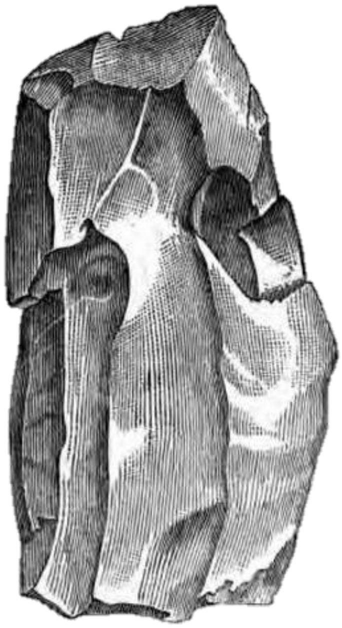


Figure 1.3. One of the earliest recorded Laminar cores,
from the Upper Palaeolithic site of Trou de Chaleux (Dupont 1873)

Text Box 1.1. Definitions of key terms used in this introduction and throughout the thesis

1.6. Importance of this Thesis

This thesis follows on from Révillion (1993b) and their subsequent work, in synthesising the quantity and nature of Levallois and Laminar technological strategies. Through the nature of the questions addressed and methods utilised, the thesis will be significant for a number of reasons. It will be unique in that it will address Middle Palaeolithic technological variability through both traditional and geometric morphometrics, and relating these to aspects of function. In terms of the material analysed, it will be unique in being the first account of blade strategies which are discussed often superficially in articles. In its literature review, it will be the most complete record of all technological blade strategies throughout the European Middle Palaeolithic, with extensive records of the evidence in Western Asia and Africa also noted. Furthermore, it will be the first thesis to thoroughly analyse the Levallois-Laminar blade relationship and the possible advantages and disadvantages of each technique. Furthermore, through the experimental and archaeological framework, it will test many of the assumptions made to explain the two different technological strategies (Bar-Yosef and Kuhn, 1999; Delagnes, 2000; Meignen, 2000), and test against experimental results by Ortega et al. (2013). This thesis will be unique in using traditional and geometric morphometric analyses to provide a framework to address fundamental differences in the shape and form of Levallois and Laminar blades. While a geometric morphometric method has been applied to Middle Palaeolithic material (i.e. Picin et al. 2014), it will be the first to investigate methods of blade production. Its originality also lies in addressing arguments of studies on Laminar material which have hitherto not been thoroughly discussed and tested e.g. the 'Colluvial Deposition Hypothesis' (Locht et al., 2010a; Antoine, 2002) through recorded primary analysis of the artefacts condition, imperative to any primary lithic analysis. Finally, this thesis will provide a methodology and framework which can be tested and applied to other regions where Levallois and Laminar blades co-exist, such as examples from the Levantine Mousterian and African Middle Stone Age (Chapter 4).

1.7. Boundaries of this Thesis

While this thesis aims to provide insight into the relationship between Laminar and Levallois technological choices that were made throughout the Middle Palaeolithic, limitations and boundaries of scope are needed nevertheless. This thesis will only consider data from the beginning of MOIS 8 (c. 300,000 BP) to the end of MOIS 5 (c.71,000 BP). Despite the occurrence of Laminar sites in MOIS 4, these are few in number and are primarily focussed in southern France (Moncel, 2005). The end of MOIS 5, therefore, represents a clear temporal boundary between the manufacturing and use of Laminar and Levallois industries in north-west Europe, and Laminar industries in the transitional Middle/Upper Palaeolithic at c. 50-

40,000 BP, e.g. LRJ (Flas, 2011), Pontinian (Kuhn, 1995) and Bohunician (Svoboda and Skrdla, 1995) technological strategies.

This thesis will focus on the data from north-west Europe; while there are a number of European sites outside of north-west Europe which contain Laminar technological strategies, (e.g. Cave dall'Olio and Abris du Maras), the scale and quantity of evidence differ considerably. These will be highlighted and discussed within the thesis, but will not be investigated through primary data analysis.

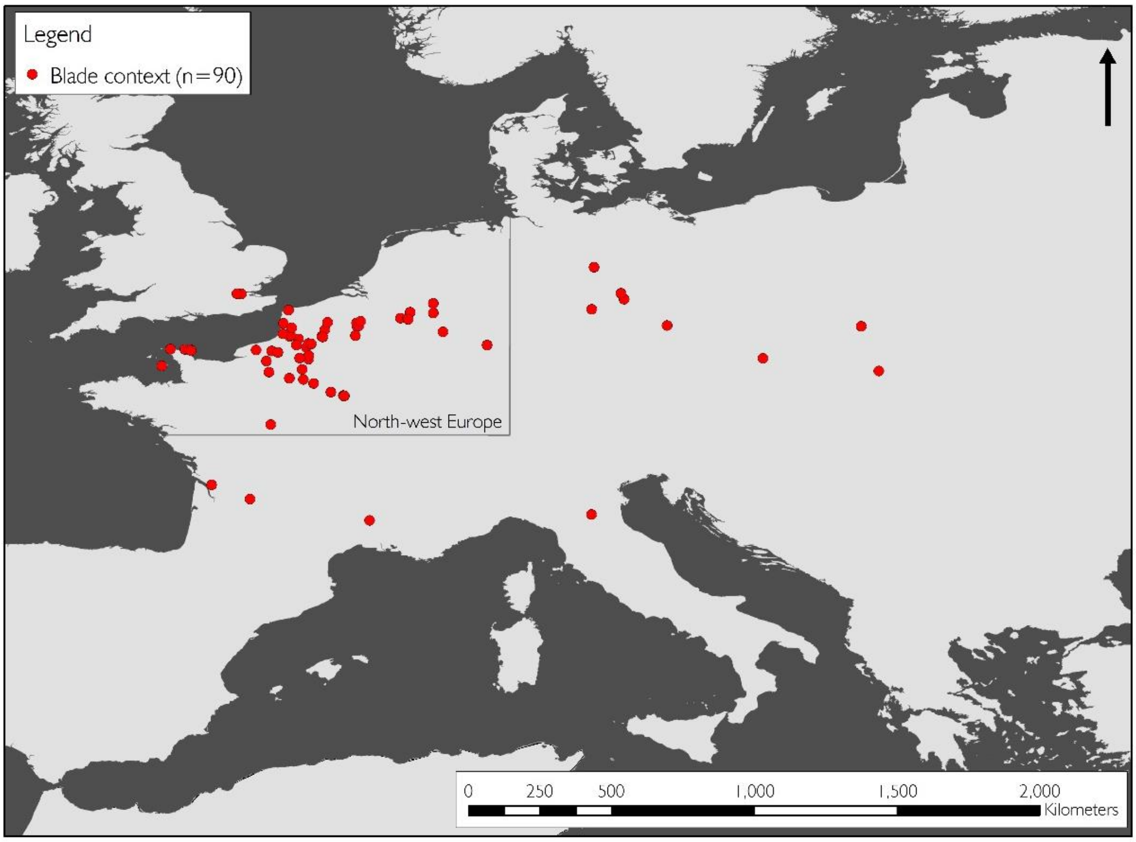


Figure 1.4. A map of Europe highlighting the definition of the area termed 'north-west Europe', with technological blade strategies before c. 71,000 BP (n=90) documented

1.7.1. Defining North-west Europe

For the purpose of this thesis, north-west Europe will be defined as the area incorporating northern France, western Germany, the United Kingdom and Ireland, the Netherlands, Belgium, regions of Scandinavia, Iceland and the Faroe Islands. This therefore includes archaeological contexts on the river Thames, Seine, Rhine and northern branch of the Loire (see Figure 1.4), agreeing with the definition used by Gamble (1999).

1.8. Summary

This thesis investigates European Middle Palaeolithic technological variability, specifically technological blade strategies, based on the physical properties of artefacts and the desirability of artefacts based on their design, through a traditional and geometric morphometric methodology. In conjunction with technological analyses, the thesis will investigate aspects of function and Neanderthal technological and social behaviour, specifically why both technological blade strategies are used independently and in conjunction with one another, and the transition from a Levallois-dominant Early Middle Palaeolithic to a Laminar-dominant Late Middle Palaeolithic. An experimental dataset will be utilised to provide a control for the morphometric analyses, and the role raw material has on blade variability (an important variable in cataloguing shape variability). Through this approach, the thesis will further substantiate the place of Laminar and Levallois technological strategies within the Middle Palaeolithic, highlight the existence and importance of Early Middle Palaeolithic blade industries, and be the first large-scale synthesis and analysis of both strategies. The methodology will also act as a template for further investigating differences in function, and the shape and form of lithic artefacts within the Palaeolithic.

Chapter Two
Talking Technology: An Introduction to Laminar and Levallois Technological Strategies and Technological Blade Production

2.1. Introduction

To construct working hypotheses of function, and their feasibility within a European Middle Palaeolithic context, a thorough appreciation of the two main methods of blade production and their wider technological significance is essential. Through a contextualisation of these two methods, the ideas and frameworks within this thesis can be placed within the wider literature on the Middle Palaeolithic, and a critical analysis of debates surrounding blade production can be undertaken and clearly communicated to the reader. A literature review in Chapter 4 will be a platform designed to guide, highlight and stress the importance of the research questions and the wider thesis content. However, this chapter focuses exclusively on the case study to examine the pertinence of artefact design and desirability within the Middle Palaeolithic, that of blade production and the two main categories of, what will be defined here as, *technological blade production* - Levallois recurrent (unidirectional/bidirectional) and Laminar blade production. The wider context, i.e. the conditions and materiality of the Middle Palaeolithic (i.e. the diversity of lithic strategies utilised) will be discussed in Chapter 3.

This chapter will discuss:

1. The fundamental elements of lithic production, including terms used within lithic analysis, and with respect to the production of artefacts. More detailed methodological definitions can be found in Chapter 5 (Methodology);
2. The different methods of blade production (technological/stereotyped vs. morphological/non-stereotyped);
3. The main methods for differentiating between the core, end-products and associated *débitage* for the two main technological blade strategies;

4. Neanderthal blade production, behavioural inferences, and their relationship to the research questions on hypotheses grounded on function, artefact design and desirability.

2.2. A Descriptive Framework: Fundamental Terms Used Throughout this Thesis

Classifying terms used throughout the rest of this chapter and beyond is essential for a clear understanding of the author's approach and theoretical/methodological perspective. As such, all terms relating to the fundamentals of stone tool production can be viewed in Text Box 2.1. Terms pertaining to blade production can be found in section 2.3. It is felt unnecessary given the nature of this specific thesis to discuss here definitions pertaining to the specifics of internal fracture mechanics and fracture initiations.

Core:	Raw material typically isotropic in structure, which features scarring resulting from the deliberate detachment and exploitation of one or a series of flakes. Characteristically cryptocrystalline silicates i.e. quartz crystal-basedsilicates (e.g. cherts and flints) are knapped, however non-silicate (e.g. basalts and limestones) and noncrystalline materials can be knapped (Shea, 2013).
Flake:	Lithic artefacts removed through force, controlled through conchoidal fracturing, and transmitted using a hammerstone which can then be used immediately or retouched for a given activity or scenario (McNabb, 2007).
Débitage:	From the French *débiter*, for 'to dispense'. In archaeology, there are two definitions: 1) The "fingerprints" (Crabtree, 1972: 43) of stone tool production which includes flakes and debris, which have been removed to shape/maintain stone tool cores, and 2) In a more active definition, *débitage* is the operational system of stone tool manufacturing and flaking, in conjunction with *façonnage* (Boëda *et al.,* 1990: 45; Baumler, 1995: 13; White and Ashton, 2003: 604).
Microdébitage:	Particles i.e. fragments or shatter, resulting from deliberate lithic reduction, smaller than 1-2mm in maximum dimensions (Fladmark, 1982; Brooke Milne, 2003). Subject to much debate on the specific measurements and classifications of *microdébitage* (Baumler and Downum, 1989; Fladmark, 1982; Vance, 1987).
Cortex:	The outer layer of raw material on the exterior face, resulting from chemical and mechanical weathering processes. Differs from patination (see Chapter 5).
Retouch:	The working of flakes through the removal of small fragments to thin, sharpen, refine/modify objects through percussion flaking (Inizan *et al.*, 1999).

Text Box 2.1. Fundamental terms throughout the thesis pertaining to lithic reduction

More detailed and substantial discussions of fracture mechanics can be found within the wider literature (Andrefsky Jr., 2005; Dibble and Rezek, 2009). Figure 2.1 demonstrates many of the terms noted below.

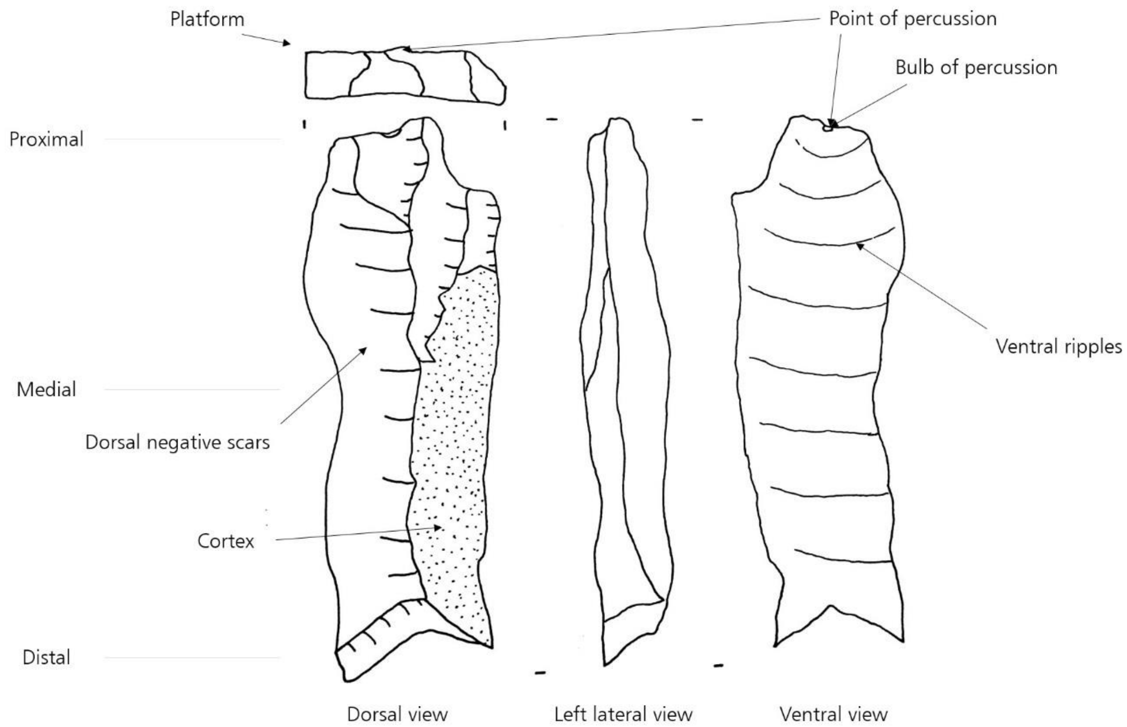


Figure 2.1. An overview of terms, drawing conventions, and orthogonal projections

In understanding the various stages of flintknapping, and the sequence of technological production (see Chapter 4 on the concept of *chaîne opératoire*), see Table 2.1 for a modified sequence of Geneste (1985). This incorporates the active decision to need/require a stone tool, and the recycling/reutilisation of artefacts. In this, 'production' refers to the concept and actions behind the reduction of a core, and how to produce artefacts in a certain way e.g. Laminar and Levallois blade production. See Frick and Herkert (2014) for an extensive discussion on production concepts.

2.3. Defining Blades and Blade Technology: An Overview

Central to this thesis are the historically value-laden terms of 'blade' and 'blade production'. This section dissects the idea of a 'blade', by outlining: 1) the fundamentals of blade technology and blade production (through technology and behaviour), 2) the history of the term 'blade', 3) the two main ways of categorising blade production (rooted in typology and technology) and finally, 4) how to distinguish between the two different types of technological blade production.

Stage no.	Stage and description
Stage 0:	*Conceptual stage* Decision to produce an artefact
Stage 1:	*Acquisition stage* Extraction and testing/acquisition of nodule
Stage 2:	*Production stage(s)* Decortification and initial shaping of core (if necessary) Preparation of striking platforms
Stage 3:	*Manufacturing stage(s)* Production of primary flake blanks (flakes, blades etc.)
Stage 4:	*Shaping/retouching stage(s)* Retouching of tools
Stage 5:	*Utilisation stage(s)* Use of retouched/unretouched pieces and resharpening/reworking of tools
Stage 6:	*Discard stage(s)* Breakage, terminal edge-wear/damage and discard
Stage 7:	*Recycling/discard stage(s)* Further retouch/modification (from a secondary context) or discard

Table 2.1. The principal stages of stone tool production (modified from Geneste 1985)

2.3.1. The Term 'Blade' within the Palaeolithic: A Brief History of Blade Technology

Since the first *in-situ* lithic artefacts were credibly documented to originate from a deeper prehistory within the Somme Valley contexts in 1859 (see Gamble and Moutsiou, 2011), stone tools have been scientifically accredited as products of early antiquity. Throughout this initial period of archaeological enquiry, through the later part of the nineteenth century major publications including John Evan's '*Ancient Stone Implements of Great Britain and Ireland*' (1872) and Gabriel de Mortillet's '*Promenades préhistoriques à l'Exposition universelle*' (1867), in addition to much smaller and less well-known publications including Edward Stevens' museum guide '*Flint Chips*' (1870) all acknowledged the existence of elongated material pertaining to a volumetric technique around the core's circumference, and the behaviour to produce elongated stereotyped artefacts (what this thesis terms Laminar blade production). Early refit analyses of more 'recent' and Palaeolithic material by Worthington G. Smith and Flaxman C.J. Spurrell (Figure 2.2) and early excavations including the Wookey Hole Cave complex by William Boyd Dawkins in 1859 (Dawkins, 1862, 1863), and his further work at Creswell Crags, Kent's Cavern and Cefn (Dawkins, 1880; Dawkins and Mello, 1879) further exemplified the use of the Laminar technique. In these excavations, and elsewhere in Britain, this material was categorised as 'flakes', 'knives' or 'long flakes', and not blades.

Perhaps the earliest use of the term 'blade', with specific reference to prehistoric material can be seen in French literature with the publication of Garnier (1862): *"…les couteaux, j'appelle ainsi des lames beaucoup plus longues que' larges, plus larges qu'épaisses…"* (Garnier, 1862: 34). Here the term '*lame*' (blade) is described in terms of its morphology, as elongated material with non-specific dimensions. Other examples, following Garnier (1862) appear to adopt the use of '*lame*': these include material at Grottes de la Vieune, la Grotte des Fées and Plateau de Pontlevoy, as documented by de Mortillet (1867), and later work by the Belgian geologist, palaeontologist and prehistorian Édouard-François Dupont (Dupont, 1873). While this and the term *éclats* (flakes) were used interchangeably throughout the later part of the nineteenth century, it is possible to suggest that the popularity of the term in central France led to its adoption in Britain and further afield.

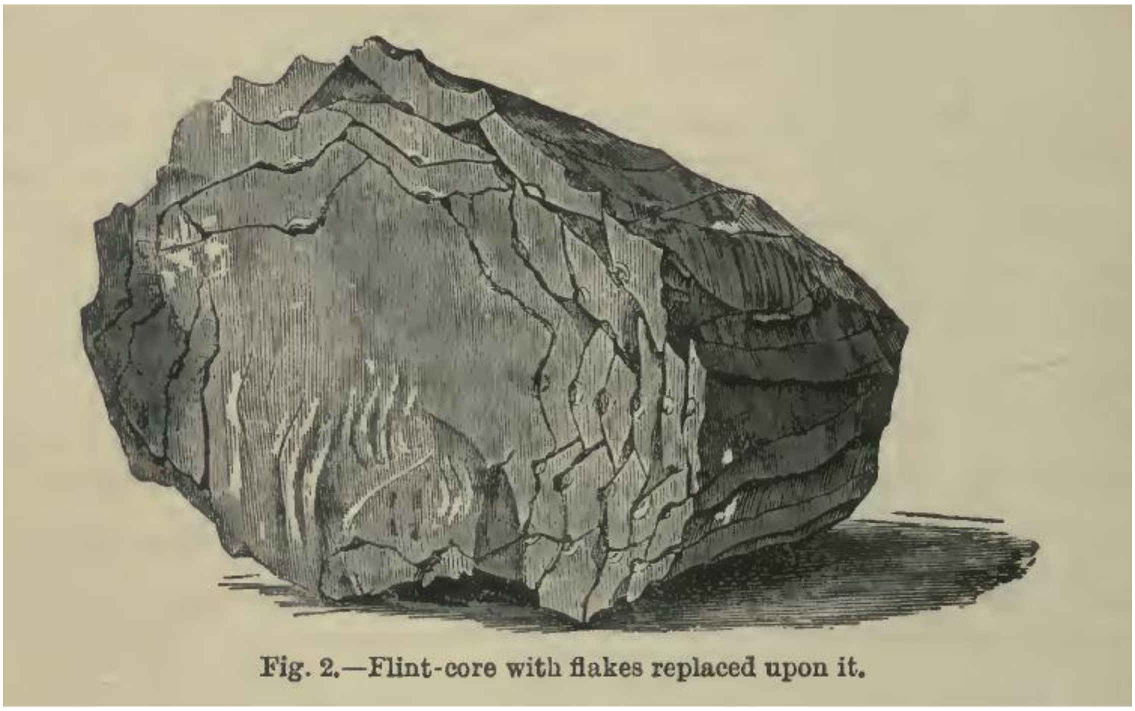


Figure 2.2. A figure from Evans (1897) exemplifying a refitted blade core (Laminar blade) undertaken by Worthington G. Smith and Flaxman C.J. Spurrell, thus demonstrating the knowledge of blade production before the twentieth century

Throughout this initial period, blades were viewed as an Upper Palaeolithic phenomenon associated with modern behaviour. This was for several reasons. Firstly, *in-situ* deposits throughout well-established stratified sites in Britain, France, and further afield showed (Laminar) blades and blade behaviour within Neolithic, Bronze Age, and later Palaeolithic contexts, typically above contexts featuring handaxes. This is, perhaps, best viewed through the deconstructed frameworks of the Upper Palaeolithic by de Mortillet (de Mortillet 1869a, 1869b, 1873, 1883) emphasising technological progression, and the increasing 'sophistication' of blade material, following bifacial technologies. Secondly, the idea of blade technology as a relatively recent idea was further supported through then-contemporary populations, particularly ethnographic catalogues and records of contemporary hunter-gatherer-fisher societies with blade technology, in addition to its known connection with post-Medieval gun-flint communities (Evans, 1897; Skertchly, 1879). Its documentation up until the 1950s, with the Brandon gun-flint company, for example, may have allowed prehistorians to relate more comfortably to blade technology rather than bifacial technologies. Thirdly, early excavations were not sufficiently refined enough to observe subtle, but important, differences between individual occupational layers and stone tool technologies. Those who did notice differences between individual layers and highlighted the existence of blade technology in the Middle Palaeolithic (such as Laminar *débitage*) were largely ignored, as they did not agree with the *status quo*. The most commonly cited example is the work of French archaeologist Victor Commont whose work at Montiéres (Boutmy-Muchembled), which highlighted the presence of the Laminar technique (in sandy and calcareous layers of the Low Terrace, now attributed to Marine Oxygen Isotope Stage (MOIS) 7, Commont, 1909a, 1909b; Tuffreau, 1983, 2009; Révillion and Tuffreau, 1994). This, too, could be suggestive of blade material, Levallois in nature, discovered in the brickearth layer of Stoneham's Pit, Crayford, where Spurrell and Raymond Chandler could not determine anything "characteristic of Le Moustier" (Chandler, 1916: 242). Finally, the abundance of blade technology in association with typical notions of 'modernity' (i.e. cave art, engraved bone and jewellery at many Upper Palaeolithic contexts), furthered hypotheses of blade technology as specifically a modern human behaviour, reinforcing the notion that 'blades equal brains'.

Throughout the beginning of the twentieth century, the association of blade technology and the Upper Palaeolithic persisted; however, following on from de Mortillet (1869, 1873, 1883) and de Mortillet and de Mortillet (1903), subsequent classifications of prehistory shifted in emphasis away from blade technology and toward categorising the Lower/Middle Palaeolithic transition and the presence of Levallois technologies within Middle Palaeolithic contexts (Table

2.2). The term 'Levallois' was adopted as early as the 1880s, and was first viewed as part of the Mousterian in de Mortillet's '*Musée préhistorique*' (1881), and a holotype for the Mousterian by Commont (Commont, 1908). In Commont's (1908) classification, two ideas were stressed for the Palaeolithic: firstly, that the presence of Levallois technology served as an index fossil for the Mousterian period, and secondly, handaxe manufacturing in pre-Mousterian contexts was structured on gradual progression from simple cortical handaxes to refined lanceolates (Commont, 1908). Commont also later argued that a similar, progression-based framework was appropriate for the Mousterian, with hominins producing large broad flakes, and gradually producing smaller, thinner flakes with a complex dorsal scar pattern (Commont, 1913). Despite an emphasis on classifications for early prehistory, sub-divisions of the Upper Palaeolithic were also reworked. This includes Henri Breuil's (1912) framework, which was characterised by the presence and definition of bone tools, types of retouch (e.g. Aurignacian retouch) and blade types (e.g. nosed and carinated end-scrapers). In these and subsequent classifications (Table 2.2), blade technology continued to be classified as Upper Palaeolithic in origin, and Middle Palaeolithic notions of blade technology were unknown. Laminar technology was incompatible with linear progressive classifications; material in earlier contexts were attributed to Upper Palaeolithic admixture, or disregarded.

In the last sixty years, substantial evidence for a series of credibly-dated, well-defined contexts featuring systematic blade production in Middle Palaeolithic contexts became apparent. The publication of Bosinski's (1966) report on blade production at Rheindahlen, Germany, and excavations at the French sites of Séclin by Alain Tuffreau (Tuffreau, 1978, 1983; Tuffreau et al. 1994), and Coquelles by August Lefèbvre in the 1960s and 1970s (Lefèbvre, 1969, 1976), among others (Tuffreau, 1976 Adam and Tuffreau, 1973), fuelled a reconsideration of existing frameworks with the inclusion of blade technologies in the Middle Palaeolithic. This, in conjunction with many discussions and debates on identifying and recognising blade technology (Nouel, 1949; Efmienko and Boriskovski, 1956; Bordes, 1961a; Leroi-Gourhan et al., 1966; Lamdan and Ronen, 1989; Révillion, 1993b), highlights the increased rigorous scholarship into the identification and nature of Laminar blade technology before the beginning of the twenty-first century. Additionally, further assessments of Levallois products and their diversity were considered by Eric Böeda (Böeda, 1988a, 1988b, 1994) among others (including the documentation of Levallois blades at Séclin) resulting in a fuller appreciation of Levallois methods of blade production in the Middle Palaeolithic.

Period	Classification	Notes and comments
19th Century	Lartet (1861)	Four-fold division: Cave-bear, Elephant, Reindeer and Auroch.
	Earliest recorded use of the term 'lame' (Garnier, 1862)	
	Lubbock (1865)	Stone age divided into Palaeolithic and Neolithic. Palaeolithic as "That of the Drift..." (Lubbock, 1865: 3), alluvium deposited by a river. Three main periods: Archaeolithic, Le Moustier Cave Period and Reindeer Period. One of the first uses of the term 'Palaeolithic'.
	de Mortillet (1869a, 1869b)	Palaeolithic divided into four epochs: La Madeleine, Aurignac, Solutré and Moustier. Distinguished by artefacts including bone points, bifacial points and handaxes.
	Dupont (1873)	Two distinct fauna-based ages: Mammoth and Reindeer Age.
	de Mortillet (1873)	Classification categorised into five industries (Robenhausian, Magdalenian, Solutrean, Mousterian and Acheulean) with fauna and climate stressed.
	de Mortillet (1883)	Palaeolithic categorised as flaked stone into the Mousterian, Cave Bear, Challean, Acheulean and Mammoth periods.
20th Century	de Mortillet and de Mortillet (1903)	System from the 'Tertiary' to 'Modern' periods; Quaternary period classified as a period of flaked stone under six 'epochs' (Tourassian, Magdalenian, Solutrean, Mousterian, Acheulean and Chellean)
	Commont (1908)	Highlights Levallois technology as a marker of the Mousterian; emphasises gradual progression in handaxe types
	Breuil (1912)	Subdivision of the Early Upper Palaeolithic into three stages (Lower, Middle and Upper Aurignacian) - categorisation based on tool-types and retouch type.
	Peyrony (1920)	Suggestion that the Mousterian was composed of two distinct contemporaneous facies: the "Classic Mousterian" and "Mousterian of Acheulean Tradition" (MAT), differentiated by handaxes and other lithics.
	Breuil (1932a;1932b)	Identification of two major industries within the Lower and Middle Palaeolithic: Ipswichian (small flakes with irregular retouch) and Clactonian. These gave rise to the Levalloisian and Tayacian, which became the Mousterian, and the Micoquian. Levallois series of seven individual industries.
	Bordes (1950a) and further works	Rejection of linear cultural evolution; branched evolution on basis of biface presence, Levallois technology percentage, facetting, and the Levallois typological index.
	Clark (1969)	Classification on the modes of production. Five modes (1-5) based on the presence of tool technologies. Notion of progress and order.

Table 2.2. Classifications of the Palaeolithic from the middle of the 19th century to the end of the 1960s

2.3.2. Technological and Morphological Methods of Blade Production

This thesis categorises blades into two distinct groups, based on their technological characteristics and the intended behaviours. Morphological (non-stereotyped) methods of blade production are not centred on the production of multiple products similar in form. Technological (stereotyped) methods of blade production are where the overall *chaîne opératoire* is focussed on the production of multiple elongated products through a homothetic morphology. This thesis focuses on technological blade production, given the extensive nature of the archaeological evidence for these systems within the Middle Palaeolithic.

2.3.2.1. Morphological (Non-Stereotyped) Methods of Blade Production

The identification and assignment of material as blades based on solely their degree of elongation (laminarity) was the predominant method among archaeologists recording blade technology. While Garnier (1862), in his use of the term blade, used laminarity as a method for the identification of blades, a ratio or elongation index (an index of length divided by width) was not specified. One of the first to use a specific elongation index was Nouel (1949: 138), who noted: "*J'appelle lame, une pièce qui attaint ou* d*épasse en longueur le double de sa largeur, les autres sont des éclats"* (Nouel, 1949: 132). Here the commonly-adopted elongation index of 2:1 is noted. Other indices exist including 3:1 (Alexander and Ozanne, 1960), and even 5:2 (Smith, 1965; Wainwright, 1968). In more detail, Leroi-Gourhan et al. (1966) notes that an elongation index of 3-3.99 can be classed as '*Laminaire'* ('blady'), and anything greater, as a blade. See Table 2.3 for a synthesis of definitions noting the identification of blades based on their elongation.

The use and adoption of classifying blades solely on morphometric attributes is problematic for various reasons. Firstly, it does not discriminate between products of core volume management strategies designed to produce elongation material, and strategies which fortuitously produce long and narrow flakes, e.g. tranchet flakes. However, some studies do highlight differentiation between elongated flakes, or 'flake-blades', and blades pertaining to a technological blade strategy (e.g. Singer and Wymer, 1982; Thackeray, 1992). Furthermore, it is often neglected whether products featuring an elongation index originate from the axial length (measured against the axis of percussion) or from its greatest length.

Reference(s)	Blade definition
Garnier (1862: 34)	"…*les couteaux, j'appelle ainsi des lames beaucoup plus longues que' larges, plus larges qu'épaisses…*"
Nouel (1949: 138)	"*J'appelle lame, une pièce qui atteint ou dépasse en longueur le double de sa largeur, les autres sont des éclats*"
Alexander and Ozanne (1960: 287)	"three of more times as long as they were broad"
Smith (1965) and Wainwright (1968)	5:2 (Smith, 1965: 137; Wainwright, 1968: 111)
Brézillion (1968: 257)	"*Produit de débitage de forme allongée*"
Bradley (1970)	2:1 (Bradley, 1970: 346)
Leroi-Gourhan et al. (1966)	Elongation indices: 'Long': 2-2.99; 'Laminaire': 3-3.99 ; 'Lame': above 4 (Leroi-Gourhan et al., 1966: 251)
Tixier et al. (1984 : 13)	"*Éclats longs et étroits*"

Table 2.3. Elongation criteria used to define blade products

2.3.2.2. Technological (Stereotyped) Methods of Blade Production

The preferred framework in this thesis is here termed 'technological blade strategies': strategies which demonstrate the production of stereotyped elongated products within a homothetic configuration. These strategies produce fairly standardised (stereotyped) products in shape and form, can feature a high elongation index (often higher than the cited 2:1, and sometimes lower), corresponding to their axial length, and feature a high degree of parallelism, originating from Levallois recurrent (unidirectional/bidirectional) and Laminar technological blade systems, and variants of these strategies. This more robust definition places the intention to produce multiple elongated products as a priority, with individual blades perhaps not exemplifying the use of this technique.

From the early part of the twentieth century, technologists have attempted to construct working methodologies in describing and differentiating between blade and flake-based strategies. Barnes and Cheynier (1935) were possibly the earliest to create methods of discrimination based on attributes including butt-size, 'tangent-distance', platform angle ('*angle de chasse*') and core dimensions. While this focused on soft-hammer/punch-based blade strategies of the Laminar technique, it was a significant contribution for quantifying, in terms of both shape and form and technology, lithic variability. This set a precedence for identifying lithics through a more technological perspective. Following Barnes and Cheynier (1935), Sonneville-Bordes (1960) and Bordes (1961a) were the first to acknowledge the axis of percussion in their definition of blade products. However, this was the furthest that (they believed) they could go towards providing a stricter definition in differentiating between elongated products produced fortuitously, and technological blades. Following this, researchers noted several other characteristics associated with blade production, including: 1) uniform parallel lateral edges, 2) lineal dorsal scars, 3) a triangular/trapezoidal cross-section and 4) the presence of one or several arrises running parallel to their longest axis (Murty, 1968; Bar-Yosef and Kuhn, 1999; Inizan et al., 1999).

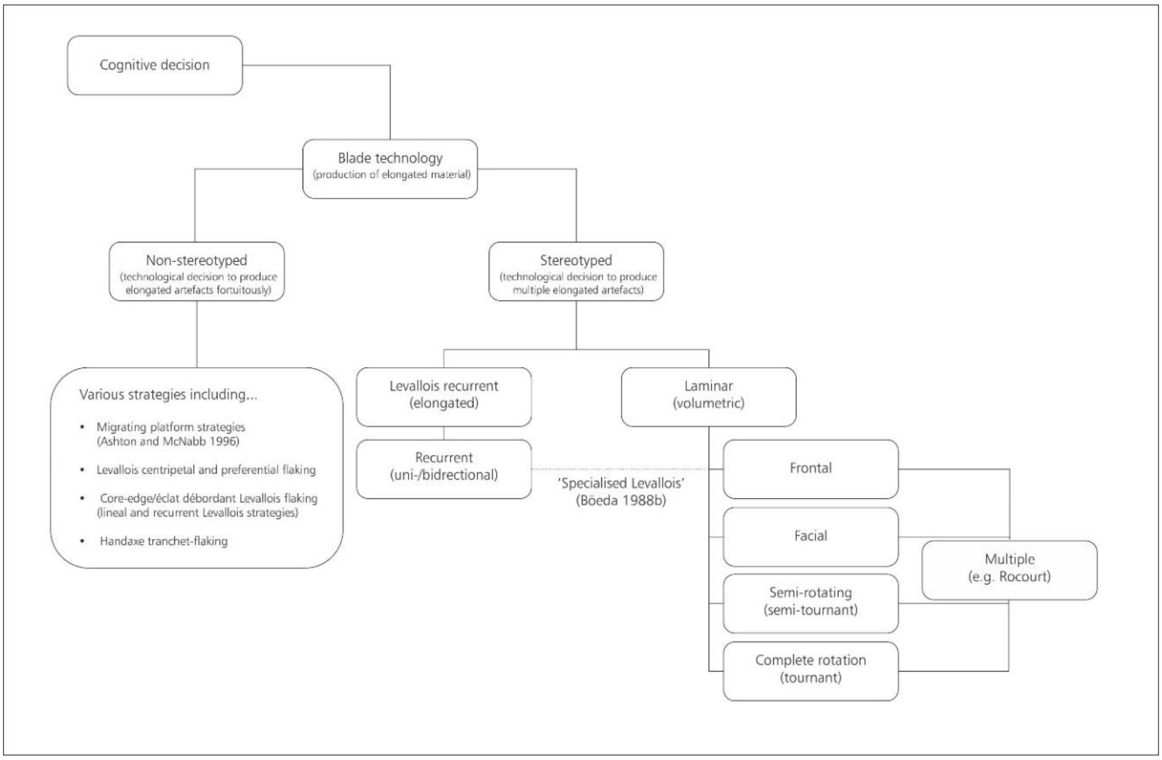


Figure 2.3. A schematic representation of non-stereotyped (morphological) and stereotyped (technological) blade production methods

These characteristics, while helpful for identifying technological blades, are not universal and present on all examples. While a central ridge may be present on most examples, this may differ given the exact point where the flintknapper strikes the blow on the core platform (whether this is exactly on the ridge, or between ridges), and/or the shape of the platform and positioning of Levallois scars. And while Bar-Yosef and Kuhn (1999: 323) stress a "technical definition", which includes a triangular or trapezoidal cross-section, this neglects the variability of blade production systems; Levallois recurrent blades can be plano-convex in shape, through faceting and peeling from a gently convex surface (Inizan et al., 1999). Furthermore, Laminar blades can also be polyhedral in cross-section, depending on the amount of removals prior to the exploited blade, and again, the exact point where the flintknapper strikes the blow on the core platform (as exemplified in Barnes and Cheynier, 1935).

Observations of core morphology are more credible indicators to produce stereotyped blades; these can be highlighted through stereotyped rectilinear, parallel, and elongated scars which conform to the set criteria for the two types of blade production (see sections 2.3.2.2.1 and 2.3.2.2.2).

In this thesis, a variety of criteria will be used for the identification of technological blade production, with a confidence level noted for each context. These criteria are as follows:

- The blade, when unbroken, will be elongated in nature, with an elongation index of at least 1.75 or higher (this is discussed and justified in more detail in Chapter 5);
- The lateral edges will feature a certain degree of parallelism;
- The blank will, typically, feature a longitudinal ridge or arrise (lineal edge formed by the meeting of previous scars), or multiple ridges/arrises on its dorsal surface (unless cortical);
- The blades within a certain context will feature evidence of stereotyping through refit analyses, or morphological standardisation;
- The core will feature continuous exploitation on one or more platforms;
- Products including crested blades or rejuvenation flakes (core tablets) may also be present.

Technological blade production also encompasses methods associated with bladelet technology, as the technological behaviours of bladelet production mirror that of Laminar blade technology (see section 2.3.2.2.1). For the identification of bladelets, a maximum of 15mm in length has been suggested as necessary (Tixier, 1963; Owen, 1988), however this arbitrary division does not take into consideration either the nature of the raw material utilised, or the overall composition of the blade assemblage. In the identification of bladelets, quantitative metric analysis on both an inter-/intra-context scale should be employed, as argued by Inizan et al. (1999), to observe and differentiate technical choices between prehistoric groups (in this case the deliberate production to produce small blades).

In their production, technological blades are produced through various types of percussion, whether direct or indirect. This is unsurprising, given the long period with which blade production is now documented (Chapter 4). For the period under examination, direct hard hammer percussion is the only documented method for extracting blades. However, given the recovery of soft-hammers at sites including the Late Middle Palaeolithic sites in the Vanne

Valley (Deloze et al., 1994), and their known use within handaxe assemblages (Inizan et al., 1999, Emery, 2010), the use of soft-hammers cannot be ruled out.

With respect to different methods of producing stereotyped blades, two different schemes are recognised, differentiated by their core volume management: Laminar (sometimes termed 'prismatic' or 'volumetric') and Levallois recurrent unidirectional/bidirectional technological blade strategies. While different types of blade production, including 'direct' (e.g. Révillion, 1995), 'Kostienki' (Kozlowski, 1984; Klaric, 2000), 'Rocourt' (Otte et al., 1990), 'Hummalian' (Böeda, 1995), and 'Taramsa' (Van Peer, 2004; Van Peer et al., 2010) strategies have been discussed as distinct methods, they can all be categorised within the wider Laminar and Levallois framework. They can all be perceived as a set of a procedural templates, purposeful in nature, resulting from specific theoretical algorithms or motoroic stereotypes (Gowlett, 1982; Riede, 2006), though in their manifestation and production, all different strategies can be classed into the two core volume management options.

2.3.2.2.1. Laminar Technological Blade Production

Laminar technological blade strategies are a distinct set of technological behaviours designed to produce stereotyped elongated blanks through volumetric exploitation of anthropogenic or natural ridges on the lateral faces of the core's perimeter. The term 'Laminar' has been used for many decades, in one way or another, as a set of methods for producing elongated material, from its earliest instances as a morphological criterion (Leroi-Gourhan et al., 1966) to its increased use from the last decade of the twentieth century onwards. Publications include specifically the work of Stéphane Révillion (Révillion, 1993a, 1993b, 1995; Révillion and Tuffreau, 1994). In some instances, the term 'Laminar' included Levallois technological blade strategies, for example Conard (1990) and in certain chapters of Révillion and Tuffreau (1994). However, in the beginning of the twenty-first century with the work of Liliane Meignen and Anne Delagnes (Meignen, 2000; Delagnes, 2000; Delagnes and Meignen, 2006; Meignen, 2007; Meignen et al., 2009), studies built on from Stéphane Révillion discussing Laminar strategies as a distinct core volume management strategy.

In the initiation of Laminar blade production, modification to some degree (in the form of decortification) is essential, as the technique is rarely achieved using a piece of raw material in its natural condition. The raw material is worked until a striking platform and ridge can be identified within the material's morphology. The platform can be flat and unmodified, or prepared through flaking and abrasion. For a successful detachment, a flat or relatively concave striking platform is ideal but not always necessarily (Bar-Yosef and Kuhn, 1999). The shape and nature of transforming the raw material throughout the production of blades allows for the use of two platforms resulting in two possible detachment techniques: unipolar/unidirectional (i.e. from one pole/direction) or bipolar/bidirectional (i.e. from two poles/directions).

Central to Laminar blade production, in addition to the noted volumetric concept, is an understanding of ridges (natural and anthropogenic) on the chosen raw material, and their subsequent exploitation. The creation of a vertical ridge down the edge of the core (by a series of unifacial or alternating/bifacial removals) are the most common method of initiating Laminar blade production in later periods of the Palaeolithic. Once a ridge is present, it is then exploited and knapped from the striking platform. This initial Laminar removal, termed the *lame â crête* or crested blade, sometimes may also be known as the 'ridge blade' or '*lames débordants*' (Inizan et al., 1999). Variants of the crested blade differ depending on the number of faces knapped (*lame â crête à deux versants* vs. *lame â crête à versant unique*) and the degree of working on the ridge (*lame â crête* vs. *lame â crête partielle*) (Barnes and Cheynier, 1936; Tixier et al., 1980; Révillion, 1993b). Once struck, the removal leaves two further ridges vertically down the core, which are then continuously exploited along part or all of the core's perimeter. This continues the sequence of *débitage*, highlighting the volumetric aspect of this reduction strategy. Its continuous nature, hypothetically until core exhaustion, highlights its homothetic structure: a structure where the size of the core may change, but its technological and morphological aspects remain largely unchanged, unlike other flake-based strategies which are non-homothetic in nature (Boëda, 2013). Throughout the process of blade production, the flintknapper can decide whether to exploit the ridge directly and position the point of percussion above the ridge, or indirectly between ridges. Because of this, the position of ridges on the dorsal surface of Laminar blades can vary. Crested blades can also be initiated partway through the *chàine opératoire* as a rejuvenation technique (see more below about rejuvenation), resulting in evidence for Laminar blade cores featuring two or more crested blades i.e. *lame seconde* (*troisième, quatrième…*) *de crête* (Révillion, 1993b). In a few examples, the technological signatures of crested blades have been viewed in association with Levallois technology in the Near East (southern Levant), Central and Eastern Europe, southern Moravia, and western Ukraine as noted by Demidenko and Usik (1993: 15). Furthermore, the creation of tranchet flakes through bifacial reduction produces a blank which may resemble a crested blade. While Levallois *éclat débordants* and tranchet flakes at this present moment cannot be differentiated, crested blades must be examined and accounted for on a context-by-context basis. On their own, with no evidence for Laminar cores, it is difficult to assert that these are proof for the existence of blade-based behaviour, and, more specifically, Laminar blade technology.

In the initial stages of core reduction (i.e. crested blades and first-order cortical blades), cross-sections of Laminar *débitage* are typically triangular, and become increasing trapezoidal, polyhedral and irregular further on the *débitage* process. However, as stressed above, this is not always the case. The shape and degree of distal curvature of the flake may also differ, and in conjunction with the exploitation technique (unidirectional vs. bidirectional), will result in varying core shapes (orthogonal, semi-orthogonal, pyramidal etc.). In this thesis, shape variation will be documented through a geometric morphometric framework of dorsal planform shape for blade products, and a series of categorical and quantitative methodologies for cores (see Chapter 5).

Throughout the archaeological literature, it is evident that there are various methods of categorising the different ways a Laminar blade core can be exploited, with many variations within the general core volume management strategy. While there are different methods of reducing the raw material, the volume management strategy does not change. Central to this strategy is the removal of elongated products around the circumference of the core. Some categorisations base their divisions on three-dimensional shape, e.g. pyramidal vs. orthogonal (Inizan et al., 1999), while others stress the method of reduction (Révillion, 1995; Delagnes, 2000). This thesis uses five different categories modified from Delagnes (2000), based on the position and sequence with which blades are exploited around the core:

1. Frontal *débitage*: Technological blades are struck on the narrowest face of the core, with the edge of the core volume typically serving as a guiding arise for the removal of the first blade (Delagnes, 2000);

2. Facial *débitage*: Technological blades are struck on a flat or slightly convex surface, typically the broadest face of the core (Delagnes, 2000);

3. Semi-turning/semi-rotational (*semi-tournant*) *débitage*: First coined by Pigeot (1987). Technological blades are struck volumetrically around less than half of the core's transversal section; this is typically one face, as a continuation of facial *débitage,* giving the core a semi-prismatic/semi-orthogonal appearance (Delagnes, 2000);

4. Full-turning (*tournant*) *débitage*: First coined by Pigeot (1987). Technological blades are struck volumetrically around more than 50% of the core's transversal section, giving the core a prismatic/orthogonal appearance (Delagnes, 2000);

5. Multiple *débitage*: Technological blades are struck from two of the above strategies e.g. the use or transition from a frontal reduction strategy to a semi-turning technique (Rocourt technique).

Schematic representations are provided in Figure 2.4.

In this technological framework, Kostienki, Rocourt and Hummalian examples of blade production can be catalogued within these five *débitage* systems. Rocourt *débitage,* named after the site of Rocourt in Belgium (Otte et al., 1990, Otte, 1994) can be defined as a system of blade production initiating from one of the core's narrow edges, i.e. frontal, and subsequently shifting to its widest surface around the core, i.e. multiple (facial/semi-rotational). Kostienki blade production, coined after the site of Kostienki in Russia, is a Gravettian-based form of blade technology known to produce backed bladelets through extensive platform preparation on a narrow ridge of the core and the use of *outrepassé* (overhanging) exploitation (Kozlowski, 1984; Klaric, 2000). For the Middle Palaeolithic, this technique can be witnessed in the MOIS 5d site of Verriéres-le-Buisson (Gouédo, 1999; Koehler, 2011b) and can be classified as a frontal/semi-rotating (multiple) method of Laminar blade production.

Hummalian blade production is perhaps best synthesised by Böeda (1995) in his evaluation of volumetric conceptions. Böeda (1995) states that Hummalian type of volume construction is characterised by two or three flaking surfaces which intersect in pairs to create a convexity which allows the regularity of blade production, as well as a corresponding striking platform surface for each flaking surface (these are never on the same plane and thus several distinct hinges are created), and similarly to other contemporary technologies, are produced with hard-hammer direct percussion, typically about 5mm from the hinge (Böeda, 1995: 63). This example is much rarer in Europe, with Riencourt-lés-Bapaume representing the only known example (Tuffreau et al., 1991; Tuffreau, 1993; Ameloot-Van der Heijden, 1993, 1994). This technique features the exploitation of elongated material around the circumference of the core, distinguishing it from Levallois strategies. Despite the use of three flaking surfaces, is an elaborate frontal system of core volume management.

It is perhaps also worth noting what some publications refer to as 'direct' Laminar blade production. 'Direct' blade production, also known as "*laminaire direct sans preparation ni mise en forme du nucleus*" (Révillion and Tuffreau, 1994: 16), includes contexts such as Coquelles (Lefèbvre, 1961, 1969, 1976), Saint-Valéry-sur-Somme (de Heinzelin and Haesaerts, 1983), and the now reclassified material of Stoneham's Pit, Crayford (Cook, 1986; Scott, 2011). In these examples the lack of core preparation is what distinguishes these sites from "*laminaire de 'style' paléolithique supérieur*" (Révillion and Tuffreau, 1994). However, with many of these contexts missing much of the original core nodule, and the apparent complete exploitation of material at sites including Saint-Valéry-sur-Somme, is such a dichotomy robust enough? As these also fit the five-fold division of core volume management strategies, all contexts above are noted as 'Laminar' throughout this thesis.

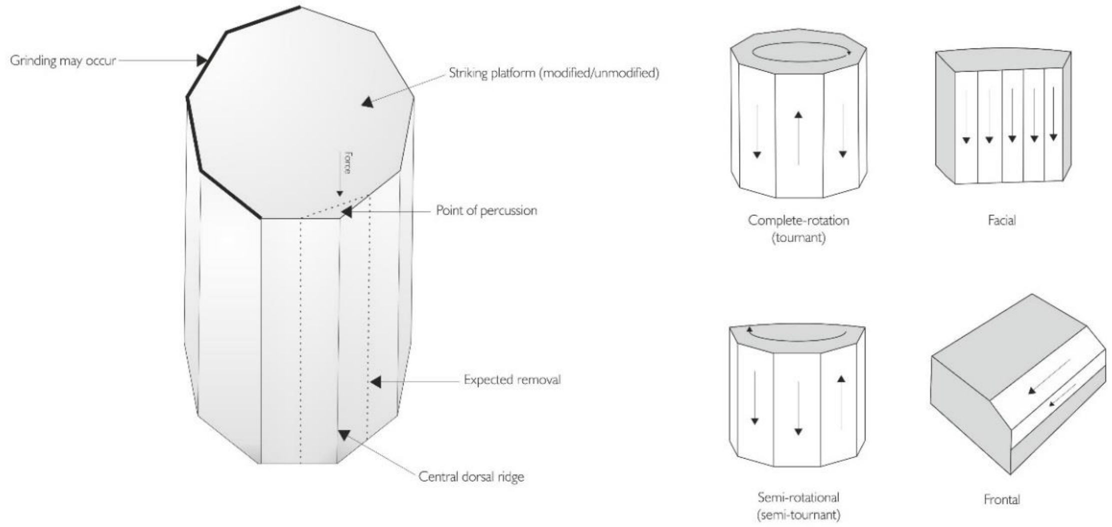


Figure 2.4. Characteristics of Laminar technological blade production (left) and the four unique Laminar core volume management systems (right)

With respect to core maintenance, it is important that the transversal and longitudinal convexities (*cintrage* and *carénage*) are maintained through platform working to ensure continuation of the production sequence (Inizan et al., 1999). If the shape of the core does not permit the removal of Laminar *débitage* during the reduction process, then other actions can be undertaken. These include the production of a second crested blade, or rejuvenation pieces/chunks and core tablets around the surface of the core. These allow the desired angles necessary for Laminar production to be present, and has been argued to explain why two opposed platforms (resulting from a bidirectional technique) are adopted, as the convexities are easier to maintain (Inizan et al., 1999).

Through an examination of literature and analyses of Laminar technological systems, the different core volume management techniques, and their associated behaviours, it is has been noted that Laminar technology in the Lower and Middle Palaeolithic is almost parallel to those within the Upper Palaeolithic. It has also been noted that the main differences between strategies before and during the Upper Palaeolithic are end-product regularity and overall core productivity, partially because of hard-hammer percussion (Meignen, 2000). Böeda (1988b) remarks that, while Middle Palaeolithic systems of Laminar blade production are not as refined as the Upper Palaeolithic, the volumetric concept of blade production unifies Middle/Upper Palaeolithic blade techniques (Böeda, 1988b: 45). This is elaborated on in Chapter 4. For a formal description and overview of Laminar blade technology, see Table 2.4. For archaeological examples of Laminar technology, see Figure 2.5.

Phase	Action	Description
0	Perception	Perception of problem i.e. need for elongated stereotyped material through a technological approach;
-	Acquisition	Acquisition of raw material: Varying morphology; Varying homogeneity Local (0-5km) vs. Distant (5-15km) vs. exotic (>15km)
1	Initial preparation	Creation of one of more striking platforms;
-	-	Additional flaking for platform convexities;
-	-	Preparation of one or more ridges along the longitudinal axis of the core; through unifacial (*one versant*) or bifacial (*deux versants*) flaking; exploitation or natural ridge if the core morphology is appropriate;
2	Production	Exploitation of crested blade/natural ridge
-	-	Phase of *plein débitage* (i.e. the main blank production phase) through the various core volume management strategies e.g. facial or multiple (frontal to semi-rotating);
2/3	Maintenance	Ensuring an adequate core morphology (*convexities cintrage et carénage*);
-	-	Maintenance of the parallel ridges on the raw material through lateral flaking and shaping;
-	-	Maintenance of the striking platform angle and extremities through grinding and overhang abrasion (*abrasion corniche*);
-	-	Rejuvenation of the blade core through the production of core tablets and rejuvenation flakes;
-	-	The creation of a second (or third in Hummalian examples) polarised striking platform, unless undertaken earlier;
-	-	Production of new crested blades for further exploitation
4	Use	Use of an unretouched blade;
-	-	Further retouching for desired use;
5	Discard/Recycling	Discard and possible recycling

Table 2.4. A formal extended description for the production of Laminar technological blades

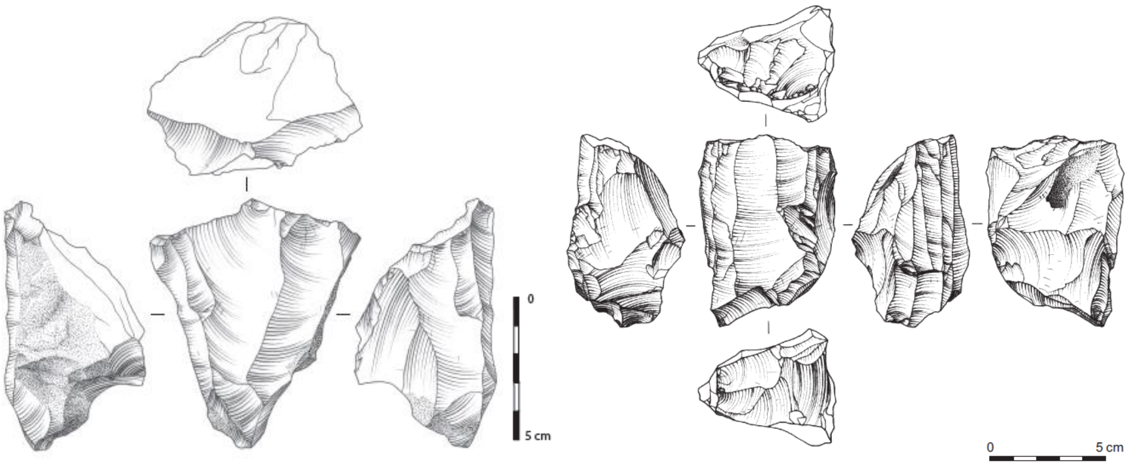


Figure 2.5. Middle Palaeolithic examples of Laminar technological blade production.
Left: pyramidal facial core from Angé. Right: orthogonal semi-rotating core from Therdonne (N3)
(modified from Koehler et al. 2014 and Locht et al. 2010b)

2.3.2.2.2. Levallois, 'Specialised Levallois', and 'Taramsa' systems of blade production

The second form of stereotyped blade production is Levalloisian-based strategies. The archaeological evidence suggests that the adoption and innovation of behaviours associated with the Levallois technique happened throughout Europe, Western Asia, and in some areas of Africa at the onset of the Early Middle Palaeolithic (MOIS 9/8) in a polycentric model (e.g. Hublin, 2009), corresponding to different eco-cultural units in isolation (White et al,, 2011; Wiśniewski, 2014). This contrasts to a monocentric model (with a single point of origin) diffusing throughout the Old World as a shared technological idea or behaviour (e.g. Foley and Lahr, 1997). This section provides an overview of Levallois technology with a discussion of Levallois methods of blade production. For an extensive list of all recognised Levallois products, and general Levallois technology, see Van Peer (1992), Boëda (1994, 1995) and Scott (2006, 2011).

Since the original definition of the Mousterian by de Mortillet and Commont in the late nineteenth century and beginning of the twentieth century (de Mortillet, 1883; Commont, 1908), the Levallois technique has been recognised as a hallmark of the Middle Palaeolithic. It is based on a set of principles that control and predetermine the overall shape and size of intended flakes through preparation of one face of a core. Two main strands of theoretical developments underpin the Levallois technological strategy as we know it today, both anchored in the French school of technology: the cognitive, technological, and theoretical frameworks in the 1950s and 1960s by experimental flintknapper and prehistorian François Bordes, and extended technological and behavioural work by Eric Böeda from the 1980s onwards.

François Bordes was one of the first prehistorians to define the Levallois technique specifically in terms of technology, in comparison to previous discussions (Commont, 1909a, 1909b; Breuil and Kozlowski, 1931; Burkitt, 1933; Breuil, 1937; Van Riet Lowe, 1945; Breuil and Lantier, 1951). Emphasis was placed on predetermination and the preparation needed. Specifically: "*…un éclat à forme prédéterminée par une preparation spéciale du nucleus avant l'enlèvement de l'éclat*." (Bordes, 1950a: 21). Bordes demonstrated a variety of different flaking techniques which could be categorised within the Levallois strategy, and the nature of its end products from the classic preferential flake to more elongated forms.

It was the variety of the manufactured end-products which Böeda wished to address in his technological studies from the 1980s onwards. His classification of the 'Levallois Concept' (Böeda, 1994, 1995) remains one of the most popular methods for classifying Levallois technology. Two specific behaviours unify Levallois flaking techniques under his categorisation: 1) preparation of a continuous striking platform extending around most of the core's perimeter, and 2) the systematic shaping of the upper surface (Böeda, 1994). Böeda (1994) listed six defining characteristics of Levallois technology:

1. The volume of the core is conceived as two surfaces separated by a plane of intersection;
2. The two surfaces are hierarchically related and non-interchangeable, one a dedicated surface of striking platforms, the other a flaking surface;
3. The flaking surface is configured in a fashion which predetermines the morphology of the products. This predetermination is controlled by the management of the lateral and distal core convexities;
4. The fracture plane for the removal of predetermined blanks is parallel to the plane of intersection;
5. The line created by the intersection of the striking platform surface and the flake surface (the hinge) is perpendicular to the flaking axis of the predetermined blanks;
6. Characterised using hard-hammer percussion.

In recent years Böeda (Böeda, 2013; Böeda et al., 2013) stressed the homothetic structure of Levallois production, as noted with Laminar blade production, and the concept of 'auto-correlation', a "global internal coherence" (Böeda et al., 2013: 198); that is, to respond and understand a series of problems arising during core reduction, or during a change of objective. Böeda's various criteria for the Levallois, throughout the last two decades, are given in Table 2.5.

Criteria	Böeda (1994)	Böeda (1995)	Böeda (2013)	Böeda *et al.,* (2013)
1	Two surfaces are separated by a plane of intersection	Two surfaces are separated by a plane of intersection	Two surfaces are separated by a plane of intersection	Two surfaces are separated by a plane of intersection
2	Hierachisation of the surfaces, one is the flaking surface and one is the striking platform	Hierachisation of the surfaces, one is the flaking surface and one is the striking platform	Hierachisation of the surfaces, one is the flaking surface and one is the striking platform	Hierachisation of the surfaces, one is the flaking surface and one is the striking platform
3	Flaking surface is formed convex to predetermine the shape of the blanks	Flaking surface is formed convex to predetermine the shape of the blanks	Flaking surface is formed convex to the predetermine the shape of the blanks; preparation of the striking platform in that way that the strike hits a ninety-degree angle	Flaking surface is formed convex to predetermine the shape of the blanks
4	Preparation of the striking platform	Fracture plane is parallel to the plane of intersection	Fracture plane is parallel to the plane of intersection	Fracture plane is parallel to the plane of intersection
5	Fracture plane is parallel to the plane of intersection	Preparation of the striking platform	Exclusively, direct percussion with a hard hammerstone	Preparation of the striking platform in that way that the strike hits in a ninety-degree angle
6	Exclusively, direct percussion with a hard hammerstone	Exclusively, direct percussion with a hard hammerstone	Auto-correlation	Homothetic morphology
7	-	-	-	Auto-correlation

Table 2.5. Eric Böeda's criteria to define the Levallois concept in various publications (modified from Frick and Herkert 2014)

Böeda (1988a, 1993) also catalogued the variety of artefacts produced through the Levallois Concept into two techniques: 'lineal' (or 'preferential'), and 'recurrent' Levallois. It is this classification which will be adopted, with a particular type of Levallois recurrent production being of particular interest within this thesis.

Lineal Levallois strategies are oriented towards the production of a single large flake removal from the prepared core surface. The butt of the flake is relatively small compared to the total surface, and the flake produced spans a large portion of the Levallois *débitage* surface (Inizan et al., 1999). These can be elongated, fitting morphological definitions of a blade; however, the lack of repetition, and the lack of a cognitive decision to produce multiple stereotyped elongated products, means this is not a method of blade production. For more of a discussion on lineal techniques see Böeda (1988a; 1994) and Scott (2006, 2012), and Figure 2.6 for a schematic representation.

In Levallois recurrent strategies, the intention is to produce a series of flakes of a predetermined shape and size from the prepared core (Böeda, 1988a). The first few flake removals may feature a dorsal scar pattern like that of preferential flaking, but the ensuing sequence and repetition of flake removals from the same surface will feature negative scars along one or more of the margins of the resulting flake (Figure 2.6). The Levallois flakes produced become a function of the preceding removal which then conditions the subsequent removal (Inizan et al., 1999). With this knowledge, Böeda (1988a) designed a framework for identifying the hierarchy and 'order' of Levallois recurrent removals, based upon their exploitation within the *chaîne opératoire* (first order, second order, and third order), all with a distinctive scar patterns on the dorsal surface.

In the removal of Levallois recurrent blades, removals are peeled off the gently-convex face of the Levallois core, from either one (unidirectional) or two (bidirectional) platforms, with the intention to produce a series of flakes, or elongated blanks. The elongated products, resulting from recurrent unidirectional/bidirectional Levallois strategies, have numerous names including 'Levallois Laminar' (McNabb, 2007), 'Elongated Levallois' (Scott, 2011), 'Laminar Levallois' (Shea, 2013) or just Levallois blades. In instances where a recurrent unidirectional/bidirectional technique is utilised to produce a series of elongated blanks, which are stereotyped, exemplifying that it was the knapper's intention to produce such, then these will be termed Levallois technological blades. Products resulting from a centripetal recurrent technology will not be considered a form of stereotyping, given the technological fluidity in the end-products produced, and will not be considered within the remit of technological blade production.

In their maintenance, angles and contours of the Levallois striking platform are adjusted through flaking of the platform, faceting or, alternatively, notching the platform edge, resulting in the signature *chapeau de gendarme* morphology (Bar-Yosef and Kuhn, 1999). Like Laminar technology, the adoption of a bipolar reduction strategy allows the necessary convexities to be maintained, allowing fuller exploitation of the raw material.

Continuing the sequence of blades requires maintenance of the core-edge through the production of *éclats débordants.* Often called *debordant* flakes, these are defined as blanks produced from the previous Levallois flaking surface, particularly the core-edge (Debénath and Dibble, 1994: 54). They can be produced through the production of either Levallois technique (preferential or recurrent), and feature a scar pattern like that of crested blades. These are often termed naturally-backed knives, as these are elongated and feature a sharp cutting edge on one margin. Backed knives or backed blades can feature a naturally cortical surface (termed naturally-backed knives/blades) or can be non-cortical, formed by perpendicular flake scars (termed atypical naturally-backed knives/blades) (*ibid*. 54). This thesis will classify these products in terms of technological classification, as *éclats débordants*. However, as these can feature parallel edges, a high elongation index, and are utilised in contexts featuring blade technology (see subsequent analyses), these will not be classified as technological blades *sensu stricto*, but will be included and considered in examinations of Laminar and Levallois recurrent blade techniques.

Like Laminar methods of blade productions, variants appear. The 'Taramsa' method of blade production is a relatively new development in studies of blade technology, originating from studies of Aterian sites in Northern Africa and discussed by Phillip Van Peer mong others (Van Peer, 2004; Van Peer et al., 2010; Spinapolice and Garcea, 2013). This method initially starts through Levallois recurrent production; however, its morphology features off-set planes (unlike a parallel plane in typical Levallois recurrent strategies), an extremely convex production surface, and multiple planes of core intersection (Van Peer et al., 2010; Spinapolice and Garcea, 2013). Its convex surface allows a volumetric method of blade production, similarly to facial or semi-rotating Laminar production, without the need to prepare the surface like typical Levallois blade production. However, as this features a hierarchical division of surfaces (with a flaking surface and an exploitation surface, and the core's volume cannot be exploited entirely despite the lack of core-edge blades), the technique will be classified into a Levallois recurrent system for this thesis. In addition, as this has not been documented in Europe, this will not be discussed further. The Taramsa method, however, does emphasise the importance of understanding the full *chaîne opératoire,* and highlights the near hybridisation of Levallois and Laminar ideas, similarly to strategies in the Bohunician (Svoboda and Škrdla, 1995; Škrdla and Rychtaříková, 2012).

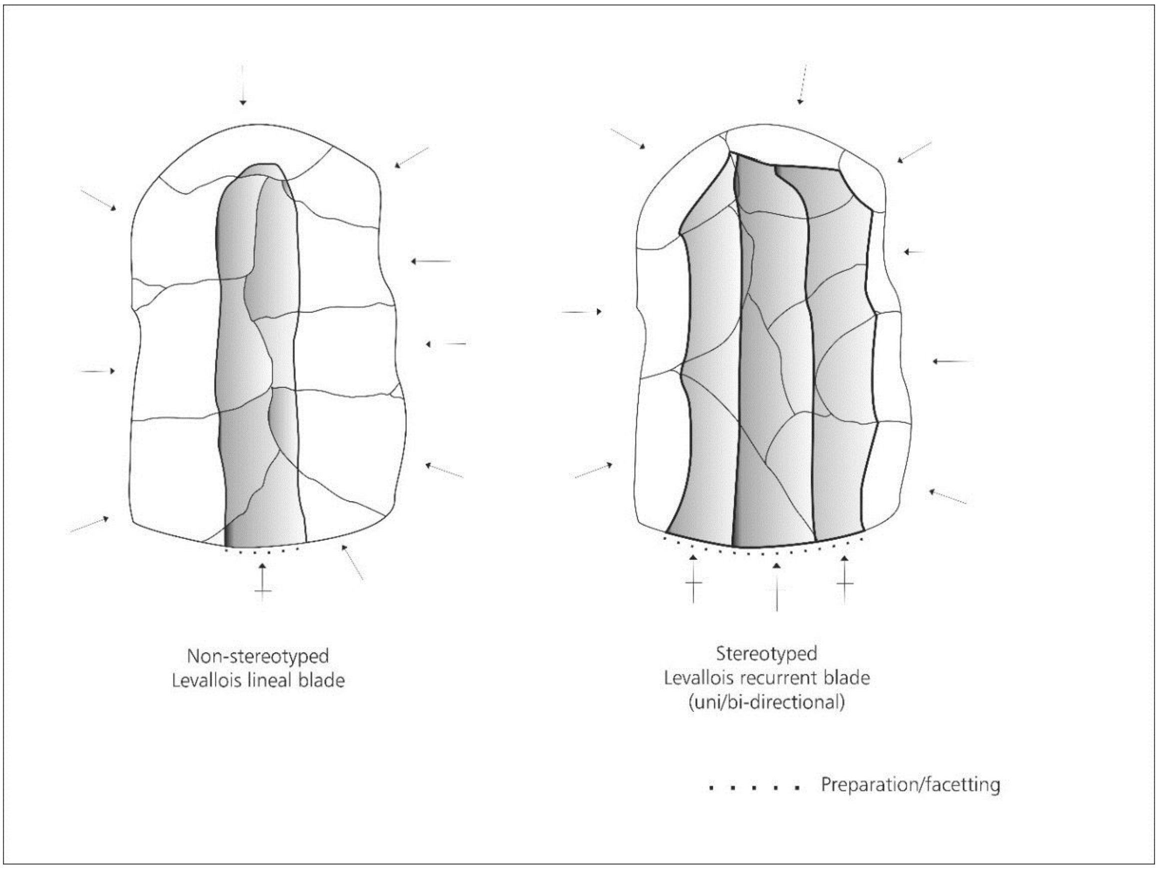


Figure 2.6. A schematic representation of Levallois blade production methods (non-stereotyped blade production vs. stereotyped blade production)

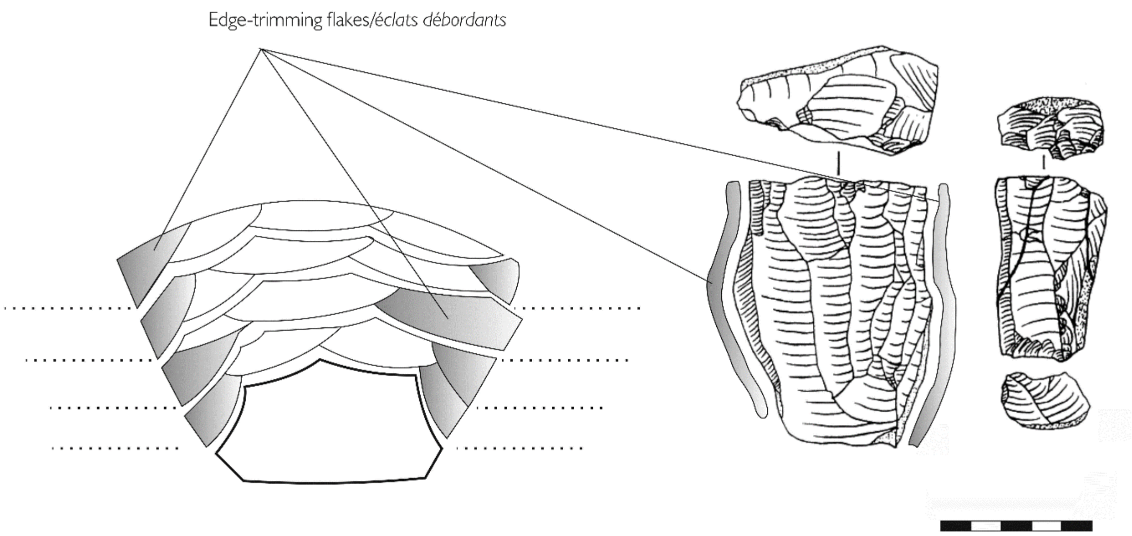


Figure 2.7. Specialised Levallois blade production with an annotated example from the site of Séclin, France (Révillion, 1993a, 1995)

This fusion of techniques was perhaps best exemplified through a technique previously classified as Levallois: that of 'specialised Levallois blade technology' (Böeda, 1988b). In this technique, Böeda (1998b) notes that specialised Levallois blade technology is a succession of technological blades that are produced from successively deeper levels of a single face of the core, with the lateral edges prepared by two large *éclats débordants*. Radial preparation (as in classic Levallois systems) is unnecessary, with exploitation continuing following the core-edge removals (Beyries and Böeda, 1983; Böeda, 1988b). These cores, similarly to the Taramsa method, are markedly convex and allow the removal of blades over a greater proportion of the total core surface (Böeda, 1988b). See Figure 2.7 for a schematic representation.

In their classification, however, it is problematic to considered this technique as Levallois, and a Laminar classification may be more applicable. Böeda (1988b) notes that this technique stretches beyond the conventional definitions of the Levallois Concept. Radial preparation, or a distinct hierarchy in flaking and striking surfaces are unnecessary, and technologically the classification of edge blades as *éclats débordants* is problematic; while these do dictate one delineated surface, the blades do not feature scar patterns akin to Levallois *éclats débordants*, and the artefacts could be viewed technologically as blades. As a core volume management strategy, it is more akin to a Laminar facial strategy, exploiting the broadest face of raw material often elongated and cylindrical in nature. Examples in the European Middle Palaeolithic are few with the site of Séclin, situated in the Nord-Pas-de-Calais region of France, as the commonly-cited example of Specialised Levallois blade technology (Révillion 1988, 1989, 1993a, 1993b; Révillion and Tuffreau, 1994). At Séclin, exploitation of elongated material around the entirety of the core's circumference (Laminar) has been discovered alongside these possible examples of Specialised Levallois blade production (Révillion, 1989). However, in these examples, the raw material shape does not permit the creation of a core hierarchy, and many of the issues, in its definition of Levallois, as above, can be documented (Figure 2.7). This is discussed in further detail by Révillion (1993a) who notes that these are not typologically (or technologically) Levallois. While a facial Laminar strategy is perhaps more applicable, it does highlight similarities in their intention, despite differences in their technological signatures.

2.3.2.3. Distinguishing Between Levallois and Laminar Technological Blade Production

As noted above, there is difficulty in distinguishing between Laminar and Levallois methods of technological blade production, particularly given the flexibility of both methods. Despite their similarities, both strategies are clearly distinct in how raw material is exploited, with the nature of hierarchisation, the necessity of preparation around the core's shape, the creation of *éclats débordants* in Levallois methods, the volumetric exploitation of the core's circumference, and its continuity in Laminar-based methods of blade production.

In differentiating between the end-products of both strategies, difficulties arise. Bordes (1961a) noted that:

"*les Lames Levallois peuvent porter sur la face supérieure des traces d'enlévements d'autres lames ou convergents et qu'il est parfois impossible de les distinguer des lames du Paléolithique supérieur"* (Bordes, 1961a: 22).

One main issue is the degree of dorsal scar variation on Laminar and, particularly, Levallois blades. This is highlighted in Perpère's (1986) experiment, designed to understand the issue of recording Levallois technological blades within a mixed assemblage. Along with two other prominent specialists in lithic technology (Alain Tuffreau and Éric Böeda), a task was created to divide an assemblage of 198 products into Levallois and non-Levallois products. While they all identified between 100-108 non-Levallois products, there was significant variation in Perpère's, Tuffreau's, and Böeda's identification of Levallois, with 98, 81, and 58 Levallois flakes identified respectively (Perpère, 1986). This is unsurprising, given the variety of Levallois shaping and flake strategies on varying qualities of raw material (a variable which has not been thoroughly examined). The problem of identifying Levallois products has also been stressed by many authors (Gricor'ev, 1972; Copeland, 1984; Böeda, 1986; Van Peer, 1992). In distinguishing between Levallois-based and Laminar-based technological blade strategies, many authors have attempted to clarify this issue, with varying levels of agreement (Table 2.6). While authors note the degree of standardisation (Clark, 1987), the end-product shape (Inizan et al., 1999), and a mixture of technological and morphological attributes (Böeda, 1998b; Bar-Yosef and Kuhn, 1999; Inizan et al., 1999; Meignen, 2000; Ortega et al., 2013), there is a distinct lack of consensus. Morphological aspects such as cross-section, dimensions, and planform shape have not been rigorously tested or quantified, and are often based on Upper Palaeolithic soft-hammer, or punched, examples. In hard-hammer percussion, differences in how the force travels through the material results in different shape, e.g. width diffusion. Furthermore, many of the indicators used, e.g. the degree of elongation, may not be appropriate for sites featuring both blade strategies. In this thesis, the technological attributes (chapeau de gendarme, scar directionality of the overall blade assemblage, nature of faceting), a confidence measure, and an appreciation of the wider assemblage (i.e. the presence of Laminar or Levallois recurrent cores) will be adopted to best identify Levallois (in addition to an experimental dataset for rigorous assessment). Following analyses, the morphological indicators can then be reconsidered. See Chapter 5 for more information on the methodology adopted.

Publication	Basis of differentiating between Laminar and Levallois blades
Clark (1987)	• Laminar blades result in a remarkable degree of standardisation in the size and shape of end products.
Böeda (1988b, 1995)	• Core volume management strategies: Levallois systems of blade production are on one delineated surface with preparation around the one face, whereas Laminar systems are on their circumference.
Bar-Yosef and Kuhn (1999)	• Greater adjustment of Levallois striking platform angles/contours; • Laminar blades can be flaked but are more likely plain or cortical.
Inizan *et al.* (1999)	• Laminar products: rectilinear with parallel edges and arrises; • Laminar products: constant thickness; • Laminar products: no obvious ripples; • Laminar products: butt that is narrower than max. width; • Levallois products can feature a *chapeau de gendarme* butt.
Meignen (2000)	• Blank shape: Levallois systems result in "wide thin elongated blanks" (Meignen, 2000: 135) whereas Laminar systems result in "narrow thick blades" (*Ibid.* 135); • Levallois is produced on relatively flat flaking surfaces, while Laminar is produced on a markedly convex *débitage* surface; • Degree of facetting: Levallois cores feature greater facetting.
Ortega *et al.* (2013)	• Elongated Levallois products tend to be wider and thinner; • The presence of a flat or steep ridge on Laminar blades; • Laminar products tend to be more elongated; • Laminar products: greater curvature; • Levallois products: more acute edges (Ortega Pers. Comm.).

Table 2.6. Criteria used by different authors in attempting to differentiate between Laminar and Levallois technological blade strategies and their products

2.4. Summary and Discussion

Within the Neanderthal technological repertoire there are two primary methods of producing elongated and stereotyped material: Laminar and Levallois. While these can be distinguished with a complete technological sequence, their end-products are difficult to distinguish, even by experienced lithicists. If they are to be considered one-and-the-same, then how can we account for the appearance of both strategies for the Middle Palaeolithic, on a concurrent level, and the transition from a Levallois-dominant Early Middle Palaeolithic to a Laminar-rich

Late Middle Palaeolithic? This chapter, while providing a contextualisation of what the two strategies are. highlights the potential of a thorough morphometric analysis alongside technological considerations of blade production methods within the Middle Palaeolithic, and a starting point for discussing aspects of artefact design, desirability and Neanderthal technological and social behaviour.

Chapter Three
The Period in Question: An Overview of the Chronological, Palaeoenvironmental, Pedosedimentary and Archaeological Framework for the Middle Palaeolithic

3.1. Introduction

In the previous chapter, the two main technological blade strategies were outlined, with commonalities and differences in the production of blades discussed. Before the different theoretical frameworks are reviewed, it is essential to review the period in question. What defines the Middle Palaeolithic? What were the environmental and climatic conditions for the Middle Palaeolithic? And what behaviours can be viewed within the archaeological record? These are incredibly important to understand and outline for various reasons. An appreciation of the climatic and environmental conditions of the Middle Palaeolithic are essential in understanding and explaining technological strategies in relation to their immediate and extended landscape(s), and within their spatio-temporal framework; for example, are blade strategies located in specific landscapes or climates, and could they represent responses to the immediate environment? The pedosedimentary record allows discussions with respect to inter-site contemporaneity, and given the increased resolution for this period (see below), the pedosedimentary sequences can often provide relatively accurate timeframes, with precision sometimes greater than conventional dating techniques available for the Early and Late Middle Palaeolithic (Di Modica Pers. Comm.). An appreciation of other archaeological evidence within the Middle Palaeolithic allows for an understanding of the context within which these strategies are used, and the diversity of lithic products. To truly understand technological blade strategies within the Middle Palaeolithic it is essential to know the Middle Palaeolithic itself.

This chapter will therefore discuss how the Middle Palaeolithic has been defined, before outlining the chronological, paleoenvironmental and palaeoclimatic, chronostratigraphic and pedosedimentary, and archaeological (lithic and non-lithic) frameworks for the Middle Palaeolithic.

3.2. Classifying, Categorising, and Understanding the Middle Palaeolithic

The European Middle Palaeolithic can be defined as beginning with the initial widespread appearance of elements pertaining to 'Neanderthalisation', i.e. behaviours typically associated with *Homo neanderthalensis* (White and Ashton, 2003) from c. 300,000 BP, continuing through to the manifestation of the 'Classic Neanderthal' behavioural package (Mellars, 1996) from the stages of the Last Glacial Period (see below), and ending with their demise c. 41,000 - 39,000 BP (Higham et al., 2014). This does exclude the evidence for possible Neanderthal activity in Gibraltar and within Iberia at later dates (Finlayson et al., 2006, 2008), however this is uniquely within an Upper Palaeolithic spatio-temporal framework, representing an isolated event. It is for this reason a preferred date of c. 41,000 - 39,000 BP is adopted here (see Davies 2014 for more information).

While one individual behaviour does not categorise the temporal parameters and the onset of the European Middle Palaeolithic, four concepts have been used as proxies: 1) the introduction of prepared core technology, with particular emphasis on the Levallois technique (Rolland, 1988; Roebroeks and Tuffreau, 1999), 2) the increased use of standardised techniques in flake manufacture (Tuffreau, 1979; Bosinski, 1982; Roebroeks and Gamble, 1999), 3) variability in the technological choices adopted by hominins (Geneste, 1985; Turq, 1989), and 4) the shift to a limited range of major tool classes including bifacial and flake (notch and denticulate, and *racloir*) tools (Dibble and Rolland, 1992). It is important to stress that the identification of the European Middle Palaeolithic should be through the prevalence, and wide-scale distribution of concepts such as the Levallois technique, and not their earliest appearance, as stressed by Richter (2011). Sites including Organc 3 (Combier and Moncel, 1992) and Cagny la Garenne (Tuffreau and Antoine, 1995), which show the appearance of the Levallois technique as early as MOIS 11 (c. 374,000-424,000 BP), would not be representative of the archaeological evidence for the Lower Palaeolithic and contemporaneous technological choices and behaviour. Other ways of identifying the onset of the European Middle Palaeolithic have been suggested, including shifts seen in hunting technique (Gaudzinski, 1999), or increased mobility and distances in raw material transfer (Feblot-Augistins, 1999).

3.3. Chronological Framework for the Middle Palaeolithic

Through these frameworks, the Middle Palaeolithic is composed of two periods: the Early Middle Palaeolithic, spanning from c. 300,000-130,000 BP, and the Late Middle Palaeolithic from c. 130,000-39,000 BP.

This period can be best expressed through the temporal framework developed by the micropalaeontologist and geologist Cesare Emiliani in the 1950s, based on marine oxygen isotope stages (MOIS). For the period in question (c. 300,000-71,000 BP) three glacial (MOIS 8, 6 and 5d-5a) and two interglacial (MOIS 7 and 5e) phases are theorised. The periodisation of these phases has since been classified through the synthesis of climatic data (climatic curves) by Lisiecki and Raymo (2005). These stages are not constant, but feature fluctuations and oscillations of varying length, severity, and kind occurring throughout each phase. These oscilliations can sometimes be identified through specific events, including the Late Eemian Aridity Pulse (LEAP) occurring c.122,000-118,000 BP (Sirocko, 2005). Others include the palaeomagnetic Blake Event correlating with the onset of the Eemian (Smith and Foster, 1969; Sier et al., 2011), and the few recorded examples of possible Dansgard-Oeschger (DO) events in the Early Glacial Period (Dansgaard et al., 1993; Grootes et al., 1993). Table 3.1 synthesises an overview of the chronological and chronostratigraphic framework for the Middle Palaeolithic, incorporating regional nomenclature.

<table>
<tr><th colspan="7">Chronological framework for the period of the Middle Palaeolithic in question (MOIS 8-5)</th></tr>
<tr><th rowspan="2">Period</th><th rowspan="2">MOIS</th><th rowspan="2">Range (BP)</th><th colspan="4">Nomenclature used within the different temporal affinities</th></tr>
<tr><th colspan="2">France</th><th>Britain</th><th>Germany</th></tr>
<tr><td rowspan="3">Early Middle Palaeolithic</td><td>8</td><td>300,000-243,000</td><td colspan="2" rowspan="3">Saalien</td><td>Early Saalian Glacial sensu lato</td><td>Fuhne</td></tr>
<tr><td>7</td><td>243,000-191,000</td><td>Aveley Interglacial</td><td>Drenthe-Warthe</td></tr>
<tr><td>6</td><td>191,000-130,000</td><td>Saalian Glacial sensu stricto</td><td>Schöningen-Wacken-Dömnitz</td></tr>
<tr><td rowspan="5">Late Middle Palaeolithic</td><td>5e</td><td>130,000-109,000</td><td colspan="2">Eémien</td><td>Ipswichian/ Late Interglacial</td><td>Eemian</td></tr>
<tr><td>5d</td><td>109,000-96,000</td><td>Melisey I</td><td rowspan="4">Weichsélien ancien</td><td rowspan="4">Early Glacial Period</td><td>Herning</td></tr>
<tr><td>5c</td><td>96,000-87,000</td><td>St Germain I</td><td>Brørup-Amersfoort</td></tr>
<tr><td>5b</td><td>87,000-82,000</td><td>Melisey II</td><td>Rederstall</td></tr>
<tr><td>5a</td><td>82,000-71,000</td><td>St. Germain II</td><td>Odderade</td></tr>
</table>

Table 3.1. The chronological framework used for the Middle Palaeolithic from the beginning of the Early Middle Palaeolithic until c.71,000 BP incorporating terminologies from north-west Europe (MOIS: Lisiecki and Raymo 2005)

3.4. Palaeoenvironmental and Palaeoclimatic Background

Variances in the Earth's orbit around the sun (through eccentricity, obliquity, and precession) influence the initiation of climate change, in long-term cycles of glacials and interglacials (Milankovitch, 1941; Schwarzacher, 1993). In outlining the palaeoenvironmental and palaeoclimatic context of north-west Europe, three forms of high-resolution proxy indicators are commonly used: 1) climatic data derived from ice-core and deep-sea chronologies (Grootes et al., 1993; Jouzel et al., 1993, 1997, 2001; NGRIP Members, 2004), 2) vegetational data from lacustrine, marine and terrestrial sediments (Grüger, 1989; de Beaulieu and Reille, 1992; Pons et al., 1992; van Andel and Tzedakis, 1996; Tzedakis et al., 1997; Guiter et al., 2003; van Andel, 2003; Tzedakis, 2007), and 3) the comparative use of regional pedosedimentary and chronostratigraphic records (for north-west Europe: Antoine, 1993, 2002; Haesaerts, 1978; Haesaerts et al., 1997; Antoine et al., 2002). Other forms of evidence include crustose-lichenometric (O'Neal and Schoenenberger, 2003), entomological and coleopteran (Coope, 2004, 2009), and dendrochronological data (Baillie, 1995), however these lack robust long-term chronologies of stasis and change. An overview of the climatic and environmental data for the Middle Palaeolithic (up until c.71,000 BP) is depicted in Figure 3.1 and Table 3.2.

3.4.1. Marine Oxygen Isotope Stages 8-6 (c.300,000-130,000 BP)

The beginning of the Early Middle Palaeolithic, i.e. MOIS 8 (c.300,000-243,000 BP), is marked by high global ice volumes and low sea surface temperatures (SSTs) in its initial stages. This contrasts with the end of MOIS 9, which is marked by high levels of solar radiation in northern latitudes, and thus the prevention of extensive ice-sheet formation (Kulka, 2005; Roucoux et al., 2006). The terminal stages of MOIS 8d are marked by a peak in *Neogloboquadrina pachyderma*, suggesting the occurrence of a Heinrich-type event (Roucoux et al., 2006). This rapid global climatic fluctuation, lasting around seven-hundred-and-fifty years, coincides with the destruction and movement of northern hemisphere ice shelves (Maslin et al., 2001; Roucoux et al., 2006). Following MOIS 8d, an interval of warmer conditions prevails, before a brief return to low climatic temperatures in MOIS 8b, with steppe-like vegetation and reduced tree populations (Roucoux et al., 2006), prior to Termination III in MOIS 8a (see below).

For MOIS 7 (c.243,000-191,000 BP), three long European terrestrial vegetation sequences are available: the French composite record of cores at Lac du Bouchet in the Velay Maars of the Massif Central (Reille et al., 1998, 2000), the Italian maar-lake sediments of Valle di Castiglione (Follieri et al., 1998, 1989), and the Tenaghi Philippon peatland in north-east Greece (Wijmstra and Smit, 1976; Milner et al., 2013). In conjunction with additional deep-sea and ice-core data for this period, e.g. MD01-2447 (Desprat et al., 2005; Desprat et al., 2006), a high-resolution record for MOIS 7 occurs, in contrast to MOIS 8. MOIS 7 comprises five substages with three major forested phases: 7e, 7c, and 7a (7.5, 7.3, and 7.1).

The period of transition to MOIS 7 (c.252,000-243,000 BP) is marked by three cold episodes and two warming episodes, collectively termed Termination III (Desprat et al., 2006). The coldest conditions of Termination III in terms of SSTs reveal summer temperatures of ~9 degrees Celsius, and winter temperatures of ~4 degrees Celsius, as modelled by the MD01-2447 deep-sea core (Desprat et al., 2006). It is the final part of Termination III which is perhaps most interesting, being the warmest phase of the deglacial transition over the continent, in addition to the ocean surface, with SSTs of ~17.5 degrees Celsius in the summer and winter SSTs of 11.5 degrees Celsius (*ibid*. 105). With CH_4 levels in ice-cores including Vostok (Princess Elizabeth Island, Antarctica) paralleling these changes (see Caillon et al. 2003), the data suggests an overall warming throughout both hemispheres.

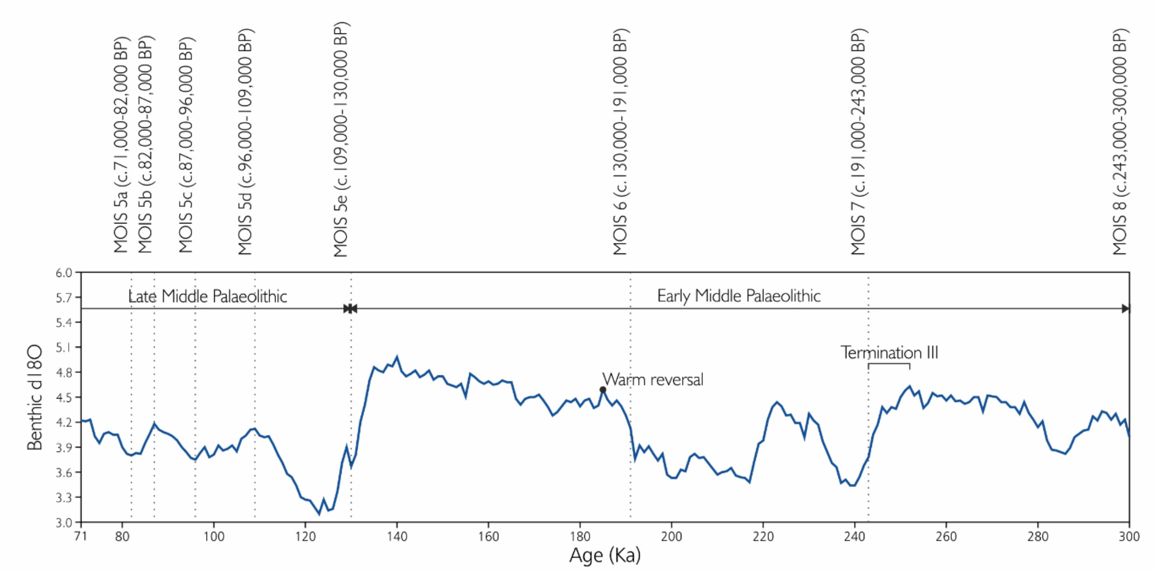


Figure 3.1. Palaeoclimatic conditions throughout the Middle Palaeolithic (until c.71,000 BP) as observed through Benthic d18O data highlighting Termination III and an example of a warm reversal in MOIS 6 (data sourced from Lisiecki and Raymo 2005)

MOIS 7e (c.243,000-229,000 BP) in Europe is marked by a decrease in *Pinus* (pine), and the maximal expansion of deciduous *Quercus* (oak) forests and evergreen oak groves, with SSTs of ~13.5 degrees Celsius in the winter, and summer temperatures of ~19.5 degrees Celsius (Desprat et al., 2006). In this period, Antarctic temperatures were their highest for any MOIS 7 warm stage (Roucoux et al., 2008). MOIS 7d (c.229,000-217,000 BP) is characterised by the most pronounced cold stage of MOIS 7, with marked cold conditions and ice sheet enlargement, to a similar extent as in MOIS 8 (Roucoux et al., 2006; Desprat et al., 2006). MOIS 7c (c.217,000-207,000 BP) demonstrates lower ice volumes, melting rapidly from MOIS 7d, with a marked forested period until the most minimum forest coverage in MOIS 7, at c.198,000 BP (Desprat et al., 2006). MOIS 7b (c.207,000-200,000 BP), is highlighted with minor ice accumulations and a minimal drop in sea level (Waelbroeck et al., 2002; Roucoux et al., 2006). MOIS 7a (c.200,000-191,000 BP), at the end of MOIS 7, is documented as the longest warm stage of any point in MOIS 7, with higher levels of floral diversity and low ice coverage (Desprat et al., 2006).

MOIS	Palaeoclimatic and palaeoenvironmental summary for north-west Europe
8	High ice volumes; low sea surface temperatures (SST); suggested Heinrich event initially; brief interval of warmer conditions before a return to low temperatures and reduced tree populations (Maslin *et al.,* 2001; Roucoux *et al.,* 2006).
7	Three major forested phases; period of transition features three cold episodes and two warming episodes (Termination III); most pronounced cold stage (c.229-217 kya); ends with a long warm stage and higher levels of floral diversity (Roucoux *et al.,* 2006; Desprat *et al.,* 2006).
6	Onset of cold and dry conditions with falling SSTs and increasing ice volumes; warm but short-lived, reversal c.186,500 BP, however climatic deterioration throughout the period; Britain becomes isolated and separated by the Channel (Martrat *et al.,* 2007; Roucoux *et al.,* 2006).
5	5e: Dense, mixed-forested and temperate landscape; species of *Picea*, *Abies*, *Carpinus* and *Quercus* are abundant; comparable to present contexts; optimum mean winter temperatures reach slightly above zero degrees; dramatic decline in temperature partway; coldest around 125-120 kya; 5d: Temperate deciduous vegetation; increased amount of *Corylus*, *Quercus*, *Carpinus* and *Pinus* pollen; short, abrupt cooling during 5d - 'Montaigu event' (c.103,000 BP); 5c: Considerably colder; *Artemisia* dominates; steppe-like conditions return; 5b: Cold and dry interval; 5a: Expansion of *Quercus*, *Corylus* and *Betula* (de Beaulieu and Reille, 1988; Müller and Sánchez-Goni, 2007; Guiter *et al.*, 2003).

Table 3.2. A summary of the climatic and environmental conditions of the Middle Palaeolithic (before c.71,000 BP)

The onset of MOIS 6 (c.191,000-130,000 BP) is characterised by cold and arid conditions, contrasting with MOIS 7a, with falling SSTs, increasing global ice volume, and shrinking forests and heathland (Roucoux et al., 2006). A warm reversal interrupted cooling at c.186,500 BP (Martrat et al., 2007); however, this was short-lived with marked climatic deterioration throughout the rest of this period (see Figure 3.1). During this period, Britain becomes isolated from the rest of Europe, separated by the English Channel/*La Manche* (Martrat et al., 2007).

3.4.2. Marine Oxygen Isotope Stages 5e-5a (c.130,000-71,000 BP)

This period boasts a fine-resolution record with greater detail than all previous periods discussed, allowing a thorough reconstruction of possible Neanderthal landscapes.

From the beginning of the Eemian (MOIS 5e), the once-open steppe-like palaeoenvironment of north-west Europe in MOIS 6 became a dense, mixed-forested temperate landscape with species of *Picea* (spruce), *Abies* (fir), *Carpinus* (hornbeam), and oak abundant throughout the palynological chronology (de Beaulieu and Reille, 1988). North-west Europe during this time can be perhaps comparable to the present context, with temperature conditions under an oceanic influence in addition to extended forest cover. As the Eemian continued, around c.117,000 years ago, mean winter temperatures reached slightly above zero degrees Celsius, as indicated from Les Echets (Müller and Sánchez-Goni, 2007). However, it is worth stressing that this refers to the record of eastern France, and thus must be treated as a proxy for northern France, Belgium, the UK and the rest of north-west Europe.

Towards the end of the Eemian, the climate deteriorated throughout north-west Europe, marked by lower sea levels, open grassland environments and *Betula* (birch) dominating the pollen record (de Beaulieu and Reille, 1988; Antoine et al., 2002). A dramatic shift to herbaceous arctic tundra and a return to steppe-like vegetation follows, with records such as Velay demonstrating an abundance of *Poaceae* (grasses), pine and a continuation of birch (de Beaulieu and Reille, 1988; Guiter et al., 2003). Annual mean temperatures at this period are estimated to be between ~-2 and ~-4 degrees Celsius as documented at La Grande Pile and at Velay (de Beaulieu and Reille, 1988; Folleri et al., 1989).

Following MOIS 5e, widespread temperate deciduous vegetation is documented with an increase in the amount of *Corylus* (hazel) and oak pollen throughout its initial period (c.109,000-104,000 BP), with a subsequent sharp peak in the amount of hornbeam (Guiter et al., 2003). This latter peak can be attributed to the Montaigu event, an abrupt cooling period around c.103,000 BP, synchronous across mainland Europe (Sánchez-Goni, 2007). From c.92,000 BP (towards the middle of MOIS 5c), the climate became considerably cooler, with conditions persisting far longer than the preceding stadial. During this time, *Artemisia* (wormwood) dominates the vegetational records, and steppe-like conditions return (Guiter et al., 2003). Towards the end of MOIS 5 (MOIS 5a), major expansions of oak, hazel, and birch are documented, emphasising the return to a truly forested landscape (Grüger, 1989; Oritz, 2004).

3.5. The Middle Palaeolithic Pedosedimentary and Chronostratigraphic Record

The pedosedimentary and chronostratigraphical records provide a framework with which data from different sites and areas can be compared, allowing an investigation into inter-regional commonalities in blade behaviour. The records for north-west Europe are an invaluable dataset, with fine-scale chronostratigraphies and pedosedimentary studies providing an incredible amount of data on the chronological positioning of contexts, in part to loessic cover and alluvial terrace systems. Frameworks include extensive examination of the Seine, Yonne and Somme valley systems in Northern France (Antoine, 1990, 1993, 2002; Antoine et al., 1990, 2000, 2002; Antoine and Locht, 2015; Antoine et al., 1999, 2000, 2002, 2003, 2010; Balescu, 2013; Balescu et al. 1997; Balescu and Tuffreau, 2004; Tuffreau and Antoine, 1995), fluvial terraces in both the Meuse (Pissart, 1974; Juvigné and Renard, 1992; Meijs et al., 2012) and Haine (Haesaerts 1984a, 1984b; Pirson et al., 2009) basins, and the Thames Valley sequences in Britain (Bridgland, 1994, 2001; Stemerdink et al., 2010; Bridgland et al., 2014). Detailed accounts for each of the regions can be found throughout the analysis chapters.

3.6. The Archaeological Context for the Middle Palaeolithic

The evidence for the Middle Palaeolithic is discussed here in terms of both the lithic evidence (the most common form of archaeological signatures for this period, and that which this thesis is centred on), and non-lithic evidence, i.e. signatures and evidence for the use of organic materials.

3.6.1. Lithic Evidence for the Middle Palaeolithic

Through continued redevelopment of the theoretical frameworks with which we can understand the lithic evidence for the Middle Palaeolithic, including technological, typological and *chaîne opératoire* analyses, our understanding of Neanderthal technological variability, fluidity, and the general plasticity of Neanderthal technological behaviour has been transformed.

Technological diversity within the Middle Palaeolithic, and more specifically Neanderthal technological strategies, have long been studied, with variability noted early on in the history of archaeological enquiry (Bourlon, 1906, 1910; Commont, 1914; Peyrony, 1930; Breuil and Lantier, 1951). It is now apparent that many core volume management strategies were employed by Neanderthals, concurrently and in isolation, throughout the European Middle Palaeolithic. These may represent geographically and temporally restricted social behaviours and cultural traditions, reflecting regional hominin behaviours and behaviour histories (e.g. Ruebens, 2012), which were in turn maintained for varying periods of time throughout the Middle Palaeolithic (c.f. Gamble, 1999). See Chapter 4 for a detailed account of understanding technological variability throughout the Middle Palaeolithic. Below are the main core volume management strategies and *chaînes opératoires* that are documented within the Middle Palaeolithic, with a brief overview of their method and spatio-temporal relationship. For this section, five different technological strategies are outlined: Quina, Discoid, Bifacial, Pucheuil-type and Les Tares flake production. For an extensive discussion of Laminar and Levallois methods see Chapters 2 and 4.

3.6.1.1. Quina Systems of Flake Production

Quina technological systems are focussed on the production of predetermined products from relatively short knapping strategies. Quina strategies are largely economic and parsimonious, with a high percentage of desired blanks obtained (Turq, 1989). This is supported through experimental analyses by Turq (1989), where 60-77% of desired products were obtained, in comparison to much lower percentages of between 5-30% for Levallois (Schelinski, 1983; Geneste, 1985; Plisson, 1985, 1988).

Quina technological systems focus on the exploitation of two surfaces which intersect at a relatively low angle (<45°), and are non-hierarchical (i.e. no surface takes priority), with surfaces alternately used as both flaking and striking platforms (Bourguignon, 1996, 1997). Given this morphology, Quina strategies are largely recurrent in nature, with unidirectional removals following secant planes, parallel to the intersection of two surfaces (Bourguignon, 1996).

The blank is typically asymmetrical in section, with the morphological axis not parallel to the main flaking axis, and with the maximum thickness located opposite the longest cutting edge (Turq, 1992). Turq (1992) defines four categories of Quina flakes: 1) naturally-back knives, 2) assymetric flakes, 3) *débitage*-backed flakes, and 4) flakes with backs formed by the butt of the flake. While there are many variants of this system Turq (1989) notes that all products derive from two different core strategies:

1. Typically referred to as the 'salami slice' (*débitage en tranche de saucisson*), this technique consists of removing a succession of transverse flakes from the lateral edges of elongated flint nodules. Products retain cortex around the edge of the blank, which are then transformed in Quina *racloirs* (scrapers). Turq (1989) notes that the technique is only pragmatic when the raw material is elongated and narrow in form;

2. A second, unnamed strategy is a more technologically complex variant of the salami slice, incorporating the production of flakes down the lateral edges of the core. This method involves initial preparation and flaking, unlike the salami slice technique, with one major preparatory flake removed from one end of the nodule, while the flaked surface serves as a striking platform for one or more typically hinged flakes. This strategy is typically unidirectional in nature and can produce elongated flakes irregular in nature.

Quina systems are best known for their 'Quina retouch', the production of invasive removals creating a convex working edge with a remarkably consistent angle. These characteristic flakes are sometimes recycled into scrapers (Borguignon, 1996); in some instances, Quina blanks are left unretouched or lightly modified (Dibble and Lenoir, 1995), but examples commonly feature this heavy retouch. For the *chaîne opératoire* of typical Quina production see Table 3.3.

Quina technological systems can be identified both on an assemblage and individual artefact level. Quina assemblages typically feature a high ratio of retouched tools (Rolland, 1981), contain a scarcity of core maintenance products (reflecting the limited degree of preparation on the flaking surfaces), and yield an abundance of small chips and fragments from extensive retouching and resharpening (Turq, 1992). On an individual level, artefacts produced using

Quina are short and thick, with a triangular cross-section, and are characterised by a wide butt, oriented at an obtuse angle to the ventral face (Bourguignon, 1997).

Stage	Action
1	Introduction of raw material to the site;
2	The removal of one or two primary trial flakes from the raw material;
3	The production of cortical knives (waste elements tend to be knapping accidents);
4	The remainder of the nodule (either at its centre or on one of the extremities) is transformed into a core through the preparation of several striking platforms or by limited removal of cortex;
5	Production of *débitage*-backed knives, 'Clactonian' flakes and assymetrical flakes;
6	Further modification of cores (either on flakes or nodules);
7	Retouching of products into notches, denticulates or scrapers.

Table 3.3. The *chaîne opératoire* of 'typical' Quina production (adapted from Turq, 1992)

Quina technological systems primarily date to the Late Middle Palaeolithic, specifically from MOIS 4 and 3 (Mellars, 1996; Turq, 1989, 1992); however, examples including Combe-Capelle (Laville et al., 1983), La Micoque 3 (Bourgon, 1957), and Artenac 7 (Delagnes et al., 1997) all highlight the existence of Quina systems within MOIS 5 contexts. Almost all examples (90-98%) of raw material utilised to produce Quina products are local in origin, i.e. derived from a Euclidean radius less than 5km from their original context (Turq, 1992). Quina industries are also primarily recovered from rockshelter sites (though a few occurrences in open-air sites are known), and are limited to certain regions of Europe, with evidence recorded in southern and central France, Spain and Belgium (Delagnes and Meignen, 2006). Given the few technological studies for Quina assemblages in Northern France, the distribution of Quina strategies may be underestimated (*ibid*. 90).

3.6.1.2. Discoidal Systems of Flake Production

Originally discussed in the work of François Bordes (Bordes, 1950a, 1961), and redefined by Böeda (1993, 1994, 1995), discoidal systems of technological production have been subject to intensive theoretical and technological debate (see Moore 2003 for a history of literature relating to discoidal technological systems).

In classic discoidal systems, the core volume possesses two convex surfaces, with neither surface assuming priority (no hierarchisation), unlike Levallois production. Both surfaces can be used in an alternate fashion for the detachment of flakes, with surfaces serving as a striking platform or flake detachment (Böeda, 1993). Like Levallois centripetal recurrent production, the core is 1) conceived as two convex asymmetrical secant surfaces with a definable plane of intersection, 2) employs initial preparation extending around its entire periphery, and 3) is exploited through multiple (recurrent) removals (Böeda, 1993, 1995). Discoidal systems can be discriminated through their highly convex surfaces, intersecting at a relatively high angle, resulting in core morphologies which are bipyramidal, and eventually pyramidal (Böeda, 1993; 1995). Due to the interaction of different technical criteria employed, a homothetic morphology is produced allowing the production of an uninterrupted series of predetermined blanks (Böeda, 1995). This definition has gained consensus among researchers, and is more robust than previous definitions by Bordes (Bordes, 1950; 1961); however, it is debatable as to whether Levallois centripetal recurrent and discoidal systems are truly independent of each other (as Böeda, 1993, 1995 supports), or were one system with a degree of variability employed (Mellars, 1996). This degree of equivalence between the two products has been highlighted by recent geometric morphometric analyses, specifically Picin et al. (2014) who employed two-dimensional closed-curved analyses (Fast Fourier Transformation) in conjunction with ordination-based analyses and Generalised Linear Models to highlight morphological correspondence between discoidal and Levallois centripetal recurrent flake production systems. For an evaluation of the definition by Böeda (1993), see Peresani (2003), and Brenet et al. (2013) for further experimental work with respect to discoidal and Levallois centripetal recurrent systems. For an overview of discoidal vs. Levallois centripetal recurrent systems, see Figure 3.2.

Discoid production systems typically produce short, quadrangular and asymmetrical flakes, including *débordant* flakes and pseudo-Levallois points. As the name implies, pseudo-Levallois occurs when the shape of the flake, through planning or accident, imitates symmetrical Levallois points. These can, however, be distinguished through examination of their axis of percussion and symmetry. Experimental studies have highlighted that the production of pseudo-Levallois points through discoidal reduction recovers as much cutting edge, per unit mass of stone, as typical Upper Palaeolithic blade core reduction, in addition to producing a similar number of usable blanks (Eren et al., 2008).

In their spatio-temporal distribution, discoidal systems are documented throughout MOIS 4/3 (Jaubert, 1993; Locht and Swinnen, 1994; Peresani, 1998; Pasty, 2000), in areas where both flint is scarce, e.g. in Catalonia and the Pyrenees, and abundantly available, e.g. Central France (Jaubert and Farizy, 1995; Delagnes and Meignen, 2006). A small number of examples have also been documented within MOIS 8 contexts (Moncel et al., 2011).

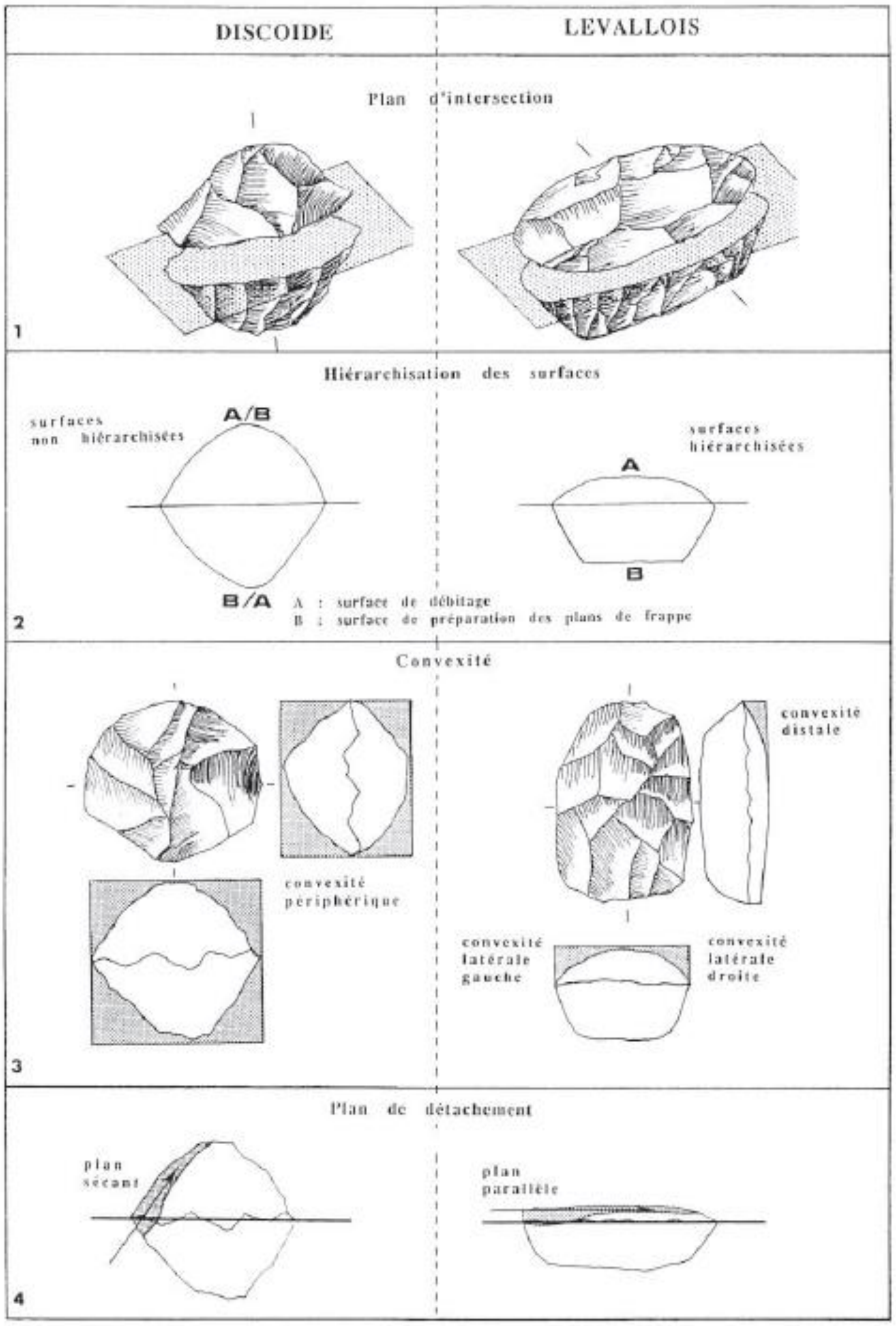


Figure 3.2. An overview of discoidal core volume management systems in comparison to Levallois technology through four criteria: 1) plane of intersection, 2) core hierarchy, 3) core convexity, and 4) the plane of detachment (Böeda, 1993)

3.6.1.3. Bifacial Production

Bifacial technology is one of the oldest identified tool types known since the 19th century, and one of the most extensively studied systems of lithic production, given its broad regional and temporal distribution. As the name suggests, bifaces are categorised by the working of raw material on both sides of the flake/blank/nodule, and can feature varying degrees of working and refinement, hence their variability in shape. Typically seen as a defining characteristic of the Lower Palaeolithic and the Acheulean (Gamble, 1999), bifacial technologies are a marginalised phenomenon in the Early Middle Palaeolithic of north-west Europe, with the widespread adoption and use of prepared core technologies documented (Monnier, 2006a; Scott, 2011). Many examples however occur throughout both periods of the Middle Palaeolithic, with a strong reappearance documented from MOIS 5 onwards (see Ruebens, 2012).

Studies of bifacial technology are often focussed on regional variability and social transmission (Cliquet et al., 2001; Soressi, 2002; Wragg-Sykes, 2009; Ruebens, 2012, Corbey et al., 2016), temporal variation in shape (White, 1998; Wenban-Smith, 2004), and the (un)importance of style, symmetry and form (Wynn and Tierson, 1990; Kohn and Mithen, 1999; Wynn, 2000; Machin et al., 2007; Pope et al., 2006). Over the last decade, a number of examples have been grounded on geometric morphometric methodologies (Brande and Saragusti, 1996; Iovita, 2010; Iovita and McPherron, 2011; Serwatka, 2014, 2015, Shipton and Clarkson, 2015), a method used in this thesis.

3.6.1.4. Pucheuil-Type Flake Production

Pucheuil-type production is a lesser-observed phenomenon within the Middle Palaeolithic repertoire, taking its name from where it was first observed, the Early Middle Palaeolithic (MOIS 6) context of Le Pucheuil, Saint-Saëns, France (Delagnes, 1993). Pucheuil-type production is a recurrent unidirectional method utilising *débitage* associated with Levallois convergent unidirectional (point) reduction sequences, whether as flakes, chunks or cores - so long as the blank is relatively thick with an extended flat face. Preparation is minimal, limited to preparation of a convex (or plano-convex) facetted edge on an otherwise unprepared flat surface of the core. All flakes are extracted unidirectionally from a single platform, with each flake superposed on the previous flake. As with other Middle Palaeolithic strategies, direct hard-hammer percussion is used.

The flakes extracted are thin and wide, typically straight or convex, with short lateral edges, and are never intentionally modified with retouch. Use-wear analyses have highlighted that the use of Pucheuil-type flakes was utilised in a variety of behaviours including butchery tasks, and the working of hide, bone, and other organic material (Lazuén and Delagnes, 2014). Furthermore, analyses highlighted that the cores were not used as tools, but solely to produce Pucheuil-type flakes (*ibid*. 345). In addition to being recovered at Le Pucheuil, the Pucheuil-type strategy has also been identified in later contexts, including the Early Upper Palaeolithic (Hahn, 1989). For more information see Delagnes (1993, 1996a, 1996b) and Lazuén and Delagnes (2014). For a schematic representation of Le Pucheuil production see Figure 3.3.

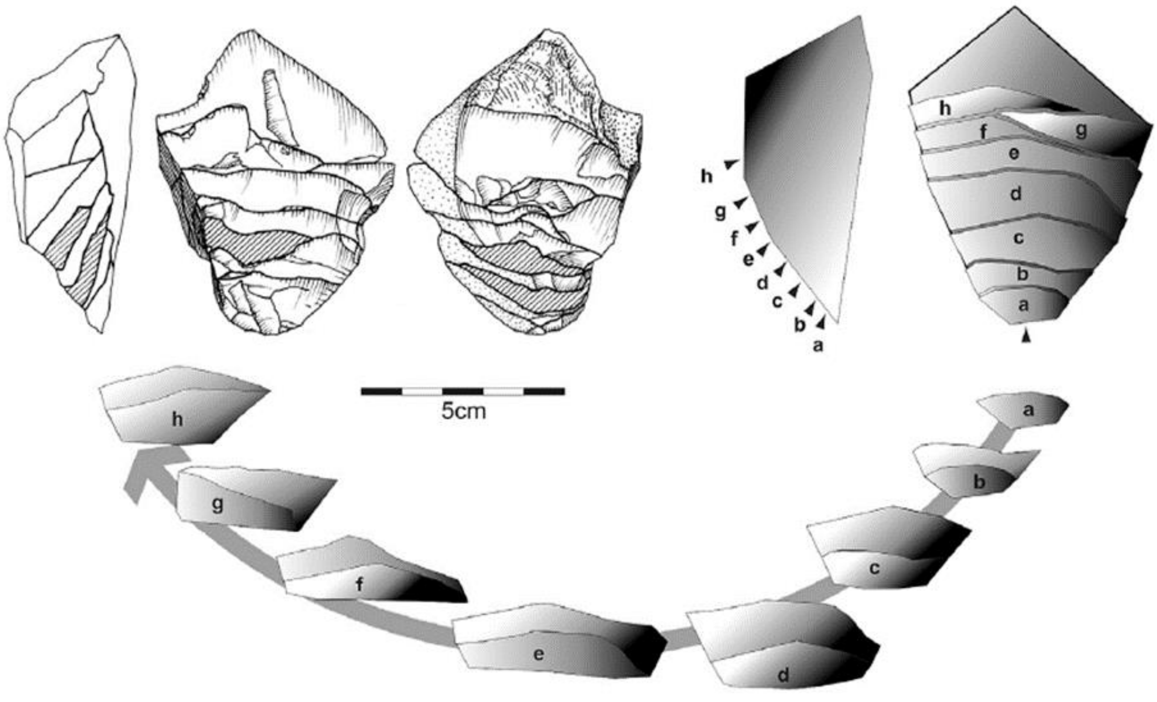


Figure 3.3. A schematic representation and archaeological example of Pucheuil-type *débitage*. Top right and bottom: Pucheuil-type reduction sequence. Top left: refit of eight Pucheuil-type flakes from Le Pucheuil (modified from Lazuén and Delagnes, 2014)

3.6.1.5. Les Tares Flake Production

Débitage des Tares or Les Tares technology is another core volume management strategy witnessed in MOIS 6, contemporary with Pucheuil-type *débitage.* It features very little recurrent exploitation, unlike Pucheuil-type technology, with unidirectional and centripetal removals around the volume of the core. Similarities with both Kombewa production (an Africa-based technique, Owen, 1938; Balout, 1967; Dauvois, 1981) and the Clactonian (McNabb, 2006) have been suggested with regards to the initial core reduction stages, with parallels suggested to the Lower Palaeolithic context of High Lodge (Geneste and Plisson, 1996).

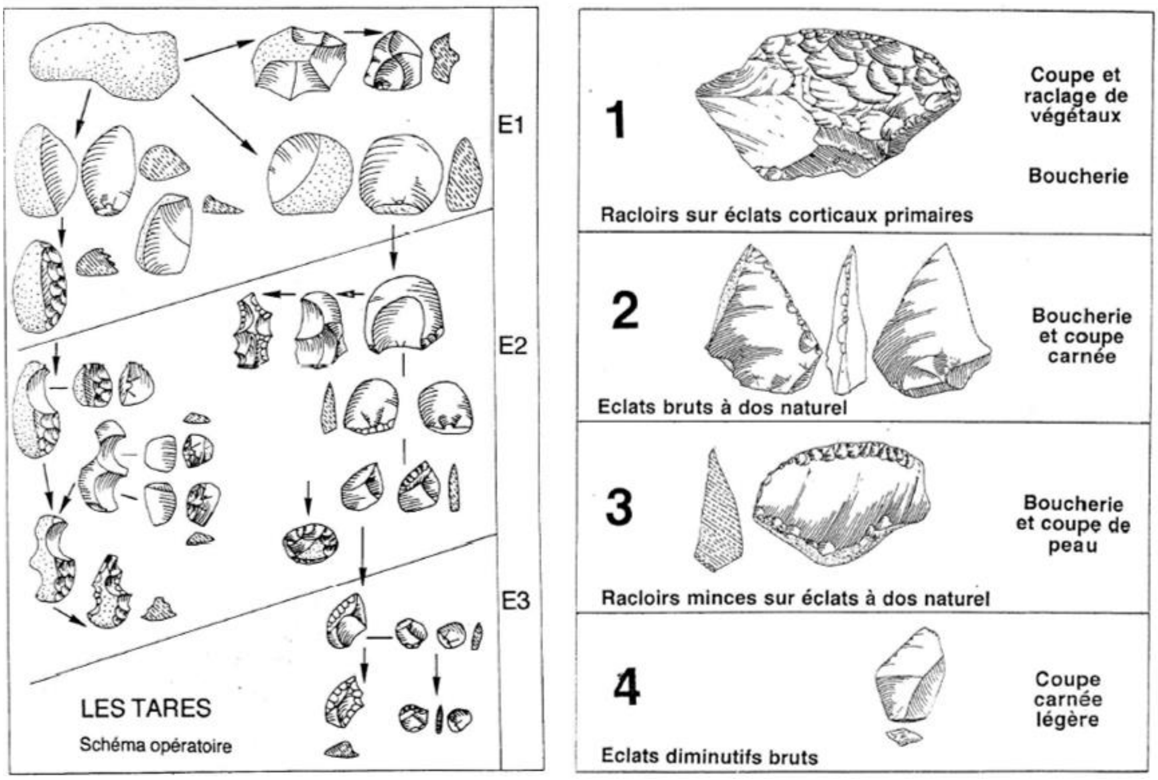


Figure 3.4. Left: The *chaîne opératoire* for Les Tares flake production.
Right: the four different types of Les Tares products and their associated task
(see Geneste and Plisson 1996 for more information).

In Les Tares production Geneste and Plisson (1996) suggest four types of product are manufactured: a) primary cortical flakes with scraper retouch (*racloirs sur éclats corticaux primaires),* b) naturally-backed unmodified flakes (*éclats bruts à dos naturel*), c) thin naturally-backed flakes with scraper retouch (*racloirs minces sur éclats à dos naturel*), and d) small unmodified flakes (*éclats diminutifs bruts*). See Figure 3.4 for more information.

Through use-wear analyses, Geneste and Plisson (1996) have highlighted how Les Tares *débitage* have been associated with activities of animal resource exploitation, particularly towards large herbivores including *equidae*, *bovidae*, and *rangifer*. Furthermore, Geneste and Plisson (1996) were able to demonstrate that the four different end-products produced were associated with individual activities of butchery, emphasising a strategy where end-products are function-specific in their adoption.

3.6.2. Other Forms of Archaeological Evidence for the Middle Palaeolithic

While this thesis focuses on the premise that lithic artefacts represent evidence for understanding Neanderthal behaviour, they only form one strand for highlighting hominin behaviour within the Middle Palaeolithic. However, there is now a corpus of archaeological evidence and statistical models (through ethnographic frameworks) which highlight the use of non-lithic technologies throughout the Middle Palaeolithic. For a summary of the evidence pertaining to non-lithic technologies see Figure 3.5.

From the onset of the Middle Palaeolithic (c.300,000-200,000 BP), a substantial amount of organic material has been unearthed. This includes evidence for wooden spears and hafts dating from c.300,000 BP at the Lower Saxony site of Schöningen (Thieme, 1997; Burdukiewicz, 2005), the adoption of tar adhesives as early as c.250,000-200,000 BP at Campitello Quarry (Mazza et al., 2006) and extensive evidence for the use and control of fire at sites including Pontnewydd Cave (Aldhouse-Green et al., 2012), Ehringsdorf (Steiner, 1975; Schäfer and Jäger, 1984) and Biache-Saint-Vaast (Tuffreau and Sommé, 1988). In addition, Pontnewydd Cave yields evidence for Neanderthal teeth with an intentional deposition hypothesised (Aldhouse-Green et al., 2012).

From c.200,000 BP, until the beginning of the Late Middle Palaeolithic, we see continued evidence for controlled use of fire at sites including Therdonne (Hérrison et al., 2013), Port Pignot (Cliquet and Lautridou, 2009; Cliquet et al., 2003) and later layers of Biache-Saint-Vaast (Tuffreau and Sommé, 1988). There are also behaviours associated with intentional restructuring of the landscape, including intentional faunal organisation at La Cotte de St. Brelade (Scott et al., 2014), and the creation of cave constructions at Bruniquel Cave (Jaubert et al., 2016). The modification of osseous material has been reported at the Early Middle Palaeolithic site of Grotte Vauffrey (Rigaud, 1988; Vincent, 1993), dating to 200,000 BP; however, evidence has cast doubt on its status as a worked artefact (Villa and d'Errico, 2001).

This issue has also been raised in a variety of other later contexts including Combe Grenal and Camiac (Villa and d'Errico, 2001: 103).

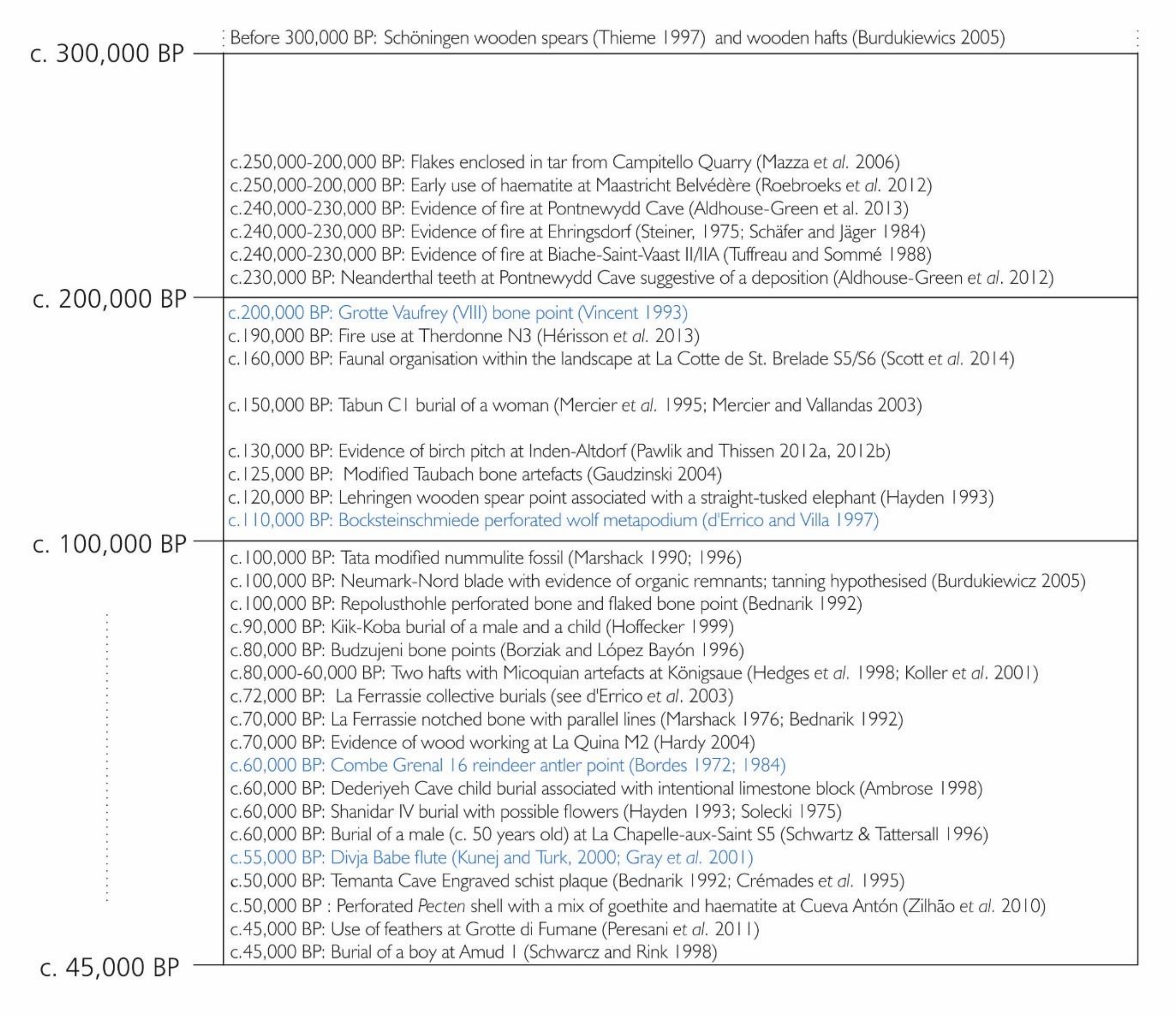


Figure 3.5. An overview of non-lithic archaeological evidence associated with the Middle Palaeolithic (blue: contentious artefacts)

From the beginning of the Late Middle Palaeolithic, the anthropogenic modification of bone can be seen at the German site of Taubach (Gaudzinski, 2004), and the more contentious piece at the MOIS 5 German site of Bocksteinschmiede (Bednarik, 1992) - see d'Errico and Villa (1997) for their rebuttal. Further evidence for wooden spears in association with a straight-tusked elephant at Lehringen (Hayden, 1993), and further evidence for birch pitch at Inden-Altdorf (Pawlik and Thissen, 2011a, 2011b) has also been documented.

From c.100,000-50,000 BP, further behaviours are exemplified including the suggestion of hide tanning at the German site of Neumark-Nord (Burdukiewicz, 2005), the modification of nummulite fossils at the Hungarian site of Tata (Marshack, 1991), flaked bone points at the sites of Repolusthole (Mellars, 1996; Rednarik, 1992) and Budzujeni (Borziak and López Bayón, 1996), and evidence for collective burials at La Ferrassie (Mellars, 1986; d'Errico et al., 2003). More recently, analyses of faunal remains on a series of late Neanderthal sites, in conjunction with ethnographic data, have led to suggestions that mammalian species typically used for cold weather clothing were present, to the extent of 'cape-like' clothing (Collard et al., 2016).

The end of the Middle Palaeolithic (MOIS 3) is marked by an increase in the variety of behaviours witnessed in the archaeological record. It is worth stressing that this may not represent a significant increase in the number of technological innovations, or of acculturated behaviours in association with modern humans, but rather preservational biases. Examples include the use of feathers at the Italian site of Grotte di Fumane (Peresani et al., 2011), the engraving of schist plaques at Temnata Cave (Bednarik, 1992; Crémades et al., 1995), behaviours associated with elaboration, decoration, and ornamentation with the working of *Pecten* shells coated with a goethite and haematite mixture from Cueva Antón (Zilhão et al., 2010), and suggested ideas of music with the Divje Babe 'flute' (Kunej and Turk, 2000; Gray et al., 2001). See d'Errico et al. (1998a, 1998b) and Chase and Nowell (1988) for critiques of the Divje Babe archaeological evidence.

3.7. Summary

This chapter has highlighted the rich corpus of archaeological material throughout the European Middle Palaeolithic, producing a high-resolution biography of hominin life. Its richness allows various questions to be addressed, and models of variability to be tested, including the influence of ideas from outside Europe (Foley and Lahr, 1997), and for this thesis, the pertinence of artefact design, desirability and function. The various core volume management strategies highlight the possible use of specific strategies for specific actions and faunal associations, the spatial clustering of certain strategies, and the importance of morphology within the Middle Palaeolithic. All these aspects need to be appreciated and considered when the relationship between Levallois and Laminar blades are investigated.

Chapter Four
The Theoretical Framework: Contextualising Middle Palaeolithic Technological Blade Strategies and Technological Variability

4.1. Introduction

This chapter presents the research framework and theoretical background underpinning this thesis. It highlights the main issues and problems within the literature pertaining to technological blade production, and justifies the necessity of examining aspects of artefact design and desirability through a technological and morphometric (both traditional and geometric) framework using archaeological and experimental data. In its structure, this chapter is divided into five sections:

1. The distribution, number, and spatio-temporal framework of individual and concurrent Laminar and Levallois recurrent (elongated) technological blade strategies throughout the Middle Palaeolithic will be documented, from its earliest instances (c. 545,000 BP) until the end of the Middle Palaeolithic;

2. Previous and current theoretical frameworks for Laminar and Levallois technological blade strategies will be outlined and analysed, discussing the evolution of blade strategies, notions of 'technocomplexes' and functional considerations of blade technology;

3. The frameworks for understanding technological variability (how and why variability happens);

4. The potential frameworks that can be applied; the strengths and weaknesses with the various methodologies which can be adopted are assessed and explained;

5. A summary of problems within the existing literature, and a justification of the questions and methodologies used throughout.

4.2. The Archaeological Evidence for Laminar and Levallois Methods of Blade Production

It is essential for any theoretical framework to outline the archaeological evidence that is pertinent to the research questions and problems outlined, as it allows the reader to evaluate the importance of the questions and methodology within the context of its broader discipline.

For this thesis, it is also important for several reasons. Firstly, the true extent and distribution of Laminar technological blade strategies throughout the European (and wider afield) Middle Palaeolithic are unknown. Publications have highlighted the nature and distribution of Laminar technological strategies (Révillion, 1995; Bar-Yosef and Kuhn, 1999; Delagnes, 2000; Moncel, 2005; Locht et al., 2010a), however these have been focussed on a sub-period or region (e.g. Locht et al's 2010a study of MOIS 5 in north-west Europe). In these instances, they do not reflect the true extent of the archaeological evidence for Laminar technological blade strategies (e.g. Bar-Yosef and Kuhn, 1999) and the changing wider Middle Palaeolithic perspective. Or, as certain chapters in Révillion and Tuffreau (1994) exemplify, Levallois technological blade strategies have been incorporated into the 'Laminar' definition. With the discovery of numerous contexts featuring specific technological blade strategies (e.g. Locht et al., 2013a), and suggestions of Laminar technology in Early Middle Palaeolithic contexts e.g. the Belgian site of Mesvin (IV) (Ryssaert, 2006a; see below), a murky picture occurs where the true extent of Laminar technological blade strategies are unknown.

This too is the same for the extent and distribution of Levallois technological blade strategies. As the diversity of Levallois technological blades has only been appreciated in recent decades (Böeda, 1986, 1988a; Van Peer, 1992; Scott, 2011), there has been a distinct lack of research into the distribution and nature of Levallois elongated (recurrent) technological blade strategies. This is beginning to change (e.g. Wiśniewski 2014); however, the evidence, distribution and nature of Levallois strategies which are designed to produce this stereotyped elongated material are unknown in north-west Europe.

Thirdly, because of these previous problems, the spatio-temporal relationship between these two technological blade strategies, or the act of producing stereotyped elongated material from two different core volume management strategies, is poorly understand. Publications have highlighted a possible relationship with Laminar technological blade strategies and Levallois technology more generally (Delagnes, 2000; Delagnes and Meignen, 2006; Locht et al., 2010a), but the specific relationship between the two blade strategies has not been investigated. How do these two technological strategies relate to each other, and how do we account for contexts which feature both methods of blade production, and the apparent change from one strategy to another throughout the Middle Palaeolithic?

A spatio-temporal overview of the sites discussed below is documented in Figure 4.1.

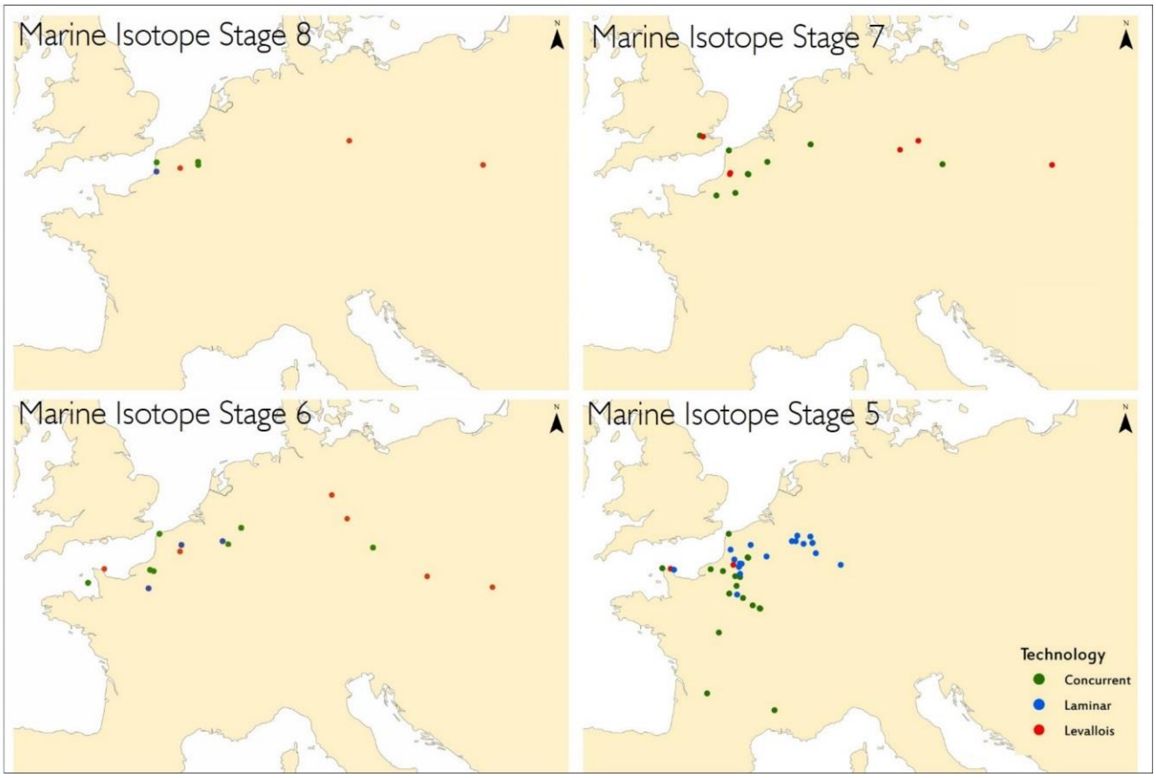


Figure 4.1. A spatio-temporal overview for archaeological contexts featuring Levallois, Laminar, and concurrent technological blade strategies (n = 90)

4.2.1. The Archaeological Evidence for Laminar Blade Production (until c. 71,000 BP)

As briefly noted in Chapter 2, our knowledge on the systematic study of Middle Palaeolithic blade production is relatively young, with just under half a century's study. While there have been many studies to highlight the existence of Laminar blade strategies in the Middle Palaeolithic, there have been few to quantify this data, to conclude how many contexts that are specifically Laminar are known to exist, and to document how many of these contexts co-exist with Levallois blade techniques. One of the first acknowledgements for the widespread use of Middle Palaeolithic blade strategies, following the publication of sites including Rheindahlen and Séclin, was the 1984 roundtable discussion on the '*phénomène lame*', by Jacques Tixier (Tixier et al., 1984) where it was noted that there was "*fait scientifique observe* *et indiscutable*" (Tixier et al., 1984: 14) existence for blades within Middle Palaeolithic contexts. This was followed by Conard (1990), who aimed not to catalogue all Laminar blade strategies, but rather challenge notions of lithic artefacts as possible 'fossil-types' by Foley (1987), through noting the existence of blade-based strategies in Middle Palaeolithic contexts. A second roundtable in 1994, chaired by Alain Tuffreau and Stéphane Révillion, addressed the phenomenon of Middle Palaeolithic strategies in further detail; this is, perhaps, better known by their 1994 co-edited volume '*Les Industries laminaires au Paléolithique moyen'* (Révillion and Tuffreau, 1994). The discussion and volume highlighted the nature of Laminar (and Levallois) strategies throughout Europe and in Western Asia (in sixteen contexts), and became the synthesis to appreciate the volume of evidence around Europe. This volume would have benefitted from a thorough inter-contextual analysis of the technological blade strategies discussed within; however, its production was a significant development in acknowledging and disseminating the knowledge that blade industries could be witnessed throughout the Middle Palaeolithic.

In 1995, this was followed by the publication of data originating from Stéphane Révillion's doctoral thesis. A variety of case studies were outlined to discuss and address whether a technological evolution of blade strategies could be noted. Révillion (1995) believed that no chronological meaning or evolution was apparent, but this view could have been developed for various reasons, including: 1) increasing the dataset size, 2) discussing the chronological framework in more detail, and 3) providing more in-depth technological analyses. Any assessment of temporal development in technology requires a thorough appreciation of the chronologies in question, in conjunction with extensive *chaîne opératoire* and technological analyses in order to understand what (dis)similarities in behaviour can be concluded. Révillion's doctoral thesis (Révillion, 1993) was exemplary in assessing technological differences among three sites: Saint-Germain-des-Vaux/Port-Racine (Cliquet, 1994), Séclin (see Chapter 2), and Riencourt-lès-Bapaume (Ameloot-Van der Heijden, 1991a, 1991b; 1993), and similar technological analyses within a wider spatio-temporal context, building on from Révillion 1995, are essential for understanding the nature of Laminar industries within the Middle Palaeolithic.

Both the work of Stéphane Révillion, and the publication by Bar-Yosef and Kuhn (1999), were important in communicating how widespread the use of Laminar techniques was within the Middle Palaeolithic repertoire, and particularly to an Anglophonic audience, in the case of Bar-Yosef and Kuhn (1999). Following these, three more large-scale overviews were published, exemplifying the use of the Laminar technique throughout the Old World: Delagnes (2000), Meignen (2000), and Kozlowski (2001).

Delagnes (2000) provided an overview of the archaeological evidence within north-west Europe during MOIS 5 and discussed the clustering of evidence within north-west Europe, what later became termed the 'Northwest Technocomplex' (Depaepe, 2007). Unique to this article was the description of the different core volume management strategies, which forms the basis of the strategies used throughout this thesis. In this, strategies such as the 'Rocourt' blade technique could be categorised within the four-fold categories of *frontal, facial, tournant and semi-tournant*. In this, Delagnes (2000) became unique at the time for detailing various core configurations in terms of their technology and morphology, allowing a more explicit understanding of Laminar technology to be cross-examined. Meignen (2000), similarly to Delagnes (2000), focussed on a specific region, south-western Asia, outlining what she describes as the 'blady phenomenon', a term first coined in Meignen (1994). In this, contexts including Tabun IX (Shimelmitz, and Kuhn, 2013; Shimelmitz, 2014), Hayonim E and F (Meignen, 2002) and Rosh Ein Mor (Marks and Crew, 1972) were noted as exemplifying both Laminar and Levallois technological blade strategies throughout the Middle Palaeolithic of south-western Asia, hinting at a possible relationship between the two technologies. Similarly, Kozlowski (2001) outlined the evidence for technological blade strategies throughout the Late Middle and Early Upper Palaeolithic of Europe, discussing elements of continuity and change. Importantly, Kozlowski (2001) also notes a transition from Levallois-rich technological blade strategies to later Laminar-rich technological blade strategies, without suggesting explicitly why this occurs.

In all three publications at the start of the millennium, Laminar technological blade strategies were noted, together with some appreciation of Levallois technology (Delagnes, 2000), and more specifically, Levallois technological blade strategies (Meignen, 2000; Kozlowski, 2001). While they did not engage with creating explanations as to why these two strategies fluctuate in quantity, or (do not) appear concurrently, these publications built on the work from others in documenting and providing some form of narrative for Neanderthals producing elongated, stereotyped strategies from both Laminar and Levallois technological blades.

Other publications from the beginning of the millennium discussed and documented the nature of Laminar industries throughout Western Asia, Africa and Europe (Moncel, 2001, 2005; Bringmans, 2006; Delagnes and Meignen, 2006; Meignen, 2007; Johnson and McBrearty, 2010; Locht et al., 2010a). In the examples above, attempts to discuss wider shared behaviours and *chaînes opératoires* are lacking. This essential framework is essential for understanding the true nature of technological variability throughout the European Middle Palaeolithic. For example, how many contexts feature evidence for the preparation of blade cores through cresting? Can a pattern be observed throughout north-west Europe? And with respect to the Northwest Technocomplex, are the techniques. the ways they prepare and exploit cores, and the degree of retouch comparable?

For an overview of different publications which discuss Laminar strategies in detail and the regions and periods they cover, see Table 4.1.

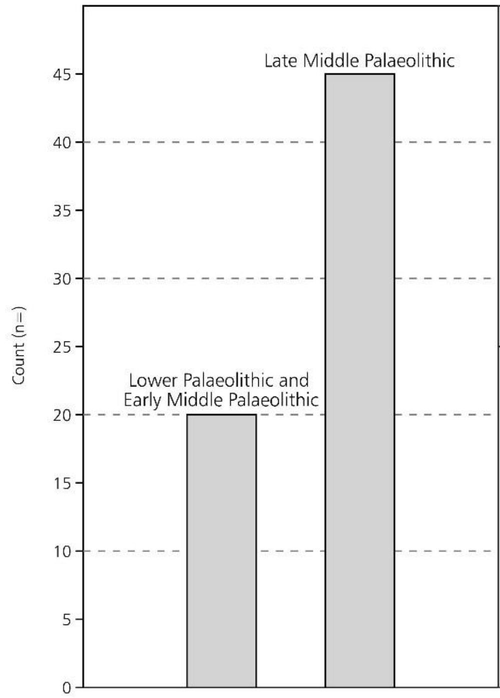
	Period covered			Region covered			
Publication	Pre-MOIS5	MOIS 5	Post-MOIS 5	Europe	Africa	Western Asia	Comment(s)
Conard (1990)		■		■			Four sites discussed
Révillion (1993)	■	■		■			General overview
Tuffreau and Révillion (1994)	■	■	■	■		■	General overview
Révillion (1995)	■	■	■	■			General overview
Bar-Yosef and Kuhn (1999)	■	■	■	■	■	■	General overview
Delagnes (2000)		■		■			Specific to the Northwest Technocomplex
Meignen (2000)	■	■				■	Specific to Western Asia
Kozlowski (2001)	■	■	■	■	■	■	General overview
Moncel (2001)		■	■	■			Specific to Southern France
Moncel (2005)	■	■	■	■		■	General overview
Bringmans (2006)	■	■	■	■			General overview
Meignen (2007)	■	■				■	Specific to Western Asia
Locht *et al.* (2010a)		■	■	■			Specific to the Northwest Technocomplex
Hoggard (2012)		■		■			Specific to the Northwest Technocomplex
Hoggard (2013)	■			■	■	■	Reviews contexts before c.130,000 BP

Table 4.1. Publications which discuss Laminar technology and the nature of evidence investigated (shading: present)

4.2.1.1. European Evidence for Laminar Blade Production Until c. 71,000 BP

Through an extensive review of literature pertaining to blade technology, and discussions with researchers and academics familiar with the archaeological record of the European Middle Palaeolithic (Locht Pers. Comm.; Otte, Pers. Comm.), a synthesis of sites featuring Laminar technology has been created, from its earliest instances in the Lower Palaeolithic up until the end of the Late Middle Palaeolithic. It is unique in scale, and provides the basis of this thesis for analysing Laminar technological blade strategies. Through its synthesis, it is evident that the evidence is, to some degree, a regionalised phenomenon, largely specific to north-west Europe. It is unknown, at present, whether this reflects technological traditions and shared behaviours within the Middle Palaeolithic, or potential archaeological bias influenced by extensive archaeological investigations by commercial and archaeological units in north-west Europe e.g. *Intitut National Recherches Archéologiques Préventives (INRAP henceforth*).

The European evidence for Laminar technological blade strategies represents the largest corpus of Laminar strategies anywhere within the Middle Palaeolithic, comprising of sixty-five contexts in total. The greatest amount of evidence (comprising just under 70% of all sites) occurs in MOIS 5, primarily sub-stages 5c and 5a (Figure 4.2), however evidence for Laminar technological blade systems can also be observed in MOIS sub-stages 5e (excluding France), and 5d. Sites excluded from this dataset, for issues surrounding chronometric issues, include Piekary (IIA) (Sitlivy et al., 2008), Oosthoven-Heieinde (Ruebens, 2006), and Omal (Bonjean, 1990). For an overview see Table 4.2.



Lower Palaeolithic and Early Middle Palaeolithic

MOIS	Context count (n=)
9	1
8	3
7	8
Transitional 7/6	3
6	5

Late Middle Palaeolithic

MOIS	Context count (n=)
5e	4
5d	7
5c	12
5b	0
5a	22

Figure 4.2. A breakdown of Laminar technological blade strategies throughout the Middle Palaeolithic divided by period, Marine Oxygen Isotope Stage (MOIS) and sub-stage

In the European Early Middle Palaeolithic, evidence for Laminar blade production can be seen in seventeen contexts. Even before the Early Middle Palaeolithic, evidence for Laminar technology can be documented as early as MOIS 9, in the Italian site of Cave dall'Olio (Fontana et al., 2009, 2013), making this context at present the only known Lower Palaeolithic context within Europe to feature Laminar technology. Interestingly, it is spatially exclusive from subsequent archaeological evidence for Laminar production systems, possibly suggestive of a localised *in-situ* innovation, prior to the breadth of evidence in the Early Middle Palaeolithic. It is also worth noting that within contexts discussed in this thesis, Cave dall'Olio is also the only Italian example of the Laminar technique prior to c. 71,000 BP.

From MOIS 8 the existence of Laminar technology is documented at several sites including: Mesvin (IV) (Cahen et al., 1984; Cahen and Michel, 1986), and Saint-Valery-sur-Somme (Moulin de la Veuve Rignon) (de Heinzelin and Haesaerts, 1983), both analysed within this thesis, and the French site of Bagarre-Étaples (Tuffreau et al., 1975). The blade core from the transitional MOIS 8/7 context of Baker's Hole (Wenban-Smith, 1990, 1992) is excluded for chronostratigraphic and taphonomic reasons (Scott, 2010) - see Chapter 9. Through MOIS 7, an increase in the number of contexts to feature Laminar technology is documented, with eight further contexts known: Rheindahlen (B1/B2) (Bosinski, 1966), Boutmy-Muchembled (Commont, 1909a, 1909b, 1912), Tourville-la-Rivière (D2) (Faivre et al., 2012, 2014), Le Rissori (IIIA/IIIB) (Adam and Tuffreau, 1973; described within), Bečov (I A-III-6) (Fridrich, 1982; Wiśniewski and Fridrich, 2010), and Crayford (note: not the refits from Stoneham's Pit, recently reassessed by Scott 2006, 2011) - see analyses for more information. Towards the end of MOIS 7 and beginning of MOIS 6, three further contexts are documented: the French contexts of Therdonne (N3) (Locht et al., 2010b; analysed within), Bapaume-les Osiers (B) (Tuffreau, 1976), and Coquelles (Lower Gravels) (Lefèbvre, 1961, 1969, 1976), before being represented by five contexts in MOIS 6: Coquelles (C5) (Lefèbvre, 1969; Tuffreau, 1971), Saint-Symphorien/Helin Pit (de Munck, 1893; de Heinzlin, 1959; Michel, 1978) La Cotte de St. Brelade (C5) (Scott, 1980; Soriano, 2000; Scott et al., 2014), Le Pucheuil (B) (Delagnes, 1993; Delagnes, 1996a; Delagnes and Ropars, 1996) and Bečov (I A-III-5) (Fridrich, 1982; Wiśniewski and Fridrich, 2010). Recent redating of the MOIS 6 context of the Veldwezelt-Hezerwater horizon (Meijs, 2011) now attributes this site to the Late Middle Palaeolithic (MOIS 5d), and is there not categorised as an Early Middle Palaeolithic context.

These contexts vary greatly in size and temporal range with Therdonne representing multiple occupations and up to c. 49,300 artefacts (including *microdébitage*) in one individual layer, and Saint-Valery-sur-Somme representing a more ephemeral context, and yielding a total of around 130 artefacts. The majority of sites are known for their Levallois component with many examples featuring Levallois recurrent elongated strategies (e.g. Mesvin and the Le Rissori complex). Examples of contexts featuring an absence of Levallois technology are also known (e.g. Saint-Valery-sur-Somme). Bifacial (to a limited degree), discoid and other flaking strategies discussed in Chapter 3 are also documented, exemplifying their association with the greater Neanderthal technological repertoire. One site, Tourville-la-Rivière, documents evidence of hominin remains associated with Laminar technology (Faivre *et al.*, 2014).

Of the nineteen contexts, only four feature radiometric dates (see Table 4.2). While there are several studies into the nature of chronologies in north-west Europe through chronostratigraphy, these are less precise and of lower resolution for the Early Middle Palaeolithic record. Further dating would ensure a more robust chronology of Europe's earliest blade industries; this too would satisfy queries about the dating of sites, for example Bapaume-les Osiers (Locht Pers. Comm.).

Throughout the Late Middle Palaeolithic (until c. 71,000 BP) however, there is richer evidence for the existence of Laminar technological blade production, in contrast to earlier periods, with forty-five contexts observed for MOIS 5 (Table 4.2). Also in contrast to evidence from the Early Middle Palaeolithic, a significant number of contexts feature radiometric dates allowing for a more detailed chronology of Laminar technological blade strategies at a sub-stage level.

Throughout MOIS 5e (c. 130,000-109,000 BP) four sites document the existence of Laminar technological blade production: the Belgian site of Soignies Le Clypot (Haesaerts, 1978), and the German contexts of Inden-Altdorf (Pawlik and Thissen, 2011a, 2011b), Wallertheim (D) (Conard, 1992; Conard et al., 1995; Conard and Adler, 1996; Conard and Adler, 1997; Conard and Prindville, 2000) and Tönchesberg 2B (Conard, 1990, 1992). It is perhaps significant to note the distinct absence of archaeological evidence for French blade contexts during this sub-stage; this is discussed in later sections.

Laminar technological blade industries reappear in greater volume during MOIS 5d (c. 109,000-96,000 BP) with seven contexts in France and Belgium documented. These are the French contexts of Verrières-le-Buisson (Gouédo, 1999), Vinneuf Les Hauts Massous (N1) (Gouédo, 1994, 1999; Deloze et al., 1994), Ailly-sur-Noye (N1) (Blondiau et al., 2009; Locht et al., 2013a), Bettencourt-Saint-Ouen (N3B) (Locht, 2002), and the Belgian contexts of Mont Saint-Martin Saint-Hubert (van der Sloot et al., 2011), and the redated Veldwezelt-Hezerwater VLB and VLL contexts (Vanmonfort et al., 1998; Bringmans et al., 1999, 2004; Bringmans, 2006, 2007; Meijs, 2011).

MIS 5c (c. 96,000-87,000 BP) marks a sharp increase in the number of sites, with twelve contexts documented, all French in nature: Villiers-Adam Le Petit Saule (N2) (Locht et al., 2003), Saint-Hilaire-sur-Helpe (Feray et al., 2013), Ailly-sur-Noye (N2) (Locht et al., 2013a), the Séclin (D4/D6/D7) complex (Tuffreau and Révillion, 1984; Tuffreau et al., 1985; Révillion and Tuffreau, 1994; Révillion, 1988, 1989, 1993a, 1993b, 1995; Tuffreau et al., 1994), Cantalouette (4) (Blaser et al., 2009, 2012), La Butte d'Arvigny (Gouédo et al., 1994; Laurent et al., 2000); La Minette á Fitz-James (Teheux, 2000), Soindres (C) (Marti et al., 2002; Koehler et al., 2014), Saint-Germain-des-Vaux/Port-Racine (Révillion, 1993a, 1993b; Révillion and Cliquet, 1990; Cliquet, 1994), Le Rouzel (TR67) (Van Vliet-Lanoë et al., 2006), and Villeneuve-l'Archeveque (C) (Deloze et al., 1994; Depaepe, 2007).

In comparison to previous sub-stages, MOIS 5b (c. 87,000-82,000 BP) is noted as yielding no evidence for technological blade strategies, and more generally no evidence for material culture in north-west Europe, owing to noted climatic deterioration from palynological and ice-core data (NGRIP Members, 2004; Locht et al., 2010a).

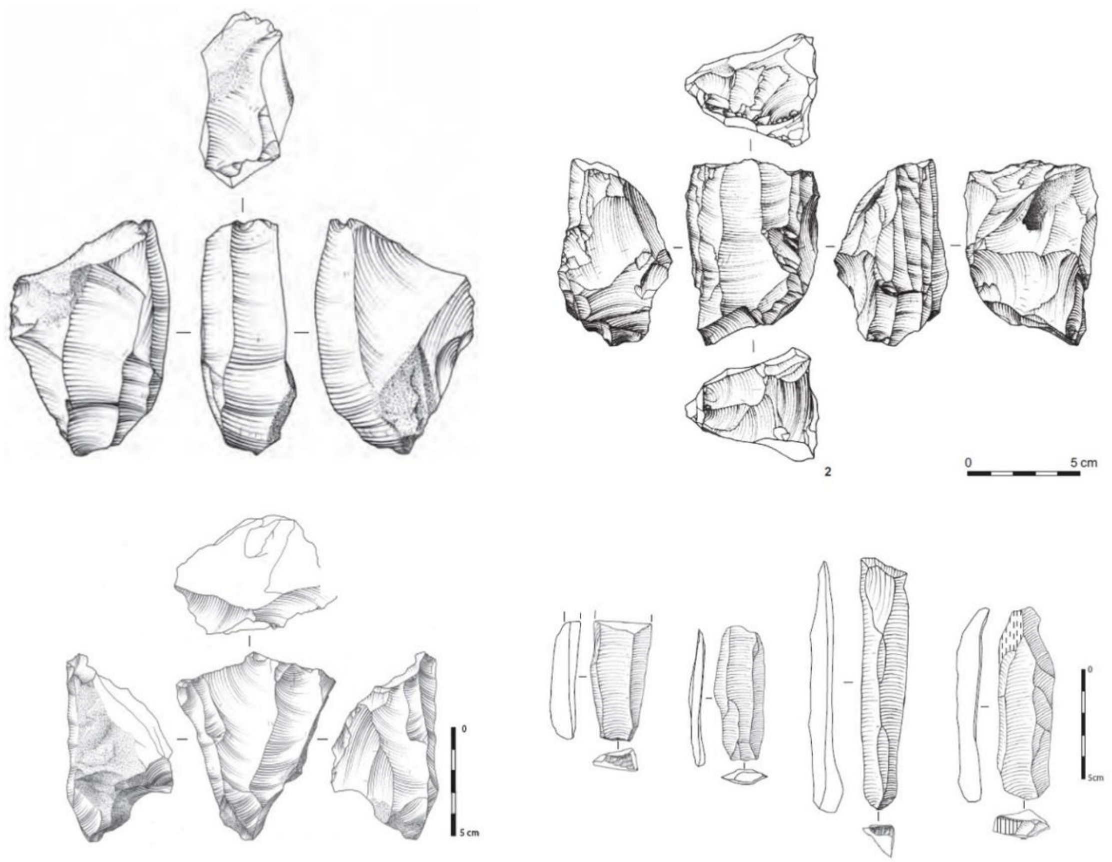


Figure 4.3. Archaeological examples of Middle Palaeolithic Laminar *débitage*.
Top left: *tournant* bidirectional core from Saint-Just-en-Chaussée (N3) (Locht et al. 2013a)
Top right: *semi-tournant* bidirectional core from Therdonne (N3) (Locht et al. 2010b)
Bottom left: pyramidal unidirectional facial core from Angé (Locht et al. 2008a)
Bottom right: blades from Soindres (D) (Koehler et al. 2014)

Context	Region	MOIS	Date provided	Site nature	Key reference(s)
Late Middle Palaeolithic (c. 130,000-71,000 BP)					
Lailly/Le Fond de la Tournerie	France	End 5a?	MOIS 5a? (Chrono.)	Stratified	Deloze et al. 1994; Depaepe, 1997
Baume Flandin	France	End 5a	MOIS 5a (Chrono.)	Stratified	Moncel, 2005; Moncel et al. 2008
Bettencourt-Saint-Ouen (N1)	France	End 5a	77.2 ± 8.2 (TL)	Stratified	Locht et al. 2002
Molinons/Le Grand Chanteloup	France	End 5a	MOIS 5a (Chrono.)	Stratified	Deloze et al. 1994; Depaepe, 1997
Lailly/Le Domaine du Beauregard (B)	France	End 5a	MOIS 5a (Chrono.)	Stratified	Deloze et al. 1994; Locht and Depaepe, 1994
Gouy-Saint-André	France	End 5a	MOIS 5a (Chrono.)	Stratified	Depaepe and Deschodt, 2001
Blangy Tronville (inf.)	France	End 5a	MOIS 5a (Chrono.)	Stratified	Depaepe et al. 1999
Fresnoy-au-Val (Série 1)*	France	5a	MOIS 5a (Chrono.)	Stratified	Goval and Locht, 2009; Locht et al. 2008b
Rocourt	Belgium	5a	MOIS 5a (Chrono.)	Stratified	Otte et al. 1990; Otte, 1994; Révillion, 1995
Étoutteville	France	5a	MOIS 5a (Chrono.)	Stratified	Delagnes and Ropars, 1996
Riencourt-les-Bapaumes (C)	France	5a	MOIS 5a (Chrono.)	Stratified	Ameloot-Van der Heijden, 1993; Goval and Hérisson, 2006
Riencourt-les-Bapaumes (C12)	France	5a	MOIS 5a (Chrono.)	Stratified	Ameloot-Van der Heijden, 1993; Goval and Hérisson, 2006
Soindres (D)	France	5a	MOIS 5a (Chrono.)	Stratified	Marti et al. 2002; Koehler et al. 2014
Mauquenchy (WA2)	France	5a	83.7 ± 7.6 (TL)	Stratified	Locht et al. 2013b
Mauquenchy (WA1)	France	5a	77.6 ± 7.2 (TL)	Stratified	Locht et al. 2013b
Angé	France	5a	84.5 ± 3.8 (TL)	Stratified	Locht et al. 2008a; Koehler et al. 2014
Saint-Just-en-Chaussée (N3)	France	5a	MOIS 5a (Chrono.)	Stratified	Tuffreau 1977; Locht et al. 2013a
Villeneuve-l'Archeveque (B)	France	5a?	MOIS 5a (Chrono.)	Stratified	Deloze et al. 1994; Depaepe, 2007
Veldwezelt-Hezerwater (VBLB)	Belgium	5a?	MOIS 5a (Chrono.)	Stratified	Vanmonfort et al. 1998; Bringmans, 2006; Meijs, 2011
Villers-Bretonneux (SHS)	France	5a	MOIS 5a (Chrono.)	Stratified	Depaepe et al. 1997
Bettencourt-Saint-Ouen (N2B)	France	5a	77.0 ± 8.1 (TL)	Stratified	Locht, 2002
Remicourt (En Bia Flo)	Belgium	5a	MOIS 5a (Chrono.)	Stratified	Haesaerts et al. 1997, 1999; Bosquet et al. 2004
Saint-Germain-des-Vaux/Port-Racine	France	5c-5a?	106.0 ± 10.0 (TL)	Stratified	Révillion, 1993a; Révillion and Cliquet, 1990; Cliquet, 1994
Saint-Hilaire-sur-Helpe	France	5c	MOIS 5c (Chrono.)	Stratified	Feray et al. 2013
Villiers-Adam-Le Petit Saule (N2)	France	5c	105.0 ± 12.0 (TL)	Stratified	Locht et al. 2003
La Butte d'Arvigny	France	5c	90.0 (ESR)	Stratified	Gouedo et al. 1994; Laurent et al. 2000
Cantalouette (4)	France	5c-4	92.7 ± 8.6 - 61.0 ± 4.8 (TL)	Stratified	Blaser et al. 2009, 2012
La Minette à Fitz-James	France	5c (?)	MOIS 5c (Chrono.)	Stratified	Teheux, 2000
Soindres (C)	France	5c (?)	MOIS 5c (Chrono.)	Stratified	Marti et al. 2002; Koehler et al. 2014
Ailly-sur-Noye (N2)	France	5c	MOIS 5c (Chrono.)	Stratified	Blondiau et al. 2009; Locht et al. 2013
Séclin (D4)	France	5c	95.0 ± 10.0 (TL)	Stratified	Tuffreau et al. 1985; Révillion and Tuffreau, 1994
Séclin (D6)	France	5c	95.0 ± 10.0 (TL)	Stratified	Tuffreau et al. 1985; Révillion and Tuffreau, 1994
Séclin (D7)	France	5c	95.0 ± 10.0 (TL)	Stratified	Tuffreau et al. 1985; Révillion and Tuffreau, 1994
Le Rouzel (TR67)	France	5c	MOIS 5c (Chrono.)	Stratified	Van Vliet-Lanoë et al. 2006
Ailly-sur-Noye (N1)	France	5d-5c	MOIS 5d-5c (Chrono.)	Stratified	Blondiau et al. 2009; Locht et al. 2013a
Bettencourt-Saint-Ouen (N3B)	France	5d-5c	80.9 ± 8.2 (TL)	Stratified	Locht, 2002
Mont Saint-Martin (Saint-Hubert)	Belgium	5d	MOIS 5d (Chrono.)	Stratified	van der Sloot et al. 2011

Veldwezelt-Hezerwater (VLB)	Belgium	5d	MOIS 5d (Chrono.)	Stratified	Vanmonfort et al. 1998; Bringmans, 2006; Meijs, 2011
Veldwezelt-Hezerwater (VLL)	Belgium	5d	MOIS 5d (Chrono.)	Stratified	Vanmonfort et al. 1998; Bringmans, 2006; Meijs, 2011
Vinneuf Les-Houts-Massons (N1)	France	5d	MOIS 5d (Chrono.)	Stratified	Gouédo, 1994, 1999; Deloze et al. 1994
Verrières-le-Buisson	France	5d	MOIS 5d (Chrono.)	Stratified	Gouédo, 1999
Wallertheim (Wal-D)	Germany	5e-5c	107.0 ± 9.0 (TL)	Stratified	Conard, 1992; Conard and Adler, 1996; Conard et al. 1995
Tönchesberg (2B)	Germany	5e	115.0 (TL)	Stratified	Conard, 1990, 1992
Inden-Altdorf (Weisweiler-124)	Germany	5e	122.0-118.2 (Chrono.)	Stratified	Pawlik and Thissen, 2011a, 2011b
Soignies (Le Clypot)	Belgium	5e	MOIS 5e (Chrono.)	Stratified	Haesaerts, 1978

Early Middle Palaeolithic (c. 300,000-130,000 BP)

Saint-Symphorien (Helin Pit)	Belgium	6	MOIS 6/5 (Chrono.)	Stratified	de Munck, 1893; de Heinzlin, 1959; Michel, 1978
Le Pucheuil (B)	France	6	Early MOIS 6 (Chrono.)	Stratified	Delagnes, 1996; Delagnes and Ropars, 1996
La Cotte de St. Brelade (C5)	Channel Islands	6	Early MOIS 6 (Chrono.)	Stratified	Scott, 1980; Callow and Cornford, 1986; Scott et al. 2014
Bečov (I A-III-5)	Czech Republic	6	MOIS 6 (Bio.)	Stratified	Fridrich, 1982; Wiśniewski and Fridrich, 2010
Coquelles (C5)	France	6	MOIS 6 (Chrono.)	Stratified	Lefèbvre, 1969; Tuffreau, 1971; Révillion, 1995
Therdonne (N3)*	France	7a/6	178.0 ± 11.0 (TL)	Stratified	Locht et al. 2010b; Herisson and Locht, 2014
Bapaume-les Osiers (B)	France	7a/6	200.0-190.0 (TL)	Stratified	Tuffreau, 1976, Koehler, 2008; Balescu and Tuffreau, 2004
Coquelles (Lower Gravel)	France	7a/6	MOIS 7 (Chrono.)	Surface/Stratified	Lefèbvre, 1969; Tuffreau, 1971; Révillion, 1995
Crayford (various collections)*	Britain	8-6 (7?)	MOIS 8-6 (7?) (Chrono.)	Surface/Stratified	Cook, 1986; Scott, 2006, 2011
Tourville-la-Rivière (D2)	France	7	226.0-183.0 (ESR-U)	Stratified	Guilbaud and Carpentier, 1995; Faivre et al., 2014
Bečov (I A-III-6)	Czech Republic	7	MOIS 7 (Bio.)	Stratified	Fridrich, 1982; Wiśniewski and Fridrich, 2010
Boutmy-Muchembled	France	7 (?)	MOIS 7 (Chrono.)	Stratified	Commont, 1909a, 1909b; 1912
Rheindahlen (B1)	Germany	7	MOIS 7 (Chrono.)	Stratified	Bosinski, 1966; Schirmer, 2002
Rheindahlen (B2)	Germany	7	MOIS 7 (Chrono.)	Stratified	Bosinski, 1966; Schirmer, 2002
Le Rissori (IIIA)*	Belgium	7c (?)	MOIS 7c (Chrono.)	Stratified	Adam and Tuffreau, 1973; Adam, 1991, 2002
Le Rissori (IIIB)*	Belgium	7c (?)	MOIS 7c (Chrono.)	Stratified	Adam and Tuffreau, 1973; Adam, 1991, 2002
Bagarre-Étaples (C7)	France	8?	MOIS 8 (Chrono.)	Stratified	Tuffreau et al. 1975
Saint-Valery-sur-Somme (MVR)*	France	8?	MOIS 8 (Chrono.)	Stratified	de Heinzelin and Haesaerts, 1983
Mesvin (IV)*	Belgium	8	300.0-250.0 (U-Th/Chrono.)	Stratified	Cahen et al. 1984; Cahen and Michel, 1986

Lower Palaeolithic (before c. 300,000 BP)

Cave dall'Olio	Italy	9	MOIS 9 (Chrono.)	Stratified	Fontana et al. 2009, 2013

Table 4.2. An overview of the archaeological evidence for Laminar technological blade strategies in the European Middle Palaeolithic prior c. 71,000 BP. Asterisk: contexts analysed throughout the thesis

The end of MOIS 5, MOIS 5a (c. 82,000-71,000 BP), marks a return to Laminar technological blade strategies with twenty-two contexts observed: Remicourt (En Bia Flo) (Hasearts et al., 1997, 1999; Bosquet et al., 2004), Bettencourt-Saint-Ouen (N2B) (Locht, 2002), Villers-Brettoneux (SHS) (Depaepe et al., 1997), Veldwezelt-Hezerwater (VBLV) (Vanmonfort et al., 1998; Bringmans et al., 1999, 2004; Bringmans, 2006, 2007; Meijs, 2011), Villeneuve-l'Archeveque (B) (Deloze et al., 1994; Depaepe, 2007), Saint-Just-en-Chaussée (N3) (Tuffreau, 1977; Locht et al., 2013a), Angé (Locht et al., 2008a; Koehler et al., 2014), Mauquenchy (WA1/WA2) (Locht et al., 2013b), Soindres (D) (Marti et al., 2002; Koehler et al., 2014), Riencourt-les-Bapaumes (C/C12) (Ameelot-Van der Heijden, 1993, 1994; Goval and Hérisson, 2006), Étoutteville (Delagnes and Ropars, 1996), Rocourt (Otte et al., 1990; Otte, 1994; Révillion, 1995), Fresnoy-au-Val (Série 1) (Goval and Locht, 2009), Blangy-Tronville (Depaepe et al., 1999), Gouy-Saint-André (Depaepe and Deschodt, 2001), Lailly Le Domaine du Beauregard (B) (Deloze et al., 1994; Locht and Depaepe, 1994), Molinons Le Grand Chanteloup (Deloze et al., 1994; Locht and Depaepe, 1994), Bettencourt-Saint-Ouen (N1) (Locht, 2002) and Baume Flandin (Moncel, 2005; Moncel et al., 2008).

The French context of Lailly de Fond de la Tournerie (Deloze et al., 1994; Locht and Depaepe, 1994; Depaepe, 1997), has not been attributed to a specific sub-stage of MOIS 5, although a later date of MOIS 5a is hypothesised (Locht Pers. Comm.).

These sites throughout MOIS 5 are noted for their increased blade quantity per context. Other strategies, predominantly Levallois (recurrent and point) and flake-based operational sequences, are also widely documented throughout many contexts. More information on these contexts are detailed below. For examples of Laminar technological blade production see Figure 4.3.

4.2.1.2. Laminar Blade Production in Western Asia and Africa Until c. 71,000 BP

To understand the scale of evidence for Laminar technological blade production within the Old World, evidence in Africa and Western is considered here.

In contrast to Europe, most evidence for Laminar technology is documented in the Early Middle Palaeolithic, with a smaller number of contexts between c. 130,000-71,000 BP. In the majority of examples, radiometric dates are recorded allowing a more robust spatio-temporal framework to be examined.

Like Europe, one site attributed to the end of the Lower Palaeolithic features an abundance of evidence for the Laminar technique. At Qesem Cave, Laminar blade technology (through advantageous exploitation of the raw material's natural shape) is documented in considerable number, and technological and use-wear analyses shows its use as cutting implements for butchery-related activities (Barkai et al., 2003, 2005, 2009; Shimelmitz et al., 2011). The presence of core tablets, crested blades, and a distinct lack of other technological systems highlight what Shimelmitz (2011: 1) notes as the "systematic production" of blades before the Middle Palaeolithic, and the documentation of an extended sequence of Laminar technological blade production.

Throughout MOIS 7, several credible dated contexts document Laminar technology. These are the sites of Khonako (III), dating from c. 240,000-200,000 BP (Schäfer and Ranov, 1998; Schäfer et al., 1998), Hayonim Cave (Lower E/F), ranging from 224,000-190,000 BP (Mercier et al., 2007), two late Hummalian contexts (6B/6A), dating between 200,000-170,000 BP (Wotczak et al., 2005; Wojtczak, 2011, 2014a, 2014b), and Rosh Ein Mor (D15), with a U-series date of 200,000 ± 9,500 BP (Monigal, 2001, 2002; Rink et al., 2003). The dating of Rosh Ein Mor is problematic, given conflicting environmental data and issues of dating as emphasised by Monigal (2001, 2002). Two further contexts, Abri Zumoffen (Kirkbride, 1961; Copeland, 1975, 1983) and the Tajikistan site of Khonako (II) (Schäfer et al., 1998) can be dated to MOIS 7/6 through their palynological and technological signatures.

In MOIS 6, fewer examples are documented with three contexts securely dated: the site of Yabrud (15-13), dated through TL to before 195,000 ± 15,000 BP (Farrand, 1994), 'Ain Difla, with ESR and TL dates ranging from 162,000 ± 18,000 BP (Lindly and Clark, 1987, 2000; Coinman, 1998, 2000; Mustafa and Clark, 2007), and Misliya Cave (II) dating towards the end of MOIS 6, with a date of 130,000 ± 33,000 BP secured (Weinstein-Evron et al., 2003, 2012; Yeshurun et al., 2007).

Many contexts within this chronology do not feature radiometric dates, and can be attributed to multiple Marine Oxygen Isotope Stages within the Early Middle Palaeolithic through their technological components. These include three layers of the Hummalian sequence (7C, 6C, 7A), Abu Sif (C) (Henry, 2003), and the Georgian contexts of Tsona Cave and Koudaro Cave (Tushabramishvili et al., 2007).

In all these assemblages, the Levallois-index is typically lower in contrast to the European Early Middle Palaeolithic, feature a high retouch-index and demonstrate a variety of differing Laminar core volume management strategies (Meignen, 2000). However, towards the end of the Early Middle Palaeolithic emphasis is placed on other technologies, with Laminar technology absent until the end of the Middle Palaeolithic (see below).

In Africa, very few publications document and trace the evidence for Laminar technological blade strategies throughout the Early Stone Age (ESA) and Middle Stone Age (MSA) periods. However, with new archaeological evidence, reassessments of Africa cultural taxonomies (including the Fauresmith and Aterian industries), and new dating, blade technology can be documented from half a million years ago and throughout both periods. The Gnjh-42 and GnJh-50 test pits within the K3 context of the Kapthurin Formation, Kenya, represents the oldest known evidence for Laminar blade strategies, deposited between layers of a pumice tuff dating to 545,000 ± 3,000 BP, and a grey tuff dating to 509,000 ± 9,000 BP (Deino and McBrearty, 2002; Johnson and McBrearty, 2010). These examples pre-date Laminar technology in Europe and Western Asia by at least two-hundred-thousand years, and even predate the widespread use of Levallois behaviour and general 'Neanderthalisation'. Here, small cobbles are utilised, with similar core morphologies to that of the Hummalian (see Chapter 2), resulting in orthogonal and rectilinear cores (Johnson and McBrearty, 2010: 196). The technique can be viewed as proceduralised and intentional, given the existence of extensive platform modification on the blade core, and examples of cores featuring at least seven blades removed in sequence. In addition to this, Laminar technological blade strategies are observed above the grey tuff, and below the K4 context, with another early date of half-a-million years (*ibid*. 193).

Laminar technology is next attested to the Eritrean site of Asfet with a maximum date of 440,000 BP hypothesised (Buffer et al., 2010; Beyin and Shea, 2007; Beyin, 2013). At present, only overviews of the site are published and, as such, very little is known beyond its recovery within contexts of 440,000 BP, without primary lithic analysis. The date, however, must be treated with caution as the dating relates to a similar basalt flow around the Abdur locality, approximately twenty kilometres north-east of the actual site, and may not represent what is happening within the Asfet context.

Assuming the date for Asfet is correct, a hiatus of ninety-thousand years then follows before the appearance of Laminar technological blade strategies in a number of sites. Given the present evidence, and the lack of other sites throughout Africa, these two examples may represent localised *in-situ* technological innovations (similarly to Cave dall'Olio), which were not interconnected, given the fragmentary nature and size of social networks almost half-a-million years ago (c.f. Gamble, 1999). Further comparative work is needed between all contexts before the Early Middle Palaeolithic, to assess commonalities and differences between Laminar technology used among pre-Neanderthal populations.

From 350,000-250,000 BP, nine contexts throughout southern, central, and eastern Africa are known to demonstrate the existence of the Laminar technique: the South African contexts of Wonderwerk Cave (MU4/MU3) (Beaumont and Morris, 1990, 2004), Bundu Farm (G6) (Kiberd, 2006), Biesiesput (2/3) (Beaumont and Morris, 1990), the Ethiopian Gademotta and Kulkuletti contexts (Schild and Wendorf, 1974, 2005), and the Zambian context of Twin Rivers Kopje (F) (Clark and Brown, 2001; Barham, 2000, 2002).

Through MOIS 6, contexts featuring Laminar technology include the South African contexts of Wonderwerk Cave (MU2) (Beaumont and Morris, 1990, 2004), Rooidam (1) (Beaumont and Morris, 1990), and Pinnacle Point (13B) (Marean et al., 2007, 2010), the Zambian site of Kalambo Falls (Clark, 2001; Sheppard and Kleindienst, 1996) and the Sai (8/B/11) context within the Middle Nile Valley (Clark, 2001).

Only a limited number of assemblages from MOIS 5 contexts feature credible dates and published descriptions of blade technology (c.f. Carto *et al.* 2009). These are the contemporaneous assemblages from Florisbad, Ysterfontein (1) and Hoedjies Punt (Wurz, 2013), and the extensive sequence from the Klaises River, dating between 115,000-80,000 BP (Wurz, 2002). The Howieson’s Poort complex, known to feature Laminar products, and Laminar core volume management strategies was once attributed to be MOIS 5b in date, however a date following MOIS 4 is preferred (Volman, 1984; Deacon and Geleijnse, 1988; Klein, 1989).

For examples of Laminar blade *débitage* see Figure 4.4.

The evidence throughout Western Asia and Africa teases at the true extent and distribution of Laminar technological blade production among pre-Neanderthal, Neanderthal and Neanderthal contemporary populations. The earliest instances of Laminar blade technology at Asfet, Qesem Cave and the Kapthurin Formation demonstrate its deep antiquity within small-world societies, long before the earliest European instances at Cave dall’Olio and MOIS 8 examples. These instances allow inter-regional investigations into their production, and into their behavioural significance. Do all these examples represent isolated *in-situ* occurrences within ‘immediate networks’ (Gamble, 1999), or represent a wider or more significant development throughout the Middle Pleistocene? In their investigation, are Laminar contexts in Africa and Western Asia under-represented? And how were they tools utilised? Were they for specific activities or for general activities similarly to other flake production methods?

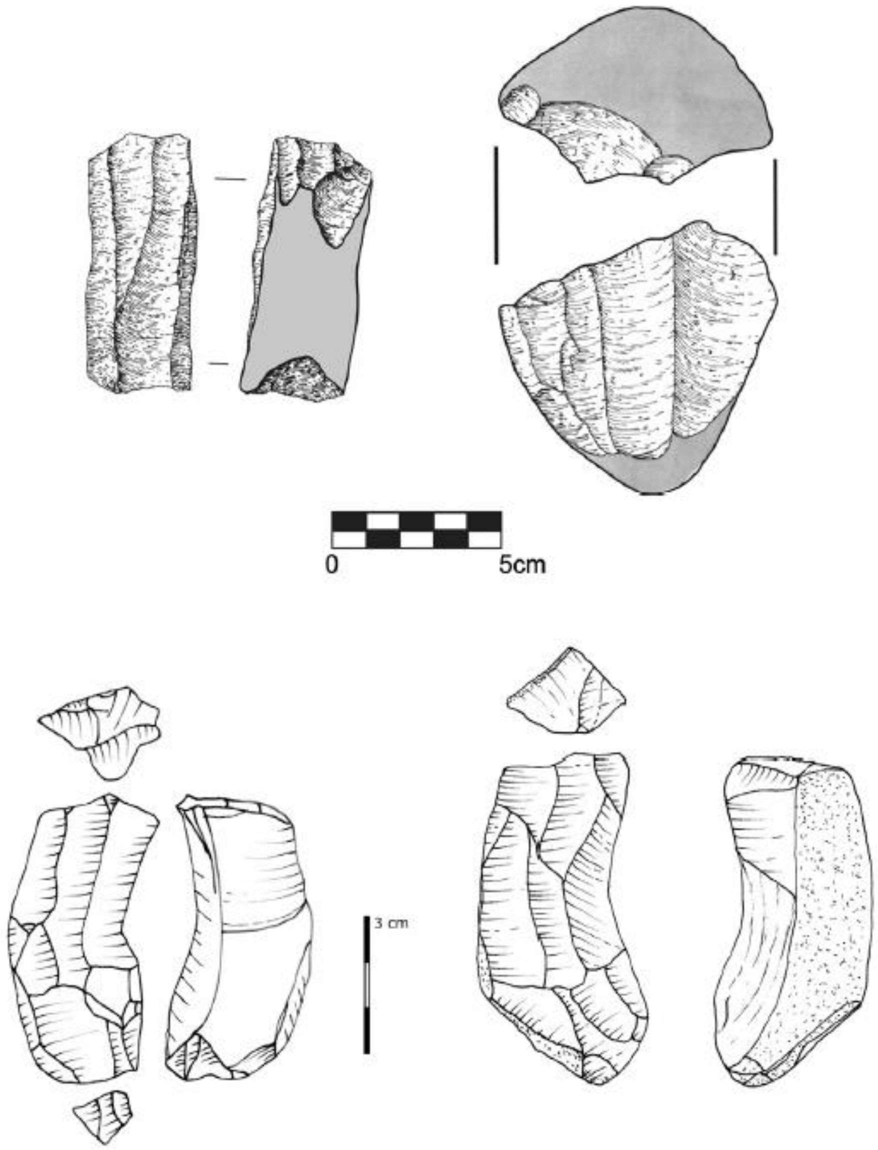


Figure 4.4. Examples of Laminar blade cores from Africa and Western Asia.
Top: Facial cores from the Kapthurin Formation (Johnson and McBrearty, 2010).
Bottom: Facial cores from the Hummal sequence (Wojtczak, 2014b)

4.2.1.3. Laminar Blade Production After c. 71,000 BP

Following MOIS 5a the number of contexts in Europe to feature Laminar technology drops considerably, until 43,000 BP. It is unknown whether this decrease represents smaller Neanderthal populations, limited mobility and Neanderthal networks resulting from deteriorating climatic conditions (c.f. Villa and Roebroeks, 2014), or an unknown general shift in core volume management strategies.

From the end of MOIS 4 and the start of MOIS 3 (c. 57,000 BP), many contexts outside of north-west Europe are documented, including the Polish site of Piekary IIA (Kozlowski, 2001), the south Georgian site of Ortvale Klde (Moncel et al., 2013), and the Pontinian sites of Grotta di Sant'Agostino and Grotta Breuil, in central-west Italy (Tozzi, 1970; Taschini, 1979; Kuhn, 1995). At these Pontinian sites, Laminar technological strategies are noted as 'pseduo-prismatic cores' (Kuhn, 1995), cores which are fairly unstandardised in shape, and feature parallel removals around the edge of their circumference. Many of these contexts feature broad dates, despite the use of radiometric dating techniques including Thermoluminescence and U-Series methods.

Towards the end of the Middle Palaeolithic of Europe, a time associated with the arrival of modern humans, between c. 43,000-41,000 BP (Higham et al., 2014), Laminar strategies are documented within the Brno basin of Moravia, specifically Bohunician sites including Bohunice, Stránská Skála, and the mixed assemblage of Ondratice/Želeč (Richter et al., 2009; Škrdla and Mlejnek, 2010; Nejman et al., 2011). In these Škrdla and Mlejnek (2010: 200) note the "contextual fusion" of Levalloisian and Laminar technologies within the same *chaînes opératoires.* This contrasts the original definition of the Bohunician by Valoch (1976) who noted the concurrent reduction of both strategies. While Laminar blades represent a large portion of the industries above, with indexes ranging from 20-45% (Svoboda and Škrdla, 2010), many cores are clearly oriented towards the production of Levallois technology, further emphasising the relationship between the two technological strategies.

Other contexts to feature Laminar technology during this period include the French site of Frettes (Lamotte et al., 2014) attributed to the Ferrassie Mousterian, Grotte Tournal (Tavoso, 1988), and Bordes Fitte (Aubry et al., 2012), the Italian site of Grotte di Fumane (Peresani and di Taranto, 2013), the Ukrainian size of Kabazi (II) (Chabai, 2005, 2006; Bataille, 2010), and the later contexts within the German site of Salzgitter-Lebenstedt (Pastoors, 2009). At Salzgitter-Lebenstedt, low Neanderthal residential mobility in association with a lack of interest in the use of blades as blanks (despite their appearance through a unidirectional rotating method) are used to explain the continuing dominant use of recurrent and preferential Levallois methods of flake/blade production (Pastoors, 2009).

In Western Asia, a pattern of declining evidence similarly to Europe is witnessed with sites that Meignen (2007: 2) notes as featuring "systematic blade production" occurring later around c. 46,000-45,000 BP in Western Asia, during the 'Initial Upper Palaeolithic' (Kuhn, 2004). These include the sites of Boker Tachtit (Marks, 1983), Kebara (IV/III) (Meignen and Bar-Yosef, 1991; Bar-Yosef et al., 1996; Rebollo et al., 2011), Ksar Akil (Mellars and Tixier, 1989), Wadi Kharar (Kadowaki et al., 2015), and Qafzeh (11) (Bar-Yosef and Belfer-Cohen, 2004) dating from c. 43,000 BP. Nearby in the Altai Mountains, Laminar industries are documented within the Kara Bom sequences (Derevianko, 2001). In many instances, emphasis is placed on the production of small blades through soft hammer percussion (Bar-Yosef et al., 1991). However, throughout the extended period of absence, prior to the appearance of Laminar technology in the 'Initial Upper Palaeolithic' Levallois industries are widespread, with high proportions of Levallois blades at sites including Kebara (XI) (Meignen and Bar-Yosef, 1991; Bar Yosef et al., 1996) and Amud (Hovers, 1998).

In Africa, Laminar blade production continues up until c. 43,000 BP, with evidence documented after c. 71,000 BP within Aterian contexts, up until c. 60,000 BP in the Sahara at sites including Haua Fteah (Douka et al., 2014), Uan Tabu (Garcea, 2001), Wadi Ain Zargha (Garcea, 2010), Shakshuk (Garcea and Giraudi, 2006), and Uan Afuda (Giraudi, 2005), and until 43,000 BP in western Libya (Garcea, 2010). Elsewhere, in East Africa Laminar technology can be dated to c. 46,000 BP at Enkapune Ya Muto (Ambrose, 1998), and sites attributed to the Howieson's Poort, and Still Bay industries highlight the use of Laminar blade technologies throughout MOIS 4 of South Africa. These include the sites of Border Cave, dating between c. 76,000-58,000 BP (Grün et al., 2003), Diepkloof, dating from c. 60,000-55,000 BP (Tribolo et al., 2005), and the Klaises River Main Site, centred at c. 66,000 ± 5,000 BP (Deacon and Geleijnse, 1988; Feathers, 2002; Tribolo et al., 2005).

In Western Asia and Europe, the existence of Laminar technological blade strategies persists, sometimes through periods of hiatus. While the number of contexts decline, there is in some form or another, in the majority of regions, a marked relationship between Laminar and Levalloisian blade strategies, and in several examples contexts which feature the fusion of both techniques.

4.2.2. The Archaeological Evidence for Levallois Blade Production Until c. 71,000 BP

In documenting the archaeological evidence for Levallois blade production several problems arise. One problem is that many publications generalise between Levallois recurrent and Levallois recurrent (elongated) core volume management strategies. While there are many sites which utilise a Levallois configuration to produce stereotyped elongated material, a significantly greater number are intended to produce flakes. And while publications document the existence for Levallois recurrent strategies it is unknown in some cases how many are designed for the intentional exploitation of elongated stereotyped material. There is also a distinct lack of literature on the nature, distribution and variability of Levallois blade strategies throughout the Middle Palaeolithic as there are few which discuss Levallois blade strategies explicitly.

4.2.2.1. European Evidence for Levallois Blade Production Until c. 71,000 BP

This chapter documents the existence of forty-three possible contexts to feature Levallois technological blade strategies until c. 71,000 BP (Figure 4.5). These are more widespread in their distribution in comparison to Laminar technological blade strategies, featuring in Central and Eastern Europe. Furthermore, in their date Levallois blade strategies are predominantly documented within Early Middle Palaeolithic contexts. In total, twenty-nine contexts before the Late Middle Palaeolithic feature Levallois technological blade strategies representing just over two-thirds (67.44%) of all contexts. In the Late Middle Palaeolithic until the end of MOIS 5a, all examples can be documented in France, with many examples also featuring Laminar technological blade strategies (see sections below). In their nature, these strategies appear less proceduralised and as sophisticated in homothetic morphology in contrast to examples in the Early Middle Palaeolithic. For a breakdown and list of all contexts to feature Levallois technological blade strategies see Figure 4.5 and Table 4.3.

Interestingly there are suggestions that Levallois blades are documented in the Lower Palaeolithic site of Cave dall'Olio, where the earliest Laminar technological blade strategies are also documented (Fontana et al., 2009). If so, this context may represent the earliest evidence for concurrent blade production within the European Palaeolithic. Irrespective, the archaeological evidence demonstrates the long-standing relationship between Laminar and Levallois (general) technologies. No further contexts are known to feature Levallois blades for this period.

In MOIS 8, six contexts are known to feature Levallois technological blade production: the Belgian contexts of Le Rissori (IV) (Adam and Tuffreau, 1973; Adam, 1991, 2002), and Mesvin (IV) (Ryssaert, 2006a, 2006b), the German contexts of Markkleeberg FC1/FC2 (Mania and Baumann, 1981; Mania, 2004; Mania and Mania, 2008), the Polish context of Biśnik Cave (19) (Cyrek, 2006; Cyrek et al., 2010), and the French context of Bagarre-Étaples (C7) (Tuffreau et al., 1975). Of these, Mesvin (IV) is the only one noted for featuring both Levallois and Laminar technological blade production methods (Ryssaert, 2006a, 2006b). Towards the end of MOIS 8 and beginning of MOIS 7, two further sites exhibit Levallois blade production: collections within the British Baker's Hole landscape, and the French context of Biache-Saint-Vaast IIA (Tuffreau and Sommé, 1988; Boëda, 1986).

Most evidence for Levallois blade production occurs within MOIS 7 contexts. These include the Belgian contexts of Le Rissori (IIIA/IIIB) (Adam, 2001), the German contexts of Rheindahlen (B1/B2) (Bosinski, 1966; Schirmer, 2002), Weimar-Ehringsdorf (Schäfer et al. 2007), and Markkleeberg (FC3) (Mania and Baumann, 1981; Mania, 2004; Mania and Mania, 2008), the Czech context of Bečov (I A-III-6), the Polish context of Biśnik Cave (15) (Cyrek, 2006; Cyrek et al., 2010) and the French contexts of Etricourt-Manancourt (LRS) (Hérrison et al., 2016), Drucat (Locht et al., 2013a), Abbeville rue de l'Abreuvoir (Locht et al., 2013a), Boutmy-Muchembled (Commont, 1909a, 1909b, 1912), Tourville-la-Rivière (D2), Coquelles (Upper Gravels) (Lefèbvre, 1969; Tuffreau, 1971), and Therdonne (N3) (Locht et al., 2010b; Hérisson and Locht, 2014). Evidence for the existence of Levallois technological blade strategies within the Crayford locale of Slades Green can be argued to be MOIS 8 in date (see Chapter 10), however issues of contemporaneity cannot exclude a possible dating of both MOIS 8 and MOIS 7.

In MOIS 6, four further contexts are known to feature archaeological evidence for the existence of Levallois blade technology: Ailly-sur-Noye (N3) (Blondiau et al., 2009; Locht et al., 2013a), Kúlna Cave (14) (Valock, 1970, 1988, 1992), Hundisburg (Toepfer, 1961, 1964, 1978; Ertmer, 2011) and Zwochau (Pasda, 1996a, 1996b).

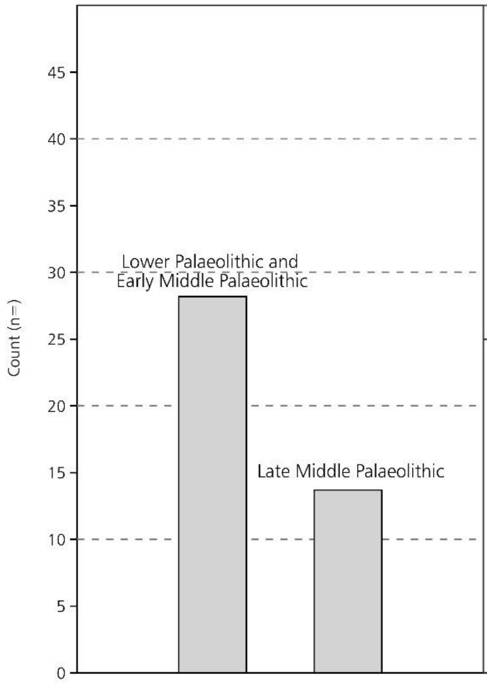
In the Late Middle Palaeolithic of Europe fourteen contexts are known to feature Levallois technological blade strategies, twelve in association with Laminar-based technological blade strategies. All examples are from MOIS 5c and MOIS 5a, with no examples exhibited in sub-stages. 5e, 5d, and 5b. In total, six contexts feature radiometric dates (see Table 4.3).

During MOIS 5c, five contexts to feature Levallois technological blade strategies: Cantalouette (4), Saint-Germain-des-Vaux/Port Racine (Révillion and Cliquet, 1990; Révillion, 1993a; Cliquet, 1994), Séclin (D7) (Tuffreau et al., 1985; Révillion and Tuffreau, 1994), Fresnoy-au-Val (Série 2) (Goval and Locht, 2009), and La Minette à Fitz James (Teheux, 2000). In three of these examples (Cantalouette (4), Saint-Germain-des-Vaux/Port Racine, and Séclin (D7)), both Laminar and Levallois blade strategies are evident.

Context	Region	MOIS	Date provided	Site nature	Key reference(s)
Late Middle Palaeolithic (c. 130,000-71,000 BP)					
Lailly/Le Fond de la Tournerie	France	5a?	MOIS 5a (Chrono.)	Stratified	Deloze et al. 1994; Depaepe, 1997
Baume Flandin	France	End 5a	MOIS 5a (Chrono.)	Stratified	Moncel, 2005; Moncel et al. 2008
Lailly/Le Domaine du Beauregard (B)	France	End 5a	MOIS 5a (Chrono.)	Stratified	Deloze et al. 1994; Locht and Depaepe, 1994
Bettencourt-Saint-Ouen (N2B)	France	5a	77.0 ± 8.1 (TL)	Stratified	Locht, 2002
Fresnoy-au-Val (Série 1)*	France	5a	MOIS 5a (Chrono.)	Stratified	Goval and Locht, 2009
Angé	France	5a	84.5 ± 3.8 (TL)	Stratified	Locht et al. 2008a; Koehler et al. 2014
Riencourt-les-Bapaumes (C)	France	5a	MOIS 5a (Chrono.)	Stratified	Ameloot-Van der Heijden, 1993; Goval and Hérisson, 2006
Riencourt-les-Bapaumes (C12)	France	5a	MOIS 5a (Chrono.)	Stratified	Ameloot-Van der Heijden, 1993; Goval and Hérisson, 2006
Villeneuve-l'Archeveque (B)	France	5a?	MOIS 5a (Chrono.)	Stratified	Deloze et al. 1994; Depaepe, 2007
Cantalouette (4)	France	5c-4	92.7 ± 8.6 - 61.0 ± 4.8 (TL)	Stratified	Blaser et al. 2009; 2012
Saint-Germain-des-Vaux/Port-Racine	France	5c-5a?	106.0 ± 10.0 (TL)	Stratified	Révillion and Cliquet, 1990; Révillion, 1993a; Cliquet, 1994
Fresnoy-au-Val (Série 2)	France	5c	106.8 ± 7.5 (TL)	Stratified	Goval and Locht, 2009
Séclin (D7)	France	5c	95.0 ± 10.0 (TL)	Stratified	Tuffreau et al. 1985; Révillion and Tuffreau, 1994
La Minette à Fitz James	France	5c (?)	MOIS 5c (Chrono.)	Stratified	Teheux, 2000
Early Middle Palaeolithic (c. 300,000-130,000 BP)					
Zwochau (?)	Germany	6	MOIS 6 (Chrono.)	Stratified	Pasda, 1996a, 1996b
Hundisburg	Germany	6	MOIS 6 (Chrono.)	Stratified	Toepfer, 1961, 1964, 1978; Ertmer, 2011
Ailly-sur-Noye (N3)	France	6	MOIS 6 (Chrono.)	Stratified	Blondiau et al. 2009; Locht et al. 2013a
Kúlna Cave (14)	Czech Republic	6	MOIS 6 (Chrono.)	Stratified	Valock, 1970, 1988, 2002
Therdonne (N3)*	France	7a/6	178.0 ± 11.0 (TL)	Stratified	Locht et al. 2010b; Hérisson and Locht, 2014
Biśnik Cave (15)	Poland	7/6	c. 160,000+ BP (various)	Stratified	Cyrek, 2006; Cyrek et al. 2010
Coquelles (Upper Gravels)	France	7/6	MOIS 7/6 (Chrono.)	Stratified	Lefèbvre, 1969; Tuffreau, 1971
Markkleeberg (FC3)	Germany	7/6	MOIS 7/6 (Chrono.)	Stratified	Mania and Baumann, 1981; Mania and Mania, 2008
Tourville-la-Rivière (D2)	France	7	226.0-183.0 (ESR-U)	Stratified	Guilbaud and Carpentier, 1995; Faivre et al. 2014
Boutmy-Muchembled	France	7	MOIS 7 (Chrono.)	Stratified	Commont, 1909a, 1909b, 1912
Abbeville (rue de l'Abreuvoir) (?)	France	7	MOIS 7 (Chrono.)	Stratified	Locht et al. 2013a
Weimar-Ehringsdorf	Germany	7	c. 200,000 BP (various)	Stratified	Schäfer et al. 2007
Drucat	France	7	MOIS 7 (Chrono.)	Stratified	Locht et al. 2013a
Bečov (I A-III-6)	Czech Republic	7	MOIS 7 (Bio.)	Stratified	Fridrich, 1982; Wiśniewski and Fridrich, 2010
Rheindahlen (B1)	Germany	7	MOIS 7 (Chrono.)	Stratified	Bosinski, 1966; Schirmer, 2002
Rheindahlen (B2)	Germany	7	MOIS 7 (Chrono.)	Stratified	Bosinski, 1966; Schirmer, 2002
Etricourt-Manancourt (LRS) (?)	France	7c	c. 220,000 BP (TL)	Stratified	Hérrison et al. 2016
Le Rissori (IIIA)*	Belgium	7c (?)	MOIS 7c (Chrono.)	Stratified	Adam and Tuffreau, 1973; Adam, 1991, 2002
Le Rissori (IIIB)*	Belgium	7c (?)	MOIS 7c (Chrono.)	Stratified	Adam and Tuffreau, 1973; Adam, 1991, 2002
Biache-Saint-Vaast (IIA)	France	7/8	MOIS 7/8 (Chrono./Bio.)	Stratified	Tuffreau and Sommé, 1988; Boëda, 1986

Baker's Hole (various collections)*	Britain	7/8	MOIS 7/8 (Chrono.)	Surface/Stratified	Wenban-Smith, 1990, 1992
Bagarre-Étaples (C7)	France	8?	MOIS 8 (Chrono.)	Stratified	Tuffreau et al. 1975
Le Rissori IV*	Belgium	8	MOIS 8 (Chrono.)	Stratified	Adam and Tuffreau, 1973; Adam, 1991, 2002
Crayford*	Britain	8-6 (7?)	MOIS 8-6 (7?) (Chrono.)	Surface/Stratified	Bridgland, 1994; Scott 2006, 2011
Markkleeberg (FC1)	Germany	8	MOIS 8 (Chrono.)	Stratified	Mania and Baumann, 1981; Mania and Mania, 2008
Markkleeberg (FC2)	Germany	8	MOIS 8 (Chrono.)	Stratified	Mania and Baumann, 1981; Mania and Mania, 2008
Biśnik Cave (19)	Poland	8	MOIS 8 (Bio.)	Stratified	Cyrek, 2006; Cyrek et al. 2010
Mesvin (IV)*	Belgium	8	300.0-250.0 (U-Th/Chrono.)	Stratified	Cahen et al. 1984; Cahen and Michel, 1986
Zwochau (?)	Germany	6	MOIS 6 (Chrono.)	Stratified	Pasda, 1996a, 1996b
Hundisburg	Germany	6	MOIS 6 (Chrono.)	Stratified	Toepfer, 1961, 1964, 1978; Ertmer, 2011
Ailly-sur-Noye (N3)	France	6	MOIS 6 (Chrono.)	Stratified	Blondiau et al. 2009; Locht et al. 2013a
Lower Palaeolithic (before c.300,000 BP)					
Cave dall'Olio	Italy	9	MOIS 9 (Chrono.)	Stratified	Fontana et al. 2009, 2013

Table 4.3. An overview of the archaeological evidence for Levallois technological blade strategies in the European Middle Palaeolithic prior c. 71,000 BP. Asterisk: contexts analysed throughout this thesis



Lower Palaeolithic and Early Middle Palaeolithic

MOIS	Context count (n=)
9	1
8	6
Transition 8/7	2
7	11
7/6	4
6	4

Late Middle Palaeolithic

MOIS	Context count (n=)
5e	0
5d	0
5c	5
5b	0
5a	9

Figure 4.5. A breakdown of Levallois technological blade strategies throughout the Middle Palaeolithic divided by period, Marine Oxygen Isotope Stage (MOIS) and sub-stage. Note: Crayford is excluded as the various collections are multi-period in nature

Throughout MOIS 5a, a further eight contexts are known all known to feature Levallois and Laminar technological blade strategies. These are the contexts of Villeneuve-l'Archeveque (B) (Deloze et al., 1994; Depaepe, 2007), Riencourt-les-Bapaumes (C12/C) (Ameloot-Van der Heijden, 1993, 1994; Goval and Hérisson, 2006), Angé (Locht et al., 2008a; Koehler et al., 2014), Fresnoy-au-Val (Série 1) (Goval and Locht, 2009), Bettencourt-Saint-Ouen (N2B) (Locht, 2002), Lailly Le Domaine du Beauregard (B) (Deloze et al., 1994; Locht and Depaepe, 1994), and Baume Flandin (Moncel, 2005; Moncel et al., 2008). Similarly, to the evidence for Laminar technological blade industries, the MOIS 5 context of Lailly Le Fond de la Tournerie cannot be attributed to a specific sub-stage, however a later date of MOIS 5a is hypothesised (Locht Pers. Comm.).

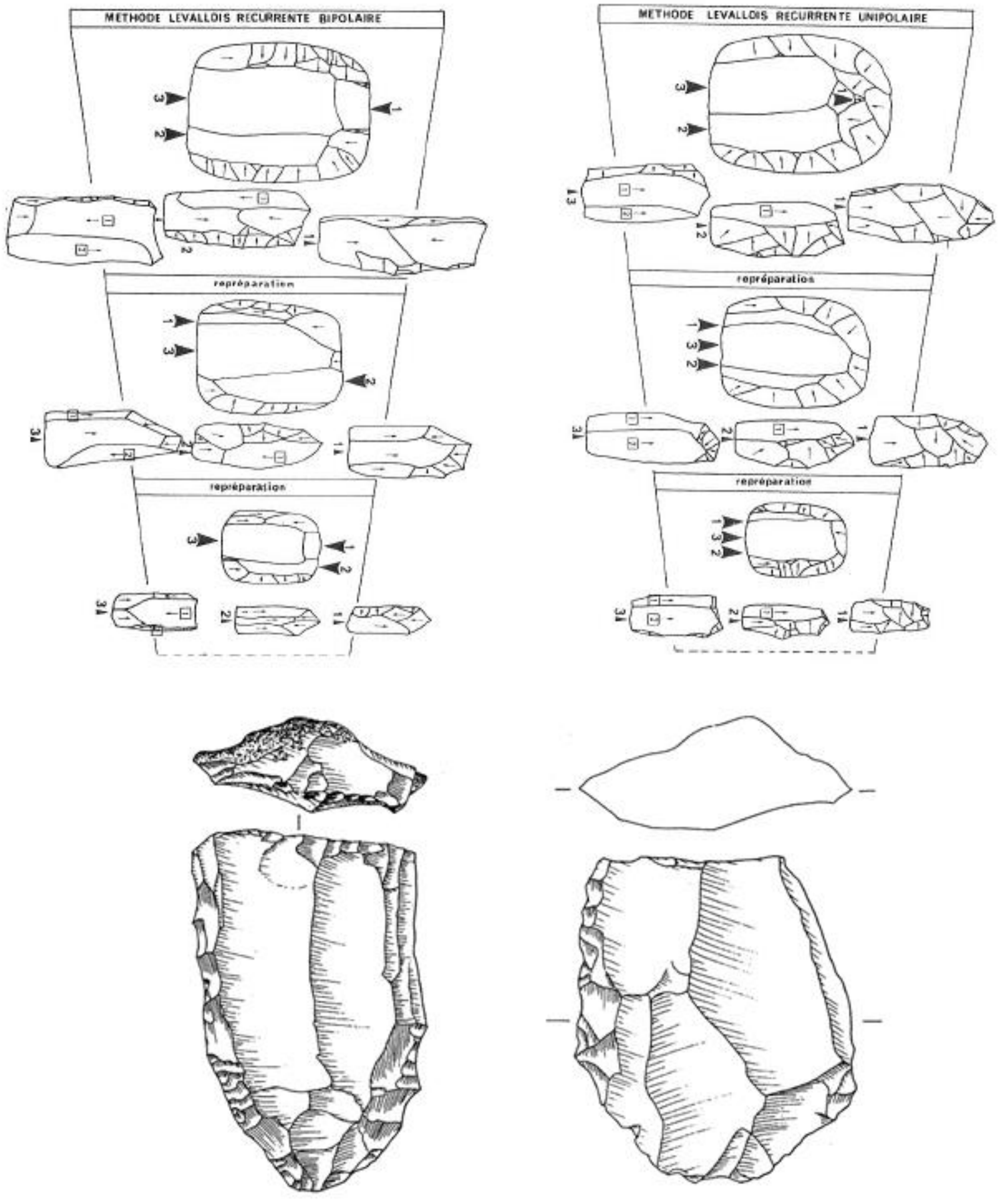


Figure 4.6. Examples of Levallois technological blade production. Top: schematic representation of unidirectional and bidirectional Levallois blade technology from Biache-Saint-Vaast (IIA) (Boëda, 1988a). Bottom: two examples of unidirectional and bidirectional Levallois technological blade strategies from Le Rissori (IIIA) (Adam, 2002). Not to scale.

All contexts within the Late Middle Palaeolithic are noted for their smaller quantities of Levallois technology and specifically Levallois blade technology as a percentage share of the overall assemblage, with blade core configurations appearing less proceudralised and homothetic. This total therefore may be an overrepresentation of the true extent for Levallois blade technology in MOIS 5, with elongated products resulting from fortuitous Levallois flake production methods, and elongated recurrent cores. Further work on elongation, directionality, and the technological sequence of these recurrent cores is needed to clarify this position, and assess the true intentionality to produce stereotyped Levallois blades. This is, however, not the case for the site of Angé, where the clear demonstration of both strategies, in large quantities, is exhibited (Locht et al., 2008a; Koehler et al., 2014). This is discussed in more detail in subsequent sections. See Figure 4.6 for examples and schematic representations.

4.2.2.2. Levallois Blade Production in Western Asia and Africa Until c. 71,000 BP

Interestingly at Qesem Cave where the earliest evidence for the existence of the Laminar technique has been documented, there appears to be no evidence for Levalloisian core volume management strategies (Barkai et al., 2003, 2005). This pattern is very distinct within the Lower Palaeolithic of the Near East and Amudian/Pre-Aurignacian contexts (Rust, 1950; Garrod, 1956), with a Laminar-rich set of assemblages, and tool-kits dominated by Upper Palaeolithic tool types (burins, endscrapers, etc.) immediately preceding the Acheulo-Yabroudian industries.

The adoption of Levallois blade technology then varies with many contexts from MOIS 8-6 featuring Levallois-rich blade assemblages including the Tabun (D-IX) (Garrod and Bate, 1937; Ronen, 1982; Jelinek et al., 1973; Jelinek, 1975, 1977, 1981, 1982; Shimelmitz and Kuhn, 2013), Rosh Ein Mor (D15) (Marks and Crew, 1972), and Ain Difla contexts (Clark et al., 1997; Lindly and Clark, 1987, 2000; Mustafa and Clark, 2007; Coinman, 1998, 2000). To a lesser extent, Levalloisian recurrent (elongated) technologies can be further documented in the contexts of Djruchula Cave (C1/C2) (Liubin, 1977, 1989; Meignen and Tushabramishvili, 2006, 2010), Hummal (6B) (Wojtczak, 2011, 2014a), Douara (IV B/C/D) (Akazawa, and Sakaguchi, 1987; Nishiaki, 1989; Copeland, 1981, 1983), and Abu Sif (C) (Henry, 2003; Neuville, 1951; Skinner, 1965). A more robust chronology, based on the integration of radiometric and technological analyses is essential to better understand these two groups of contexts, and the relationship between the two technological blade strategies. Following these Early Middle Palaeolithic contexts, there is a gap in the production of technological blade industries generally end of the Middle Palaeolithic.

Africa features a long tradition of utilising Levallois recurrent (elongated) strategies throughout the Middle Stone Age period. Interestingly in the older K3 deposits of the Kapthurin Formation, where the earliest evidence for Laminar technology is attested, Levallois is only present as a technique to produce handaxe blanks (McBrearty, 2003; Johnson and McBrearty, 2010). One of the earliest examples of Levalloisian blade technology is attested in the South African site of Kathu Pan (1) (Wilkins and Chazan, 2012), with the Fauresmith 4a layer dating between 511,000 and 435,000 years ago, based on a combination of OSL (464 ± 47 ka) and ESR (542 + 107/−140 ka) dating methods (Porat et al. 2010). While attested to be Laminar (Wilkins and Chazan, 2012), Porat et al. (2010) notes that the cores fit the technological and typological criteria for the Levallois method, with the extreme lateral convexities the only technological factor distinguishing the material from the norm for the Levallois method (Porat et al., 2010: 272).

Levallois blades are also attested to the Nile Valley towards the beginning of c. 200,000 BP (Van Peer, 1992, 1998; Kleindienst, 2000), in addition to the Middle Stone Age of East Africa at contexts including Koimilot Locus 2 (Tyron, 2006) of the same period. They are also documented within the later periods of the Middle Stone Age e.g. Kapedo Tuffs (Tyron et al., 2008). In Southern Africa too evidence for Levallois blade technology is documented in contexts including the early Middle Stone Age sites of Florisbad (Grun et al., 1996), the undated levels at the Cave of Hearths (McNabb and Sinclair, 2009), and the Mapangubwe, Keratic Koppie, Hackthorne, Kudu Koppie (Pollarolo, 2004; Wilkins et al., 2010), and later Pinnacle Point (13B) (Marean, 2010) contexts.

4.2.2.3. Levallois Blade Production After c. 71,000 BP

In Europe, Levallois technological blade continues throughout the later part of the Late Middle Palaeolithic, with evidence occurring throughout southern Europe. Contexts include Abri du Maras (C1) (Moncel, 1996; Moncel et al., 2010; Moncel et al., 2014), Abri Mandrin (Yvorra and Slimak, 2001), Bau de l'Aubesier (Moulin, 1903, 1904; de Lumley, 1971; Lebel, 2000), Grotte Tournal (Tavoso, 1987) and Grotte du Prince (Moullé, 1996) in southern France, and the Italian contexts of San Francesco (Tavoso, 1988), Abri Mochi (Grimaldi and Santaniello, 2014) and Arma delle Manie (Cauche, 2007). These persist until the 'technological fusion' of Levallois and Laminar core volume management strategies in the Bohunician, as highlighted above.

In Western Asia, as highlighted previously, Levallois industries reappear during the Late Middle Palaeolithic, between c. 70,000-45,000 BP, with assemblages featuring high proportions of Levallois recurrent elongated strategies, with more than c. 30% of the overall assemblage featuring Levallois blades. This can be documented at Kebara (XI) (Meignen and Bar-Yosef, 1991), Tor Sabiha (Henry, 1995), and Amud (Hovers, 1998).

While the diversity of Levallois products was a major characteristic of the Middle Stone Age (Tyron, 2006), there are fewer examples in the African Later Stone Age, with focus on bladelet technology from a Laminar. However, examples including the Taramsa (Van Peer et al., 2010; see Chapter 2) highlight behaviours Levallois-like blade technology in towards c. 40,000 BP.

4.2.3. Concurrent Technological Blade Production Until c. 71,000 BP

In the European Middle Palaeolithic, up until c. 71,000 BP, twenty-four contexts demonstrate the possible presence and co-existence of both Laminar and Levallois technological blade production, with an even greater proportion feature Laminar and Levallois (recurrent) flake production. It is interesting to note that the earliest example of Laminar technological blade production and Levallois technological blade production is the Italian Lower Palaeolithic site of Cave dall'Olio. It is, therefore, possible to conclude that pre-Neanderthal populations (should MOIS 9 not be represented by Neanderthal hominins) were potentially producing stereotyped elongated material from two core volume management strategies.

Those which feature concurrent strategies are almost evenly distributed the Middle Palaeolithic, with eleven Early Middle Palaeolithic, and twelve Late Middle Palaeolithic contexts. These are:

- Early Middle Palaeolithic (c. 300,000-130,000 BP): Mesvin (IV), Bagarre-Étaples (C7), Baker's Hole, Le Rissori (IIIA/IIIB), Rheindahlen (B1/B2), Bečov (I A-III-6), Boutmy-Muchembled, Tourville-la-Rivière (D2) and Therdonne (N3);
- Late Middle Palaeolithic (c. 130,000-71,000 BP): Séclin (D7), Saint-Germain-des-Vaux/Port Racine, Cantalouette (4), Villeneuve-l'Archeveque (B), Riencourt-les-Bapaumes (C12/C), Angé, Fresnoy-au-Val (Série 1), Bettencourt-Saint-Ouen (N2B), Lailly Le Domaine du Beauregard (B), Baume Flandin and Lailly Le Fond de la Tournerie.

The relationship between Levallois and Laminar core volume management strategies is therefore apparent, with a smaller quantity demonstrating the concurrent use of both blade production methods throughout Europe, Western Asia and Africa. However, as noted for

Europe, while concurrency occurs in both periods, the presence of Levallois blades within the Late Middle Palaeolithic may be overemphasised. With all this, how can we account for the concurrent use of two methods of technological blade production: do they represent differing behaviours or are they equifinal in nature and the technologies, more generally? And how can we account for the shift from contexts which feature a high-Levallois/low-Laminar ratio in the Early Middle Palaeolithic to a low-Levallois/high-Laminar ratio in the Late Middle Palaeolithic?

4.3. Theoretical Frameworks and Studies into Technological Blade Strategies

This section provides an overview of Laminar and Levallois technological blade strategies and the ways with which both technologies have been understood, interpreted, and analysed within the wider archaeological literature. It details investigations in the different methodologies utilised and highlights many of the interpretations and models advocated by researchers.

4.3.1. Laminar Technological Blade Strategies: Approaches and Investigations

4.3.1.1. Studies in the European Early Middle Palaeolithic: An Overview

In Europe, studies of Laminar technology within the Early Middle Palaeolithic are few and cursory, with emphasis placed on the Late Middle Palaeolithic. Despite studies highlighting the use of proceduralised methods of Laminar blade production within the Early Middle Palaeolithic (Révillion, 1993b; Koehler, 2011b), and similarities between the two periods (Koehler, 2011b), emphasis has been placed on MOIS 5 contexts. This may be in part due what Koehler (2011b: 116) terms the "sporadic evidence" for Laminar technology within the Early Middle Palaeolithic. While lists of examples within the Early Middle Palaeolithic have been documented (Moncel, 2005; Bringmans, 2007), and technological analyses of individual Early Middle Palaeolithic contexts have been conducted, including Saint-Valery-sur-Somme (Moulin de la Veuve Rignon) (de Heinzelin and Haesaerts, 1983), Tourville-la-Rivière (Guilbaud and Carpentier, 1995; Faivre et al., 2012), and the recently discovered site of Cave dall'Olio (Fontana et al., 2009, 2013), rigorous inter-site analyses are missing. For any understanding of commonalities and differences in Neanderthal technological and social behaviour, in-depth technological and morphometric analyses, under a unified framework, are needed. How do these contexts compare to the preparation, exploitation, and use of Laminar technology, and with respect to the artefacts produced? Can models of social transmission or individual innovation support the nature of the evidence in question? Just how similar are Early Middle Palaeolithic examples from their Late Middle Palaeolithic counterparts? Are there any chronological trends throughout the Early Middle Palaeolithic? And should they truly be discriminated from MOIS 5?

4.3.1.2. Studies in the European Late Middle Palaeolithic: An Overview

Studies of Laminar technology in the European Late Middle Palaeolithic are more detailed than in the earlier period, with studies discussing the broad technological and chronological framework of MOIS 5, models for understanding blade technology, similarities in context composition, and differences in how Laminar strategies were utilised.

Perhaps the most discussed notion within the archaeological literature on blade technology, is that of the *Technocomplexe du Nord-Ouest* (Northwest Technocomplex), a technological and cultural phenomenon existing in north-west Europe during the beginning of Late Middle Palaeolithic. One of the first studies which highlighted a possible relationship between Laminar-based technological contexts within MOIS 5 was that of Conard (1990), in his refutation of Foley (1987). In this, four sites were discussed: Rheindahlen (B1), the Séclin complex, Rocourt and Tönchesberg (2B). It was suggested that similarities between these four sites, through documentation of standardised bladelike *débitage* and the unusually small size of artefacts and retouched tools, that these may represent a distinct shared behaviour and cultural phenomenon. Names such as the 'Rheindahlian', from the first published site to feature Laminar technology (Bosinski, 1966), or the 'Middle Palaeolithic blade complex' (Conard, 1990) were offered to classify this set of sites with similar technological and typological characteristics.

Similarities in blade technology among MOIS 5 contexts were highlighted at the roundtable discussions (as discussed previously), and particularly reiterated by Delagnes (2000). In this study, Delagnes (2000) studied the archaeological evidence for Laminar technology with explicit reference to a dozen contexts within the different sub-stages of MOIS 5 (MOIS 5d-5a) and their technological make-up. Delagnes (2000) emphasised aspects including the lack of artefact modification (which were explained as being used expediently), the existence of possible soft-hammers in the Vanne Valley (*ibid*. 183), and categorised contexts in France, Western Germany, and Southern Belgium, as a "phenomenon" (*ibid*. 184). The appearance of Laminar technology throughout MOIS 5 (excluding MOIS 5b) in conjunction with the existence of contemporary excavations including the Bettencourt-Saint-Ouen complex (Locht, 2002), featuring long-term chronologies, amplified a narrative that Laminar technology appeared in MOIS 5d/5c, disappeared in MOIS 5b, and returned in MOIS 5a. This phenomenon was described, by Delagnes and Meignen (2006: 95), as a "technical phenomenon with a very restricted distribution in time", with possible affinities to the later Châtelperronian (Pelegrin, 1995; Delagnes, 2000; Soressi, 2002). One year later in an analysis of Palaeolithic material from the Vanne Valley, Depaepe (2007) proposed the term '*Technocomplexe du Nord-Ouest de l'Europe*', or European Northwest Technocomplex, for this affinity.

The term 'technocomplex' brings with it "interpretive baggage" (Gamble et al., 2005: 195), specifically implications regarding the nature of shared demography, and technological and social behaviour. First defined by Clarke (1968), a technocomplex was defined as a group of cultures characterised by assemblages sharing a polythetic range (a similarity in the number of characteristics apparent), but differing specific classes of artefact types (Clark, 1968: 323). Initiated through the widespread integration and implementation of a specific artefact and subsistence strategy, or rather a blend of strategies, a technocomplex shares commonalities in environment, economy and technology, but can have differing ethnic, sociocultural or linguistic attributes (*ibid*. 324). In distribution, Clark (1968) defined a distribution of between 750-3000 miles in Euclidean radius, and a negligible level of affinity (around five percent or less) in shared specific types (i.e. tool types), but a residual medium level of affinity (c. 30-60%) in type families (i.e. technological strategies). While it is possible to suggest that the distribution of Laminar industries in MOIS 5 can be viewed as a technocomplex, within the definition of Clark (1968), as the contexts are featured within similar ecologies and feature similar technologies, it does not fit other attributes as defined by Clarke (1968). The archaeological evidence suggests a range of 320 miles in radius (as determined through analysis in ArcGIS), in contrast to Clarke's 750-3000 miles. In addition, it is unknown whether the different contexts feature similar technological behaviours, above their general core strategy. To assess the degree of behavioural similarity, a thorough analysis and account of different behaviours is important to understand how each context differs, through a goodness-of-fit test, or pairwise statistical analysis (e.g. Tostevin 2012), within the individual sub-stages of MOIS 5 and with the Early Middle Palaeolithic.

In its use, the term was circumvented by Locht et al. (2010a) when overviewing hominin behaviour for northern France during MOIS 5. In this study, sites which feature the coexistence of flake, Levallois and Laminar *chaînes opératoires* were detailed in conjunction with available intra-site spatial data, from sites including Bettencourt-Saint-Ouen, Fresnoy-au-Val, and technological data from the Vanne Valley sites of Lailly and Molinons, to discuss notions of shared behaviour. In contrast to many studies, sites within Germany and Belgian were also discussed to highlight similarities in the appearance of blade technologies in north-west Europe; this was not exhaustive, but rather to highlight adjoining examples. Other ideas including issues of contemporaneity, mobility, and the concurrence of Levallois (flake) and Laminar technological blade strategies (see sections below) were briefly discussed. In addition, points raised throughout this publication were reiterated in Locht and Depaepe (2011) when overviewing the Middle Palaeolithic of Belgium and France. In Koehler (2011a), the Northwest Technocomplex was appreciated, when discussing population dynamics and lithic facies towards the end of the Middle Palaeolithic Interestingly, Koehler (2011a) included sites not typically discussed in reference to the Northwest Technocomplex, e.g. Villiers Adam and Verrières-le-Buisson. Finally, the notion of the Northwest Technocomplex was highlighted throughout Koehler et al. (2014), in their analysis of Laminar technology, and its postulated association with differing mobility patterns, specifically Binfordian concepts of 'producing' and 'receiving' sites, during MOIS 5.

Throughout most studies which consider Laminar technological blade production, the cultural significance of these products directs discussion within the archaeological literature. There is a clear chronological and spatial association between sites which feature Laminar technology within north-west Europe during Marine Oxygen Isotope Stage 5, however at present there are very few analyses utilising a thorough technological framework to understand the relationship between sites commonly attributed to the Northwest Technocomplex, new contexts including Ailly-sur-Noye and Saint-Just-en-Chaussee (Locht et al., 2013a), and contexts within Belgium and Germany. How different are the technological signatures, and environments, adopted by Neanderthals within these sites, and with respect to the Early Middle Palaeolithic? Do they represent cultural transmission across both periods, or independent innovations, whether through adaptive convergence or cultural drift? Can we relate contexts from earlier periods to strategies in MOIS 5, and how do variables including the shape and type of products influence their production?

4.3.1.3. In Further Detail: Behavioural Inferences of Laminar Blade Production

Throughout studies of Laminar technology, three themes are discussed: 1) ideas pertaining to the 'origins' and 'evolution' of Laminar technological blade production, 2) functional studies into how Laminar blades were used, and 3) studies discussing spatial technological organisation and mobility within the landscape. These are discussed in detail below. Material relating, specifically, to technological variability within the wider Middle Palaeolithic repertoire, and in relation to Levallois technological blade strategies, is discussed in section 4.4.

4.3.1.3.1. The 'Origins' and 'Evolution' of Laminar Technological Blade Production

Central to any technology is a consideration of their conceptual and technological origins, as it is associated with significant changes in Neanderthal social and technological organisation (Hayden, 1993; Wynn and Coolidge, 2004; Eren and Lycett, 2012), and can include a number of different aspects including the specific mechanism(s) of its origin, and the very nature of the chronology in question (e.g. monocentricism vs. polycentricism).

In understanding the origins of Laminar blades and Laminar technological blade strategies in Europe, a consideration of the wider evidence is essential. Wilkins and Chazan's (2012) study into evidence of Laminar technological blades from Africa and Western Asia represents the only in-depth study into their origins, through a technological and statistical framework. Primary data from the South African context of Kathu Pan (1) was used in conjunction with published results for blade Laminar technologies at the Kapthurin Formation and the Israeli site of Qesem Cave, both discussed in previous sections. Through comparative technological analyses, including analyses of core organisation, and a morphometric (lineal) and raw material framework, Wilkins and Chazan (2012) hypothesised that the diversity among the three regions represented multiple origins. However, as noted previously, issues with the nature of material at Kathu Pan (1) makes any assessment problematic, as they would represent differing technologies. Analyses of published data from other early contexts including Cave dall'Olio, Asfet, and later Kapthurin contexts would also strengthen initial analyses and conclusions made by Wilkins and Chazan (2012).

The concept of technological evolution has received considerably more attention, particularly through overviews on the existence of Laminar technology. Many of the views, however, do not appreciate the corpus of archaeological evidence available, lack thorough technological and morphometric analysis, and focus on individual regions and not the greater framework. Furthermore, in many examples, the impetus is on the link between examples in MOIS 5 and evidence in the Châtelperonnian, and not from both periods of the Middle Palaeolithic or before.

Révillion (1995) was one of the first to address the temporal and technological dimension of the relationship between European examples in the Middle Palaeolithic. Révillion (1995: 438) concluded that:

"*L'évolution technologique au paléolithique moyen est constituée d'une succession de phases de rupture et de continuité, car la tendence laminaire, présente dans d'autres regions du monde, n'est pas un phénomène synchrone*."

This conclusion was drawn without acknowledging the wider corpus of data, only considering a handful of examples from both periods of the Middle Palaeolithic, and did not consider aspects of shape and form or rigorous statistical and technological analysis.

Following this, Delagnes (2000) shifts emphasis observing the lack of technical similarity or evolution between examples in MOIS 5 and the transitional MOIS 4/3 period Châtelperonnian industries. Noting the period of absence for technologies between MOIS 5 and the Châtelperonnian, and the lack of spatial correspondence in the distribution of contexts to feature Laminar technology (north-west Europe vs. southern Europe) an "absence of any direct technical filiation" was noted (Delagnes, 2000: 185). This disassociation is also stressed by Kozlowski (2001) who noted periods of discontinuity with the Middle and Upper Palaeolithic. Kozlowski (2001), however, notes two possible "directions of advance" (Kozlowski, 2001: 11) in terms of evolution, citing Sitlivy (1995). Sitlivy (1995) stresses the evolution from sites with Levallois (recurrent and lineal) technologies to prismatic core techniques, and from direct to semi-volumetric cores when discussing the greater framework for the Palaeolithic. The two evolutions proposed by Sitlivy under-emphasises Early Middle Palaeolithic Laminar blade strategies, but does consider the relationship between Laminar and Levallois technologies, and specifically changes in core technique.

The archaeological literature on the evolution of blade techniques, therefore needs to consider approaches akin to Wilkins and Chazan (2012) if any robust relationship between individual periods of the Middle Palaeolithic of contemporaneous contexts can be discussed with some confidence. Rigorous technological and statistical frameworks allow replicability and a platform for building working hypotheses on their evolution and origins within Europe, and with respect to later blade industries.

4.3.1.3.2. Past and Current Use-wear/Functional Analyses of Laminar Blade Technology

The inference of behaviour through a scientific framework of use-wear and functional studies has been possible and more accessible since the pioneering work of Lawrence H. Keeley (Keeley, 1980), Sylvie Beyries (Beyries, 1987), and others (Anderson-Gerfaud, 1981; Plisson, 1985; Vaughan, 1985) in the 1980s. With regards to the Middle Palaeolithic, studies began quite early on in south-western France (e.g. Anderson-Gerfaud, 1981), however with the acknowledgement of post-deposition processes (mechanical and chemical) on use-wear traces (Levi-Sala, 1986; Coffey, 1994; Caspar et al., 2003) many were discouraged in using use-wear analysis. It was only later on, with the development of growing reference frameworks on taphonomic processes and iterations (Knutsson, 1988; Knutsson and Lindé, 1990; Shea and Klenck, 1993; Coffey, 1994), in conjunction with refined recording and observational systems (Plisson and Lompré, 2008, Van Gijn, 2013), and more robust catalogues and frameworks of behaviours (González-Urquijo and Ibáñez, 1994), when functional studies strengthened in their credibility and as such its applicability in Middle Palaeolithic studies is growing. Its application in Middle Palaeolithic contexts, including Biache-Saint-Vaast (IIA) (Beyries, 1988; Rots, 2013), Les Tares (Geneste and Plisson, 1996), Le Pucheuil (Lazuén and Delagnes, 2014) and Grotte Vaufry (VIII) (Beyries, 1987) is continuing to encourage the development of a Middle Palaeolithic database of use-wear studies.

With this considered, it is no surprise that there are so few studies of use-wear analysis on blade technology throughout the Old World (see Table 4.4). In some instances, it is unsure if Laminar blades were analysed, or were analysed at all. While Pawlik and Thissen (2011b) in their analysis of material at Inden-Altdorf could identify a variety of behaviours, including the processing of plants and hides, they do not outline how many blades within the assemblage were examined. Similarly, at Remicourt, Bosquet et al. (2004) six artefacts were examined, but they did not outline how many were unmodified or modified blades.

At Bettencourt-Saint-Ouen, the three sections ('secteurs') of the N2B context (see Chapter 7) were analysed. In N2B1, one blade was subject to microscopic study, however chemical alterations to the blade resulted in inconclusive results (Caspar in Locht, 2002). In N2B2, sixty-two artefacts of which twenty-five were Laminar exhibited behaviours associated with butchery, providing similarities with analyses of Rots' (2011) study of Levallois points within the same layer. In the N2B3, two blades were subject to analysis and, again, behaviours associated with butchery were hypothesised (*ibid*. 93). At Qesem Cave, a much larger number of artefacts were examined. Lemorini et al. (2006) examined seventy-four artefacts through a variety of analyses, and inferred behaviours including cutting and scraping on soft material. It is perhaps worth stressing that while we know Low Powered (LPA) and High Powered (HPA) microscopic analyses were used in conjunction with an experimental reference collection for Qesem Cave, no methodology was published for Bettencourt-Saint-Ouen.

Therefore, for any meaningful discussion on the relationship between different Laminar technological blade strategies in MOIS 5, and similarities in behaviour throughout the Middle Palaeolithic, a much larger analysis of material is required, complimenting other forms of analysis. Given the difficulty in concluding any clear relationship between tool types and the tasks they were utilised in, beyond a significant association between butchery-related activities (González-Urquijo and Lazuén, 2013) and wood-working activities (Hardy, 2004; Rots, 2009) and flakes, it is the author's view that investigations into desirability, edge performance and artefact design provide a gateway for investigating the potential use of blade technology, complimenting any use-wear study which may follow.

4.3.1.3.3. Experimental Approaches to Laminar Technological Blade Production

Experimental approaches and studies to Laminar technology are often utilised for understanding many aspects of blade technology, whether as comparative material for investigating different core volume management strategies e.g. discoid (Eren et al., 2008), or bifacial production (Jennings et al., 2010), and in estimating original flake mass e.g. 3D platform area (Muller and Clarkson, 2014). In these, studies have often focused on soft hammer or punch blade production, and difficulties arise in considering them as a parallel for Middle Palaeolithic blade technology. Differing degrees of core maintenance (e.g. *cintrage*) are required in comparison to Upper Palaeolithic examples, and as such cores will differ in their productivity. Furthermore, given the nature of hard-hammer percussion, products may differ with respect to morphology and shape.

Only one study has used an experimental framework designed to address a Middle Palaeolithic blade dataset, and particularly to investigate differences between Laminar and Levallois technologies. Ortega et al. (2013) used archaeological evidence from MOIS 6 (Therdonne (N3)), to late MOIS 3 Châtelperonnian (Vieux Coutets: Grigoletto et al., 2008), and Aurignacian (Barbas (III): Ortega et al., 2006) contexts, in conjunction with an experimental dataset of Laminar and Levallois blade technology to highlight criteria for the identification and discrimination of technological blade strategies, and to assess similarities between Middle and Upper Palaeolithic Laminar technological blade production. Several conclusions were drawn.

Firstly, analyses suggested that Laminar production within Middle Palaeolithic contexts were almost identical in technique to periods of the Upper Palaeolithic. The nodules tended to be exploited from the longest and narrowest surface, and featured similar behaviours of maintenance, particularly with respect to their distal convexities (Ortega et al., 2013). Secondly, they concluded that the main difference between the two periods, was that in the Upper Palaeolithic all technological behaviours (preparation, exploitation, and maintenance) were applied in synergy (*ibid*. 224). Using the archaeological data, in conjunction with the experimental data, Ortega et al. (2013) also identified morphological differences between Laminar and Levallois technological blades. Specifically, that Laminar products tended to produce technological blades which featured a high elongation index, a lower flattening index, and a higher degree of curvature (Ortega et al., 2013). Finally, Ortega et al. (2013) concluded that Middle Palaeolithic Laminar production was undertaken for very specific functions, in association with butchery. This conclusion was reached on a lack of transformation needed for their use.

Central to our understanding of the two technologies, Ortega et al. (2013) represents the individual analysis to thoroughly consider Levallois and Laminar technological blade strategies through extensive morphometric and technological analyses. The study would have benefitted from a more robust methodology, particularly in its dataset and analysis.

The study would have benefitted from a consideration of raw material. It is unknown whether differing raw materials, or flints of differing quality and silification influence aspects of elongation, flattening, and curvature. Secondly, a consideration of the archaeological evidence for Levallois blades would have been interesting when examining differing blade strategies, and between the archaeological and experimental assemblages. As a difference, can be documented between experimental and archaeological Laminar material within their study, it is important to consider archaeological Levallois blades. It would also be interesting to replicate the experiment with earlier examples of Laminar technology, such as material from Saint-Valery-sur-Somme (Moulin de la Veuve Rignon), to understand if the earliest examples compliment or challenge conclusions drawn in this study. Only archaeological material as early as MOIS 6 is considered, with a distinct lack of analysis on blades from Laminar techniques which feature less preparation.

In its analysis, to truly understand morphological differences in the two datasets. other factors of performance and desirability need to be considered including edge regulation (width variation), edge angle variation, and the actual amount of cutting edge per product and per weight of stone. Is one technique more economical? Is one technique sharper, or are they morphologically equivalent? And can any of these factors account for the apparent shift from Levallois-rich Early Middle Palaeolithic contexts to Laminar-rich Late Middle Palaeolithic sites? And if one does serve advantages over the other, then why do we see the use of both Laminar and Levallois recurrent (elongated and non-elongated)?

4.3.1.3.4. Technological Organisation and Aspects of Mobility Within Laminar Technological Blade Production

One of the main themes discussed throughout literature pertaining to Laminar blade strategies is with respect to the mobility and spatial organisation of blade technology, on a context/site level, and within the greater landscape. These are discussed in turn below.

One of the main themes discussed throughout literature pertaining to Laminar blade strategies is with respect to the mobility and spatial organisation of blade technology, on a context/site level, and within the greater landscape. These are discussed in turn below.

There are many frameworks and methods for understanding mobility and technological organisation through Laminar technology. One of the simplest methods is to analyse site composition and site density, and the actual total number of artefacts. With Laminar technological strategies varying from a total of around one-hundred and thirty artefacts at Saint-Valery-sur-Somme (Moulin de la Veuve Rignon) (de Heinzelin and Hasaerts, 1983), to much larger sites like Angé, featuring one-hundred and five Laminar blade cores (Locht et al., 2008a). Through these two statements it is already possible to hypothesise small sites like Saint-Valery-sur-Somme as representing an ephemeral visit within the landscape, and much larger sites, like Angé representing a place of longer occupation (similarly to views by Koehler et al. 2014).

Use-wear Studies: An Overivew				
Study	Site analysed	Type(s) of analysis	Study size	Inference(s)
Pawlik and Thissen (2011b)	Inden-Altdorf	Experimental analysis: SEM and EDX	120 from 126 (amount of blades unknown)	Identification of projectile points (two flakes with birch pitch); other activities include the processing of plants, hide and skins, and harder materials e.g. bone.
Caspar in Locht (2002)	Bettencourt-Saint-Ouen ('Secteur' N2B1)	Microscopic study; not extensively detailed	4 artefacts (1 blade)	Chemical alterations did not provide any credible results.
Caspar in Locht (2002)	Bettencourt-Saint-Ouen ('Secteur' N2B2)	Microscopic study; not extensively detailed	62 (25 blades)	Butchery of meat and animal tissue.
Caspar in Locht (2002)	Bettencourt-Saint-Ouen ('Secteur' N2B3)	Microscopic study; not extensively detailed	241 (2 blades)	Butchery.
Rots (2011)	Bettencourt-Saint-Ouen ('Secteur' N2B2)	Macro- and micro-scopic wear traces; method not detailed extensively	27 from 128 (all Levallois points)	Animal processing, wood percussion, woodworking, and animal hunting (spears?).
Lazuén and Delagnes (2014)	Le Pucheuil (B)	LPA and HPA magnification with an experimental program and reference collection	139 artefacts (4 cores and 135 flakes) - all Pucheuil-type flakes	Identification of activities including hide scraping, wood and non-woody plant working and butchery tasks.
Bosquet *et al.* (2004)	Remicourt	LPA magnification	186 artefacts examined, 6 for use-wear analysis (Bosquet et al. 2004)	Identification of activities including graving, scraping, piercing and cutting. Woodworking and a use on an unidentified hard material.
Lemorini *et al.* (2006)	Qesem Cave	Comparative experimental analyses with LPA and HPA magnification	74 from 1270) (amount of blades unknown)	Identification of a variety of activities including cutting, scraping and whittling; cutting of soft material; engraving hypothesised.
Other contexts noting microwear studies (observational)				
Study	Site(s) analysed	Type(s) of analysis	Study size	Inference(s)
Conard and Adler (1997)	Wallertheim	Lithic analysis	Observational (number unknown)	Damage to tips indicating their possible use as weapons; presence of retooling and curation
Conard (1990)	Tönchesberg 2B	Lithic analysis	Observational (number unknown)	Damage to tips indicating their possible use as weapons

Table 4.4. An overview of Laminar-bearing contexts with use-wear/functional analyses detailed

The spatial analysis of artefacts, and their associated refits, provides perhaps the most direct methodology for investigating technological organisation. On a site level, spatial data as highlighted in many instances, stress that Laminar products are separate from zones where Levallois knapping strategies have taken place. Locht et al. (2010b) highlights how contexts including Bettencourt-Saint-Ouen (N2B), Fresnoy-au-Val (Série 1), Molinons (A), Villiers-Adam, and Lailly-Beauregard (B) exemplify this disassociation between Levallois and Laminar technology. It is in this framework with which Locht et al. (2010b) suggests the Colluvial Deposition Hypothesis (Antoine, in Locht 2002), and notes that they represent two different contexts (see later sections).

In understanding mobility within the greater landscape, various methodologies have been adopted including: 1) raw material sourcing/procurement strategies, 2) technological and *chaîne opératoire* analyses, and 3) the use of Binfordian models of curation and settlement systems. Given the concentration of studies into European Middle Palaeolithic systems of core volume management, a complex picture of mobility strategies has been highlighted. Still, while analyses have been undertaken, assumptions about the nature of archaeological assemblages destabilise various conclusions drawn, including assumed strict contemporaneity within multiple contexts, and notions of a 'site'. Furthermore, very little has been undertaken with respect to contexts dating to the Early Middle Palaeolithic.

The first publication to explore aspects of mobility in detail came towards the end of the twentieth century through studies at Wallertheim (D) and Tönchesberg (2B) (Conard and Adler, 1997). Through *chaîne opératoire* analyses of different raw materials on-site, Conard and Adler (1997) demonstrated the presence of curated products (Binford, 1973, 1979) i.e. products produced in anticipation of future use and transported beyond their areas of production for specific unknown activities. Conard and Adler (1997) concluded that products of grey-green andesite were brought to the site as prepared cores, and products of red-brown rhyolite were brought to Wallertheim (D) as retouched products before both subsequently being transported off site. Furthermore, cores produced from grey andesite were transported to Wallertheim, as prepared raw material, and left once desired tools (i.e. blade blanks) were produced (*ibid*. 166). This was supported through their identification of 'strict contemporaneity' (*ibid*. 156) i.e. artefacts which were deposited or occurred/produced simultaneously, or within close temporal succession. Through additional *cementum annulia* and zooarchaeological studies (Conard and Adler, 1997; Burke, 1997; Pike-Tay, 1997), Conard and Prindiville (2000) noted the movement of skeletal portions to the site (from low frequencies of metapodia and phalanges), interpreting Wallertheim as an extensive camp, supported by large groups of people over relatively long periods, or, alternatively, sites visited by smaller groups on several occasions. In Tönchesberg, Conard (1992) also highlighted the use of non-local raw materials to produce blades, sourced as far as 100km away. Similarly to Wallertheim (D), zooarchaeological analyses were able to highlight the nature of the site, with emphasis on horse processing (*ibid*. 54).

Elsewhere in north-west Europe, analyses of contexts more closely associated with the Northwest Technocomplex have been undertaken, with Koehler et al. (2014) representing perhaps the main effort to investigate explicitly Laminar *débitage* and mobility. Through technological and *chaîne opératoire* analyses of five open-air sites associated with the Northwest Technocomplex (Angé, Soindres, Villiers-Adam, Vinneuf-Les Hauts Massous, and Verrières-le-Buisson), Koehler (2014: 5) concluded that these five contexts "may have been a response to the singular organisation of knappers of the period, in line with a high degree of mobility". First, technological differences by raw material revealed that Laminar material was both imported and produced *in-situ* at Angé, a context hypothesised to feature many occupations, some for long periods (*ibid*. 8). Through the absence of Laminar core *débitage* at Villiers-Adam, Auteuil, and Soindres, Koehler et al. (2014: 11) hypothesised that material was imported to site. And in contrast, missing products and the absence of refits at Soindres (D) were inferred to be the result of exporting Laminar material off-site (*ibid*. 12). Relationships were then hypothesised between producing, exporting, importing and consuming sites. Using Binfordian concepts these contexts were identified as having different functions, and were classed through 'base camps' and 'logistical camps' *sensu* Binford (1966). Koehler et al. (2014) further concluded based on technological similarity that these contexts could represent one population or group of peoples (*ibid*. 15). This form of reductive reason while logical, is problematic for various reasons. Firstly, as stressed by Koehler et al. (2014), 'strict contemporaneity', similarly to Wallertheim (D), cannot be concluded, given the problems of inferring contemporaneity, in any form, over such a large area (c. 200km), and the range of radiometric dates. Secondly, the logic of inferring the movement of peoples, by the absence of either cores or products is challenging unless the adjoining artefacts can be successfully identified elsewhere. It is also problematic to argue that the area excavated, however large, represents the true extent of the occupation by peoples in the Middle Palaeolithic. It is just as credible to hypothesise that missing refits are a few metres away away from the excavation site. Reductive reason is valid when knapping scatters can be demonstrated, but it would be dangerous to infer the large-scale movement of populations and artefacts, when a more parsimonious reason can be sought.

In south-western France, Laminar technological systems of blade production and aspects of mobility were considered in Delagnes and Rendu's (2011) analyses of technological variability through a zooarchaeological framework. Throughout their study of Quina, Discoid, MTA, and Laminar and Levallois blade production, and using a framework originating from early work on technological variability (Bourguignon et al., 2006; Meignen et al., 2009), Delagnes and Rendu (2011) highlighted that Laminar and Levallois technological systems represent long and elaborate reduction sequences which produce single purpose products and are thus associated with a low degree of transportability and mobility. There are, however, several issues and points which need to be considered. Firstly, both Laminar and Levallois blade systems are homogenised and considered as one general technique of production. As the archaeological evidence exemplifies differences between examples in the Early Middle Palaeolithic (largely retouched Levallois blades), and those in the Late Middle Palaeolithic (largely unretouched Laminar blades), can this homogenisation be validated? While Delagnes and Rendu (2011) consider a different area to that of Koehler et al. (2014), their conclusions differ with respect to the degree of movement associated with Laminar technological blade products. Furthermore, while the preparation time may be of some length it may be hypothetical to suggest that, given their homothetic morphology, cores (and particularly Laminar cores) could be utilised instantly within the landscape.

Finally, through a more holistic approach incorporating raw material analyses and *chaîne opératoire* studies, similarly to Conard and Adler (1997), Moncel and Daujeard (2012) highlighted varying levels of mobility for a variety of Laminar contexts. Using their approach, certain contexts were hypothesised as being a series of short term occupations, with Abris du Maras suggestive of a long-term residential camp. Revisions by Moncel et al. (2014), with new archaeological evidence, further highlighted the varying types of occupation, the organisation of Neanderthals around the landscape and the organisation of important resources including raw materials, tools, fauna and flora.

In both Conard and Adler (1997) and Moncel and Daujeard (2012), robust analyses grounded on technological and raw material studies provided interesting perspectives on the movement of blade material within the Middle Palaeolithic. It would be interesting to assess the results, drawn from both studies, with respect to blank regularity, standardisation and shape. Is there an association between products which appear more mobile within the archaeological record, and characteristics grounded on artefact design e.g. retouch potential?

In sum, a variety of studies have made explicit reference to the spatial organisation of artefacts within the greater landscape, on varying levels of scale. To understand changes in how

Laminar technology has been used within the wider landscape, further analyses on an inter-site, inter-regional basis is essential. Furthermore, studies need to incorporate material from the Early Middle Palaeolithic, to understand the nature of mobility patterns among early Neanderthals, when Levallois blades are also in abundance. Are they both used on-site or taken off elsewhere? And how do concurrent technological blade strategies fit into ideas drawn from the literature above?

4.3.1.4. Summary

In the last fifty years, from their initial discovery within Middle Palaeolithic contexts, a considerable amount of information is now known, including their origins, their use within immediate and extended landscapes, and their possible cultural affinity among various contexts. It is nevertheless apparent that there are significance gaps in our knowledge, particularly with respect to the relationship between contexts of multiple periods and regions, the relationship between Laminar methods of blade production throughout the Early Middle Palaeolithic, in comparison to the Late Middle Palaeolithic, and considerations of artefact design. Many potential avenues of research have also been highlighted, many of which are highlighted further towards the concluding section of this chapter.

4.3.2. Levallois Technological Blade Strategies: Approaches and Investigations

While there have been many studies into the technological make-up and diversity of Levallois products (Van Peer, 1992; Scott, 2006, 2011), their origins and cognitive implications of the widespread use of the Levalloisian technique (Wiśniewski, 2014; White and Ashton, 2003; White et al., 2011), and an extended catalogue of experimental frameworks incorporating Levallois-based core volume management strategies and products (Eren and Bradley, 2009; Sisk and Shea, 2009; Eren et al., 2011; Eren and Lycett, 2012; Iovita et al., 2014; Picin and Vaquero, 2016), there are significantly fewer publications which explicitly investigate Levallois blade technology. Works primarily consider the broader technological strategy or products other than Levallois blades, including Levallois points (Shea et al., 2001; Sisk and Shea, 2009; Goval et al., 2016), recurrent centripetal flakes (Picin et al., 2014; Picin and Vaquero, 2016) or preferential/lineal flakes (Eren et al., 2011; Eren and Lycett, 2012). Similarly, studies which consider notions of mobility in association with the Neanderthal Levallois toolkit have focussed on point (e.g. Goval, 2008, 2012; Goval et al., 2016) and not Levallois recurrent or recurrent elongated strategies. Finally, there are no publications which have adopted a use-wear analysis to explicitly address Levallois blades, their use retouched or unretouched, and within the toolkit.

4.3.2.1. The 'Origins' and 'Evolution' of Levallois Technological Blade Production

In general, the origins of Levallois technology has attracted great interest among a diverse scholarship. It is now evident that the appearance of Levallois technologies, classified under the umbrella term of Mode 3 (prepared core) technologies, features no common centre of origin, or featured a significant major conceptual or technological breakthrough. The multiple region-based approach, is now emphasised throughout the archaeological literature concerning Mode 3 technologies (Rolland, 1995; Tuffreau, 1995; DeBono and Goren-Inbar, 2011; White and Ashton, 2003; White et al., 2011). These two facts are perhaps unsurprising given the internal flexibility permitted within the definition of Levallois, and the various core volume management strategies that, while do not appear to fall under the definition of Levallois *sensu* Boëda (1988a), do feature a strikingly similar number of technological characteristics typical of the Levallois technique. These include the Safaha (Van Peer, 1992), 'proto' (Wymer, 1985) or 'reduced' (Roe, 1981), Victoria West (Sharon and Beaumont, 2006; Sharon, 2007), Tachengit-Tabelbala (Tixier, 1957; Sharon and Beaumont, 2006) and 'Bent' (Schild, 1971) Levallois methods of core reduction. This is elaborated by White and Ashton (2003) and White et al. (2011) who note that Mode 3 technologies were an option within Acheulean core manufacturing, as it was the integration of two pre-existing systems: *façonnage* and *débitage*. Through this perspective, c. 300,000 BP represents the technical maturity of the Levallois technique, with many populations converging in its adoption. With respect to Levallois recurrent (elongated) strategies, this too represents the fusion of both *façonnage* and *débitage* as White and Ashton (2003) note. And while there are only a handful of examples of contexts exhibition Levallois blade technology before the European Middle Palaeolithic it is possible to suggest, too, that technical maturity of Levallois blade technology occurs from c. 300,000 BP onwards too, with the 'Neanderthalisation' (White and Ashton, 2003) of Europe, and the widespread use Levallois blade technology. For more information on the evolution of Levallois technology see White and Ashton (2003) and White et al. (2011).

4.3.2.2. Experimental Approaches to Levallois Technological Blade Production

It is important to note experimental methodologies which refer to ideas pertaining to Levallois technological blade production, and particularly how they could have contributed to our understanding of 'why' Levallois was adopted. While Ortega et al. (2013) examined the relationship between Levallois and Laminar blade products (see previous sections), most experimental studies have focused on other products, and reasoning for their production. These include notions that Levallois preferential flakes can be linked to factors deemed desirable in their morphology i.e. degree of standardisation, and potential for retouch (Eren and Lycett, 2012), the role of raw material and knapping skill (Eren et al. 2011), and the degree of waste produced (Lycett and Eren, 2013). Similarly, recurrent centripetal flakes have been investigated for differences in their morphology against other technologies (Picin et al. 2014) and flake productivity (Picin and Vaquero, 2016). In all these studies a replicable and robust methodology, with a controlled replicable dataset was used to examine two different end-products. These frameworks provide a method for an extensive investigation into why Levallois blades were adopted, why Laminar technological blade strategies became more commonplace, and why blades were used in isolation and in conjunction. Could desirable characteristics including retouch potential and standardisation explain the use of Levallois blade production throughout the Early Middle Palaeolithic, and does the Late Middle Palaeolithic, by inference, mean a change of ideas, to more expedient technologies?

4.3.2.3. Summary

In studies of Levallois technology, despite the corpus of information relating to the general technique, there is a distinct lack of scholarship on Levallois technological blade strategies. While studies have focused on the advantages of Levallois over other techniques, this has not been undertaken for technological blade strategies, and similarly, while notions of mobility have been discussed with specific reference to Levallois end-products, this too has not been undertaken for technological blade strategies. How can we relate Levallois blade technology to their immediate and extended landscape? Do they have different mobility signatures in comparison to Laminar technological blade products? Are they used as expediently as suggested for Laminar blades? And if so can aspects of their use and artefact design explain this? An extensive analysis of Levallois recurrent elongated products is essential to understand the technological behaviour of Neanderthal populations, and more generally, their importance to the wider technological repertoire.

4.3.3. The Relationship Between Technological Blade Strategies in Europe

Towards the beginning of this chapter it was noted there are a large number of contexts before c. 71,000 BP which feature elongate stereotyped material from Laminar and Levallois technological blade strategies. This section notes how the relationship between these strategies has (not) been discussed, the notion of contemporaneity, and issues of differentiating between the two technological blade strategies, as noted in Chapter 2.

4.3.3.1. The Concurrent Technological Blade Relationship: A Literature Review

While there are many authors who appreciate, and demonstrate that there is a relationship between the two methods of core volume management, with the exception of Ortega et al. (2013), there are no explicit studies into this relationship. There are a number of studies which discuss Laminar and Levallois blade production within the wider Middle Palaeolithic repertoire (Section 4.4), but these do not go into specific detail about the manifestation, nature and types of different blade strategies present on each context.

As noted previously, Delagnes (2000) noted the "direct technical filiation" (Delagnes, 2000: 184) between the general use of the Levallois technique and the existence of Laminar blade *débitage*, however this was not elaborated. Similarly, in Delagnes and Meignen (2006), this relationship between Levallois techniques (note not explicitly blades) and Laminar blade production, writing that "the Levallois recurrent uni/bidirectional methods are most commonly associated with laminar production systems in Mousterian assemblages" (Delagnes and Meignen, 2006: 89). Again, this relationship was not elaborated further.

Locht et al. (2010a: 337) notes that one of the "main characteristics of these lithic (Levallois) assemblages is the presence of blade production using a turning method (Laminar)". Locht et al. (2010a), however attributes this association with taphonomic processes in the construction of the Grey Forest Soil complex, what this thesis calls the 'Colluvial Deposition Hypothesis' (see below).

Koehler (2011b) was one of the first to acknowledge that there is an association between Levallois and Laminar technologies within Early Middle Palaeolithic contexts. Through her case study of Bapaume-les Osiers, Koehler (2011b: 118) notes that "in effect, following the example of the Early Middle Palaeolithic, production within Late Middle Paleolithic assemblages is systematically associated with Levallois production", Again, no further information is provided about their significance within the same assemblages, or what specific Levallois technique Koehler (2011b) refers to. This echoes Moncel and Daujeard's (2012) study into south-west France, which noted with respect to Baume Flandin, that "the laminar method is nearly always associated to the Levallois method" (Moncel and Daujeard, 2012: 108).

In almost all instances, the relationship between the two technologies is not elaborated on or explained. Why do we see the concurrent use of both techniques? Do they represent equifinal responses or differing behaviours and activities?

4.3.3.2. Issues of Contemporaneity: The Colluvial Deposition Hypothesis

One recent development has recently challenged notions of contemporaneity of both Levallois and Laminar technological strategies. As highlighted previously, many *chaînes opératoires* of both blade strategies do not share the same knapping wastage area. Proposed by Pierre Antoine (Antoine in Locht, 2002), strict contemporaneity (*sensu* Conard and Adler 1997), on an excavation level was viewed as incorrect, given the nature of taphonomic and colluvial processes, what this thesis terms the Colluvial Deposition Hypothesis.

Many industries from MOIS 5, some which have been analysed within this thesis, have been recovered within a slope context at the base of a Grey Forest Soil, a context constructed by slow-developing colluvial deposits under forest cover (Antoine in Locht, 2002). Using the Holocene sequences of the Somme Basin during the Boreal period (7.8-8.4 ka BP) as a proxy, it was concluded by Antoine in Locht (2002) that occurrences of colluvial deposits in forest-covered slope contexts may have accumulated at a sedimentary rate of 40-50mm per century (Figure 4.7). Through this, they believe, this results in contexts which feature Laminar and Levallois material to blend, forming one contemporaneous context (Antoine in Locht, 2002; Locht et al. 2010a). Locht et al. (2010a: 351) state that such a situation is "quite conceivable", however many issues arise under further examination. Further work is essential to determine the rate of sedimentation; the proxy from the Boreal period may feature a much quicker sedimentation rate, given these are two different isolated periods within two different landscapes and periods. Secondly there are a variety of contexts with (apparent) contemporary contexts, as highlighted throughout this chapter, not in slope contexts, and contexts other than a Grey Forest Soil. While it may explain a certain number of contexts it is only a hypothesis. Similarities in the taphonomic histories of artefacts, with an appreciation for the local sedimentary records and context, may provide one way into understanding artefacts within a Grey Forest Soil layer.

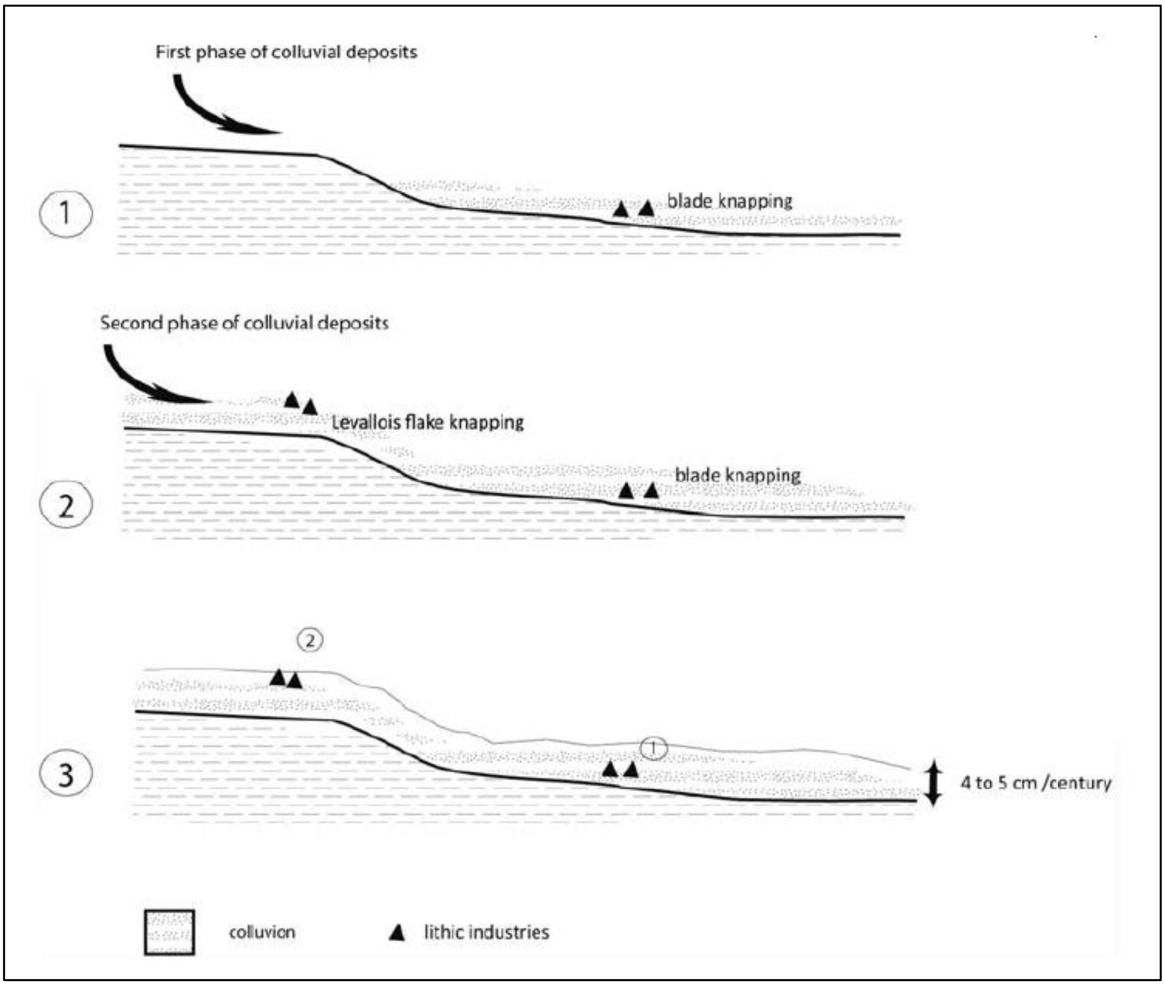


Figure 4.7. A schematic representation of the Colluvial Deposition Hypothesis
(from Locht et al. 2010a)

4.4. Frameworks for Understanding Middle Palaeolithic Technological Variability

This section discusses the concept of *chaîne opératoire* methodologies, and their importance to our understanding of technological variability, before outlining the underlying models and concepts discussed within the relevant literature pertaining to technological variability. Finally, this chapter discusses how Laminar and Levallois technological blade strategies have been understood within a framework of technological variability, in conjunction and with respect to the greater Middle Palaeolithic technological repertoire.

4.4.1. A Note on the Importance of Chaîne Opératoire Studies

The concept of *chaîne opératoire* and more broadly the concept of technology explicitly within an empirical framework, largely originates from the work of the ethnologist André Leroi-Gourhan (Leroi-Gourhan, 1964). Prior to the adoption and concept of *chaîne opératoire*, studies of stone tool variability were based on the researcher's personal ability to understand differences in the products produced, and synthesise these differences temporally. Soressi and Geneste (2011) note that this approach, based on subjectivity, encouraged the development of linear and progressive frameworks within human evolution. And as there was no precise and explicitly typology or framework, specific tools could be designated and catalogued differently by different researchers (*ibid*. 334). The *chaîne opératoire* approach on the other hand is grounded on understanding the process of use and manufacture, with each artefact as a product of a technical system within a society (Leroi-Gourhan, 1964; Inizan et al., 1999). With this approach, each artefact can be positioned within a technological process of sequence, through primary lithic analysis, refitting and the nature and location of large flake scars (Pelegrin et al., 1988). This approach allows archaeologists to reconstruct the temporal dimension of lithic products pertaining to specific *chaîne opératoire*, and a landscape-based approach can be hypothesised. Several studies within this chapter (e.g. Conard and Adler, 1996; Koehler et al., 2014) have already highlighted the success of this approach, for blade technology, within a holistic framework. Given recent discussions on the fragmentary nature of technological systems within the Middle Palaeolithic (see Turq et al., 2013), this approach is becoming more widely adopted in understanding the artefact's social and object biography, and the technological and social behaviour of Neanderthal populations. Authors have noted problems and issues with the *chaîne opératoire* approach, particularly the extreme subjective nature of replicating *chaînes opératoires* and categorising (Boëda, 1994), issues arising from the lack of refits (Tostevin, 2012) and inconsistencies in definitions by lithic analysts (Monnier and Missal, 2014). While these arguments are pertinent, and do deserve further discussion, the examination of an artefact's biography through a framework relating to its manufacturing is a humanising and holistic mechanism for understanding all aspects of a technological strategy, from the acquisition of raw material to its discard, and remains the most credible technique for understanding core volume management strategies and the nature of technological variability. For this reason, it is no surprise that many of the different arguments and concepts for understanding technological variability, below and throughout the Palaeolithic, are grounded on *chaîne opératoire* frameworks.

4.4.2. Understanding Technological Variability within the Middle Palaeolithic

This section first discusses the history of Middle Palaeolithic technological variability, before discussing case studies which make explicit reference to Laminar and Levallois technological blade strategies, before noting specifics of artefact design and transmission ignored throughout these frameworks.

4.4.2.1. Technological Variability within the Middle Palaeolithic: A Brief History

It is important to first note the contribution of studies to Middle Palaeolithic technological variability at the beginning of the twentieth century, as notions of Middle Palaeolithic variability is not a new concept. One of the earliest and most significant contributions includes Peyrony's (1921) model of parallel traditions within the Mousterian, through the existence of what Peyrony (1921) classified as the Mousterian of Acheulean Tradition (MTA) and the Typical Mousterian. This early publication discussed variability in terms of concurrency, an element which mirrored his later models for the Perigordian and Aurignacian industries (Peyrony, 1933, 1934, 1936), and complimented contemporary works on technological concurrency in other periods, including Breuil's (1932a) model for Lower Palaeolithic industries of flake and bifacial based phyla.

The most significant contribution to our understanding of Middle Palaeolithic technological variability originates from the 'Mousterian Debate', a debate on the importance of functional and cultural explanations for inter-assemblage variability within the Middle Palaeolithic, led by Lewis Binford and François Bordes from the 1950s onwards. While their own strand of this debate ended in stalemate towards the mid-1980s, its legacy, and the basis of the Mousterian Debate can still be seen in many of the publications in the last few years (see below). François Bordes, in his examination of different Middle Palaeolithic industries, formulated a cultural taxonomy of five different Mousterian groups which he had defined quantitatively through formal artefact typology (Bordes, 1961a, 1961b). Challenges traditional notions of *fossiles directeurs*, the Bordian view was viewed as a 'branching' (*buissonate*) complex of five traditions, or 'facies' randomly stratified. These were the: *Charentian* (subidivided by *Quina* and *Ferrassie* groups) categorised by high frequencies of scrapers in association with Levallois flaking, the *Mousterian of Acheulian Tradition*, associated with handaxe technologies, the *Denticulate Mousterian*, categorised by denticulated and notched artefacts, and the *Typical Mousterian*, heterogeneous in nature (Bordes, 1953b, 1978, 1984, Bourgon, 1957; Bordes and Bourgon, 1951). For Bordes, these traditions represented different cultural entities or populations, with variability within an assemblage attributed to the deposition of tools by different cultural groups (Bordes, 1961a, 1961b, 1973). Grounded through typological and technological traits (Bordes, 1953a, 1961a, 1961b), this 'cultural' perspective incorporated unique constraints composed by climate, fauna and the environment, rather than an evolutionary lineal mode towards perfection (Groenen, 1994). An underlying assumption throughout Bordes' model was that any Middle Palaeolithic assemblage represented the sum of hominid behaviours that took place at that site and at that time. This contrasted Lewis and Sally Binford's interpretations that, while groups could be identified, these differences were attributed to hominin behaviour under a function-based paradigm, and then to cultural systems (Binford and Binford, 1966; Binford, 1973). Variation was explained through aspects of site function and behaviour, with variation partially indicative of different time periods (Binford, 1973). Through multivariate statistical analyses (emphases on factor analyses), Lewis and Sally Binford isolated five factors which "define clusters of artefacts that exhibit internally consistent patterns of mutual covariation" (Binford and Binford, 1966: 245). An important point in their work is to note that different assemblages represented facies of a single, though heterogeneous Mousterian entity (*ibid*. 247). These in addition to many other frameworks Binford created through an ethnographic and archaeological lens, including expedient vs. curated technologies (Binford, 1973), drop and toss zones, and active/passive/insurance gear (Binford, 1979), shaped a more function-based prospective to technological variability, much to the contrast of the Bordesian stylistic approach.

This temporal element highlighted in both elements was extended and investigated by Paul Mellars, whose chronological ordering refuted Bordes' view as populations which were contemporaneous, with a distinct succession of Ferrassie, Quina and MTA assemblages, in that order, anchored into relative and absolute chronologies (Mellars, 1965, 1969, 1986, 1996). These two contrasting views, with the consideration of chronology and diachronic change, provided a heuristic framework for testing notions of technological variability and provided much discussion on the nature of technological variability (Gamble, 1986; Barton, 1988; Geneste, 1985; Hayden, 1986). Noted by Monnier (2006b) and Monnier and Missal (2014), discussions on technological variability over the last few decades have seen a paradigm shift from culture-historic approaches to synchronic variability and cultural explanation. This includes the work of Harold Dibble, whose re-evaluation of Bordes' interpretations captured tools in various stages of resharpening and outlined how these facies, and the variability of facies, can reflect in some part the differential reduction of tools (Dibble, 1987, 1988; Dibble and Rolland, 1992; Dibble, 1995). Other examples include Rolland's studies into the utilisation of lithic resources in conjunction with climate models, to highlight ecological adaptation in inter-assemblage variability (Rolland, 1981; Dibble and Rolland, 1992), and Steven Kuhn's frameworks into technological adaptations on inter-assemblage variability, and the provisioning of people (similar to that of Binford's personal gear) and places (Kuhn, 1991, 1992). In recent years, many researchers continue to critique, elaborate on from, or use many of these aspects to interpret and understand Middle Palaeolithic technological variability (Guibert et al., 2008; Moncel and Daujeard, 2012; Brenet et al., 2013, 2014; Monnier and Missal, 2014; Morin et al., 2014), many of which discuss Laminar and Levallois technological blade strategies (discussed in more detail below).

Throughout these studies, mechanisms of technological stasis and change whether synchronic or diachronic, continue to be underpinned through artefact function and style and the nature of the social transmission. However, considerations of these two aspects are underemphasised throughout the Middle Palaeolithic. These are discussed in more detail below.

4.4.2.2. Frameworks of Technological Variability with Explicit Reference to Laminar and Levallois Methods of Blade Production

In recent years, a number of publications have begun to discuss Middle Palaeolithic technological variability with explicit reference to the incorporation of both Laminar and

Levallois technological blade strategies. In all instances, frameworks are focussed on the Late Middle Palaeolithic toolkit, and are limited by their chosen methodologies.

Perhaps the most explicit reference to both technologies is that of Bourguignon et al. (2006), later featured as Meignen et al. (2009). In their study of Middle Palaeolithic technologies, Bourguignon et al. (2006) and Meignen et al. (2009) analysed the production of Levallois preferential, Levallois recurrent (unidirectional/bidirectional), Levallois recurrent (centripetal), Discoidal, Quina and Laminar core volume management strategies, through a qualitative evaluation to understand technical investment, planning-depth and technological organisation (see Chapter 1). In this they concluded that no system of flaking appears to be more complex once the whole manufacturing sequence has been taken into consideration. Laminar was concluded to feature: 1) some degree of core shaping and/or maintenance, 2) some degree of end-product predetermination, 3) a moderate degree of desired end-product normalisation, 4) some degree of potential for sharpening, 5) very little ramification during its production, and 6) a moderate degree of productivity (Bourguignon et al., 2006; Meignen et al., 2009). In comparison, Levallois recurrent (unidirectional/bidirectional) features, in comparison to Laminar blade production: a greater degree of core shaping, a greater degree of predetermination of desired end-products, the same degree of end-product normalisation, the same resharpening potential, a greater degree of ramification, and the same level of productivity (Bourguignon et al., 2006; Meignen et al., 2009). There are, however, various problems in their assessment of the two technological blade strategies. Firstly, they do not specify how their conclusions were reached, and the specifics of the qualitative evaluation. This includes what contexts were discussed, what experimental frameworks they considered, or the role raw material influences aspects of their production. It would be beneficial to undertake a similar approach, adopting a more quantitative and statistical framework, to analyse measures of edge-length, edge angle (directly or through a flattening index), and the efficiency of each of these two strategies and their variations (e.g. with cresting or maintenance). Secondly, the Middle Palaeolithic systems analysed are oversimplified, and assumptions are made with respect to the nature of unipolar and bipolar products, and the different Laminar core volume management strategies which can be undertaken. A systematic, replicable, methodology is essential to understand these two systems of Middle Palaeolithic *débitage* systems.

In 2006, Delagnes and Meignen (2006) furthered discussion in Middle Palaeolithic technological variability and blade technology through their spatio-temporal framework of Levallois, Laminar, Discoidal and Quina systems in northern and south-western France. Using a framework incorporating chronostratigraphic, biostratigraphic, and radiometric data for seventy-nine assemblages Delagnes and Meignen (2006) highlighted how Laminar blade production is a fairly localised phenomenon within northern France, with Levallois flake production noted in greater number, throughout northern and southern France. They hypothesise that Laminar technological was needed for the production of quadrangular elongated blanks (Delagnes and Meignen, 2006: 89), and conclude that the emergence of a flexible, multifunctional tool with a high curation potential arose from the coexistence of "human groups with different technical traditions" (Delagnes and Meignen, 2006: 85), who adopted similar mobility patterns while keeping their own "fundamental technical identity" (*ibid*. 85), during the unstable climatic period towards the end of the Middle Palaeolithic. In this somewhat Bordesian approach, attributing systems to shared cultural behaviour, of their dataset only ten attributed to feature Laminar technologies were analysed all confined to MOIS 5 (Delagnes et al., 2007). In this, technological variability attributed to different technological systems was absent. Will different patterns be observed if recurrent and preferential Levallois strategies, or the individual Laminar core strategies, are incorporated? Finally, while they hypothesise the need to produce quadrangular elongated blanks they do not specify why. Is it for a regular elongated cutting edge? And if so, why adopt Levallois recurrent systems of flake production? And how curated are Laminar technological blade strategies in comparison to Levallois blades? Functional perspectives, acknowledging calculated advantages in the different strategies, in addition to an appreciation of the larger dataset (as earlier in this chapter) are essential in understanding the nature of technological variability, and in order to test hypotheses made within Delagnes and Meignen (2006).

This framework reappears in Delagnes et al. (2007) synthesis of Middle Palaeolithic technocomplexes. In this, a similar framework on geographic and diachronic patterning is noted but they conclude that there are two categories of toolkits: those with little or no transformation through retouch (preferential Levallois, recurrent Levallois and Laminar), and those in which blades are transformed through shaping (Delagnes et al., 2007). This notion of technocomplexes, explained by their functional requirements, is interesting but several points needed to be addressed: what are the particular characteristics that may be advantageous for both the appearance of Levallois recurrent (elongated) and Laminar blade technologies? And can we draw parallels with Levalloisian blade technologies in the Early Middle Palaeolithic?

Spatio-temporal frameworks continued to be utilised following the publication of these papers. Both Guibert et al. (2008) and Vieillevigne et al. (2008) utilised radiometric data to plot technological changes within a spatio-temporal framework, similarly to Delagnes and Meignen (2006) and Delagnes et al. (2007), through northern, central, and southern France. In both instances, the absence of Laminar blades in MOIS 6 and MOIS 5 in southern France was noted, contrasting evidence in northern France. Reasons for their absence in south-west France, was however not accounted for.

One final study worth considering is combined technological and zooarchaeological analyses by Delagnes and Rendu (2011). This approach examining the relationship between techniques and fauna, echoed Binfordian methodologies and considered three different attributes: duration of reduction sequence, blank versatility (i.e. the successive transformation of blanks for multiple tasks) and tool maintenance (long use-life vs. short use-life). Delagnes and Rendu (2011) note that Levallois and Laminar strategies are associated with a wide variety of non-migratory species, and concluded that both systems were not very mobile as they featured limited potential for recycling, with long and elaborate flaking processes. Again, there are however a number of problems with this conclusion. Firstly, it contradicts suggestive evidence for mobility, as advocated by Koehler et al. (2014) in their study of various contexts in northern France. While the products may, hypothetically, feature a short use-life, the homothetic morphology of cores do not restrict mobility, but rather enhance. Secondly, it homogenises the two reduction sequences and does not explain why both Laminar and Levallois strategies occur together on the same site, both in isolation and in conjunction with the wider Middle Palaeolithic repertoire.

4.4.2.3. A Consideration of Artefact Design, Style and Social Transmission within Studies of Technological Variability

While the studies above make reference to notions of site function, aspects of artefact design, and the transmission of knowledge, these are not detailed with potential avenues of investigation ignored. This section details considerations of artefact design, style and social transmission, before noting how these can be best investigated.

Studies of artefact form and design, and strategies which take into consideration these elements, are of particular interest to archaeologists understanding toolkit composition and technological variability. Within this, there are three important aspects of artefact design and strategy which need to be considered if design and strategy is defined as a problem-solving process (Nelson, 1991; Gamble, 1986). The first relates to the 'portability' of the toolkit, and increasing portability (Ebert, 1979; Gould, 1969; Nelson, 1991; Kelly, 1988). Typically achieved through increasing efficiency, through the adoption of multifunctional tools, lighter raw materials, standardised products, and producing an optimal cutting edge, increased portability permits an increase in the quantity of other resources which can be carried around the landscape (Kuhn, 1994, 1995). The second relates to technological attributes relating to time (Torrence, 1983, 1989a, 1989b), and optimising time and energy resources through various mechanisms of time scheduling/provisioning (Binford, 1978; Jochim, 1976) within a context of latitude and the environment (see Gamble 1986). The third and final aspect of artefact design relates to artefact composition, specifically the over-design and specialisation of toolkits i.e. reliable vs. maintainable systems (Bleed, 1986) for specific behaviours.

These three aspects incorporate what (Skibo and Schiffer, 2001: 143) term the "performance attributes" of an artefact. This is best defined by Schiffer and Skibo (1987: 599) as "the behavioural capabilities that an artefact must possess in order to fulfil its functions in a specific activity". As "performance attributes are influenced by an artefact's formal properties" (Schiffer and Skibo, 1987: 31), the artefacts produced may be 'engineered' to influence their performance in a given activity (Eren and Lycett, 2016).

While these aspects of artefact design strategy may be considered a form of risk reduction (Oswalt, 1973, 1976; Smith, 1983; Torrence, 1983, 1989a, 1989b; Bleed, 2001), grounded on optimising the artefact, this may not always be the case (Pierce and Ollason, 1987). Thorough testing through model generation, goodness of fit, and primary lithic analysis (Kuhn, 1994) is therefore essential. As Eren and Lycett (2016: 393) note: "a reasonable prediction of 'intent' underlying particular archaeological patterns is that they vary in ways that might logically have been beneficial in practical terms". Through an assessment of various morphometric considerations of artefact design, various findings can provide a strong basis of said 'intent'.

Another important consideration of artefact form and design is through artefact 'style' and explaining technological variability through style (Carr, 1995a, 1995b; Wobst, 1999; Wiessener, 1985; Lechtman 1977; Lechtman and Steinberg 1979) and particularly isochrestic variation (Sackett, 1982), where unconscious or conscious choices from a spectrum of equally viable methods of achieving the same means to an end can be chosen. In this sense, equifinality, and with respect to this thesis the use of both technological strategies can be viewed as both technological 'choice' (Lemonnier, 1986, 1992) and technological 'style' (Lechtman, 1977; Sackett, 1982). See Tostevin (2012) and Sacket (1985) for more information on style theory the style/function dualism, and Sackett (1986: 271) for the application of the isochrestic method to the archaeological record.

Finally, the nature with which technological and typological tradition is transferred through different populations and peoples is the second mechanism, complimenting artefact form and design. Knowledge, or hypothetically two populations featuring the same technology, per Boyd and Richardson (1985) can either be the product of independent innovation, resulting from adaptive convergence (whether direct biased transmission resulting from identical tasks) or cultural drift (chance convergence), or through cultural transmission across space. This cultural transmission across space can be through either: 1) symmetric transmission through demic diffusion via natal dispersal (with or without gene flow), or asymmetric transmission (behavioural vs. stimulus diffusion) (*ibid.* 85). These can also be viewed through the lens of cultural capacity, the traditions and socially transmitted knowledge i.e. how to make blades, and cultural performance i.e. the biological, historical and social framework for blade production (Haidle and Conard, 2011).

As Tostevin (2012) notes model expectations, inter-regional patterns, and goodness of fit tests can begin to understand the likeliness of specific transmission methods, and the relationship between different contexts. For blade technology, this means that different aspects of their production can be assessed, 'intent' can be investigated, and the true nature of their variability can be detailed, and investigated through the lens of artefact design and desirability, to an extent previously unseen. For Middle Palaeolithic technological blade strategies, a consideration of artefact design and the behavioural potential of artefacts, through 'performance attributes', provides a gateway into better understanding their concurrency and potential use within the Middle Palaeolithic technological repertoire.

4.4.2.4. Discussion

The Middle Palaeolithic of Europe features an exhaustive history of investigation into the technological choices, and, by extension, technological and social behaviour of Neanderthal choices and actions. Through the adoption of various qualitative, chronostratigraphic, biostratigraphic, radiometric, qualitative, and zooarchaeological evaluations, in conjunction with a *chaîne opératoire* framework, aspects of technological variability have been extensively studied, under the concepts of function/style and social/cultural transmission. Issues were noted including the lack of rigorous statistical and quantitative analyses, the homogenisation of both methods of blade production, the exclusion of evidence from the Early Middle Palaeolithic, and an absence of investigation into the strengths and weaknesses of both techniques. For a thorough understanding of Neanderthal technological and social behaviour, the desirability of the artefacts need to be considered. These artefacts were produced for an intention, and the nature of those intentions are unknown Through extensive analyses of these blade strategies in both periods of the Middle Palaeolithic, then a robust and credible understanding of both blade strategies can be undertaken.

4.5. Adopting and Justifying a Morphometric Approach

In order to better understand the relationship between technological blade strategies, a technological investigation is essential to truly understand the nature of the variability in question, and possible notions of social transmission. To explain why these strategies occur togethe, and change in their quantity throughout the Middle Palaeolithic, aspects of artefact design, advantages and disadvantages in both methods of blade production and the desirability of artefacts is one avenue which has not been pursued by archaeologists. In order to provide a robust analysis of such factors, a morphometric framework appears ideal. The statistical significance of differing attributes can be assessed in conjunction with the technological data to conclude statistical significance, and to provide working hypotheses on the relationship between blade strategies throughout the Middle Palaeolithic.

Morphometrics can be generally defined as the application of geometric principles to document, characterise and quantify shape i.e. the total of all information that is invariant under translation, rotations and isotropic rescales (Small, 1996). This can include the assessment and quantification of form (i.e. shape *plus* size), and morphological variation among a dataset or assemblage. In Archaeology, and specifically the Palaeolithic, this can be seen in the paradigm shift to empirical quantitative analyses in the 1960s / 1970s processual movement, in the form of traditional morphometrics (*sensu* Marcus, 1990), focusing on distance data and measurements of various lengths, widths, and indices e.g. Bordes (1961a) and Roe (1968). Fundamental to the concept of traditional morphometrics is that the structure of an object (artefact) can be replicated and represented through a set of length measurements. These can be with, or without, the aid of areas of morphological correspondence (landmarks), and can include schemes of triangulation (e.g. Rao and Suryawanshi, 1998) and truss systems (e.g. Strauss and Bookstein, 1982).

Geometric morphometrics, first accredited to Bookstein (Bookstein, 1978: 63), is in contrast, grounded on, primarily, two types of data: landmarks i.e. points of geometric correspondence or equivalence (see MacLeod 1999 on the confusion of geometric and biological differences of homology), and outline/surface-based datasets. In both types of data, two types of abstraction are undertaken: 1) abstraction from the artefact form to a set of attributes which are tractable for mathematical and quantitative analysis (and can be measured precisely), and 2) the transposition from measured features to a morphospace, in which each specimen can be represent by a single point. Given the lack of geometric correspondence on certain types of lithic artefacts, for which Levallois and Laminar technological blades are included, closed-contour outline-based analyses are often preferred.

Outline contours are a rich and accessible form of data allowing the analysis of variance and covariance, and can provide an opportunity for shape descriptions to be quantitatively studied and evaluated. Data can be collected through laser scanners or digital photographs, are relatively easy to locate automatically on morphometric software, and can be analysed using various forms of algorithmic tools (e.g. Costa and Cesar Jr., 2001). Two-dimensional closed outlines (i.e. complete and unbroken in two dimensions) are the most widely used approach within lithic analyses (Iovita, 2009; Costa, 2010; Iovita, 2010; Iovita and McPherron, 2011; Serwatka, 2014, 2015), as this is sufficient to provide a good representation of shape-variation, where artefacts are particularly flat. In the process, once the edges of the object are detected, a line is represented by a number of equidistant points, and can be at most up to a few hundred, depending on the scale and variability of the shape (Bookstein, 1997). These are then converted into analysed through Fourier descriptors (e.g. elliptical and fast-Fourier), and analysed through multivariate ordination-based techniques to analyse variance and covariance within a group, or groups, of artefacts. With the increasing availability of open-source and accessible software (e.g. Image J, PAST, tpsDig2, HShape, R), morphometrics is becoming increasingly more accessible to archaeologists interested in analysing shape variance.

Within studies of the Palaeolithic, a considerable amount of work has been invested into notions of symmetry (Carper, 2005; Saragusti et al., 1998), and on accounting, documenting and explaining variation in stone tools (Wynn and Tierson, 1990; Gowlett et al., 2001; Shott, 2003; Buchanan, 2006; Clarkson et al., 2006; Buchanan and Collard, 2010). Many of these approaches have focused on shape variation within handaxe assemblages given the imposition of shape and form (see Stade and Hoggard submitted for an overview), however examples on Levallois cores (Eren and Lycett, 2012; Lycett and von Cramon-Taubadel, 2013) and discoid end-products (Picin et al. 2014) do occur.

Geometric morphometric studies allow an objective method for analysing the actual degree of morphological variability within technological blade strategies, despite having little or no distinctive morphological features. Geometric morphometric methodologies allow an analysis of shape, variation of shape in different periods (Early Middle Palaeolithic vs. Late Middle Palaeolithic), product regularity, and the role of other influences on shape (e.g. raw material type, Laminar core reduction strategy, size) on a replicable level. Furthermore, it provides an opportunity for shape-descriptive comparisons of artefacts (see Chapter 2) to be tested rigorously.

Geometric morphometric methodologies can only examine artefact design in terms of shape, and a consideration of lineal measurements to investigate edge angle, edge circumference, and the cutting edge. In conjunction, these methodologies cover the global artefact design of blade technologies, allowing a thorough consideration of differences and commonalities in the use and behavioural potential of each strategy.

4.6. Summary

Through an extensive analysis of literature pertaining to technological variability it is evident that there is a larger-than-thought dataset for the existence of Levallois and Laminar technological blade strategies in both periods of the Middle Palaeolithic. It was demonstrated that blade strategies stretch back to pre-Neanderthal populations, before their widespread appearance around Europe, Western Asia, and Europe c. 300,000 BP. While we can now begin to understand the quantity and distribution of blade technology before c. 43,000-41,000 BP, there are a number of gaps in our understanding of technological blade strategies, with which a framework incorporating technological and morphometric methodologies would begin to fill in these gaps. These problems include how technological blades have been interpreted, the lack of quantitative and replicable methodologies, and a lack of appreciation for material throughout the Middle Palaeolithic. Specifically:

1. Blade technologies have not been subject to thorough technological and inter-regional analysis throughout north-west Europe;

2. Methodologies have yet to thoroughly investigate aspect of artefact design and desirability through a rigorous statistical and morphometric approach;

3. Methodologies have not accounted for the concurrent nature of Levallois and Laminar technological blade strategies, and the change in their quantity throughout the Middle Palaeolithic from Levallois-rich blade strategies in the Early Middle Palaeolithic to Laminar-rich blade strategies in the Late Middle Palaeolithic;

4. Blade technologies in the Early Middle Palaeolithic have not been thoroughly analysed or compared alongside examples in MOIS 5.

By addressing these problems by considering the artefact design and cultural transmission of technological blade strategies, through a morphometric/technological approach (elaborated further in Chapter 5), then aspects of function, cultural association and the contemporaneity of blade strategies can be thoroughly investigated and appreciated within the Middle Palaeolithic.

Chapter Five
The Methodological Framework for this Thesis

5.1. Introduction

This section details the methodological framework underpinning the thesis. It will first outline the questions being addressed, and detail the framework for tackling each of the four questions which make up the overall aim of the thesis, assessing to what extent artefact design and the physical attributes of artefacts can contribute to Middle Palaeolithic technological variability. This includes the specific methodology, the four main aspects of technological behaviour assessed to understand variability, the three main aspects of artefact design considered, and a justification of the morphometric and experimental frameworks utilised. This chapter will then detail the data collection procedure of both the archaeological and experimental material, outlining what raw materials will be used and what contexts will be examined, before detailing the composition of the dataset. Finally, the chapter will conclude by detailing the continuous and non-continuous variables examined, and detailing considerations of measurement error and statistical testing employed.

5.2. Aims of the Methodology: A Consideration of the Research Questions Proposed

The previous chapters contextualised the period and technologies in question, discussed the different aspects of blade technology within the Middle Palaeolithic, and the potential of extensive technological and morphometric frameworks through an investigation of artefact design. Using the null hypothesis (H_0) outlined in Chapter 1, that contexts which feature either/both technological blade strategies are randomly stratified, and are not linked within a spatio-temporal framework:

1. What differences or commonalities in the chaîne opératoire, use, and modification of Laminar and Levallois blade *débitage* are observed throughout the Early and Late Middle Palaeolithic of north-west Europe?

2. How do Levallois and Laminar technological blade end-products differ in terms of their artefact design, behavioural potential and desirability? What is the role of raw material variation in shape and in the nature of Levallois and Laminar technological blade end-products?

3. Can an explanation, grounded in hypotheses of function and artefact design, explain the use of Levallois and Laminar technological blade strategies in isolation and in conjunction, and the shift from Levallois-rich blade contexts in the Early Middle Palaeolithic to Laminar-rich contexts in the Late Middle Palaeolithic?

These three questions address perhaps the main gaps in our knowledge of technological blade strategies, and act as a case study for understanding the extent which aspects of artefact design and the behavioural potential of artefacts provide a better understanding of Middle Palaeolithic technological variability and aspects of Neanderthal technological and social behaviour.

5.3. Framework for Analysis: Technological Variability and Cultural Transmission (Question 1 and 3)

To test whether aspects of tool function are pertinent to explaining the distribution, concurrency and isolative use of technological blade strategies, and technological change throughout the Middle Palaeolithic, a thorough appreciation of technological variability and social transmission is essential. To do this, a three-stage approach was undertaken.

Firstly, extensive technological analyses were undertaken through lithic and refit analyses, and detailed *chaînes opératoires* will be outlined. Attributes of the taphonomic histories of technological blade strategies, and commonalities and differences in taphonomy on an intra-site level, were considered to assess whether ideas of technological contemporaneity within MOIS 5 contexts (Colluvial Deposition Hypothesis) can be detected. This includes differences in mechanical damage (e.g. rolling, scratching and abrasion) or chemical alteration (e.g. patination and leaching). During this stage, all unretouched complete and incomplete blades were photographed (using a protocol described below), to later investigate aspects of product regularity, aspects of cutting edge, and aspects of shape variability between and within contexts.

All contexts, with their technological information are then compared through a four-fold analysis of behaviour, which highlights the nature of variability in question. Using an amended analysis of Tostevin (2012), the four criteria assessed are:

1. Intensity of core and tool reduction: this includes ratios of unretouched and retouched blades, core-scar counts, core-exhaustion, and non-cortical/cortical blade ratios;

2. Core management strategy and core exploitation: this includes aspects of preparation and exploitation, and the use of behaviours incorporating core-edge flakes and cresting;

3. Core surface dimensions and convexity: this includes aspects of the raw materials morphology, including aspects of convexity (curvature and blank convexities), core elongation and flattening index;

4. Tool-kit morphology: this includes aspects of blank elongation and flattening, artefact condition (complete vs. whole), and scar direction.

These four criteria capture a high resolution of Neanderthal blade behaviour, and through comparative analyses they permit an investigation of differences and commonalities between the contexts analysed, with respect to the wider literature and both periods of the Middle Palaeolithic. Through this three-fold approach (lithic analysis, comparative studies, and an appreciation of the wider literature), aspects of social transmission are investigated through a goodness-of-fit and an assessment of model expectations (social transmission vs. independent innovation). These, in sum, addressed question one and, in conjunction with question two, question three.

5.4. Framework for Analysis: Artefact Design, Behavioural Potential and Desirability (Questions 2 and 3)

Question three can only been answered following a consideration of the previous three questions. To test the pertinence of a function-based argument, its relevance must be assessed alongside the archaeological record. Furthermore, for a controlled blade dataset an experimental assemblage was also produced.

To investigate aspects of artefact design and differences between the types of blade production, three aspects are investigated through the lens of optimality and risk minimisation. These are:

1. Properties regarding the shape/nature of the cutting edge (performance):
    a. Two-dimensional planform shape (through geometric morphometrics)
    b. Flattening Index (as an indicator of sharpness)
    c. Working edge angle
    d. Elongation (the amount of lineal working edge)
    e. Edge regularity

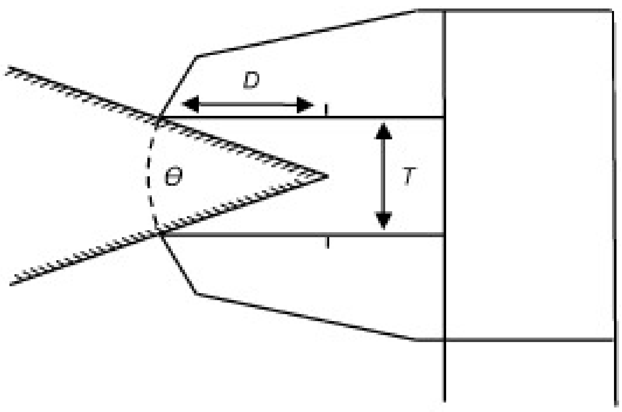
2. Raw material economisation (efficiency)
    a. Aspects of reduction (number of blades produced)
    b. Cutting edge (mean cutting edge per blade/per weight of stone)

3. Aspects of product regularity (standardisation)
    a. Aspects of shape (shape regulation)
    b. Aspects of cutting edge

These three categories (performance, efficiency and standardisation) are not mutually exclusive as aspects of all three influence each other (e.g. standardisation and performance can both be an indicator of efficiency); however, these three categories best describe the collective aspects of artefact design and allow discussions into investigations of other considerations (e.g. portability).

In more detail, and with respect to the cutting-edge angle, experimental blades were analysed using the Dibble and Bernard (1980) 'Calliper Method', as this is viewed as a more accurate way of determining edge angles in contrast to other recording methods, e.g. goniometers (Key and Lycett, 2014). The 'Calliper Method' measures edge angle through a known distance perpendicular to the working edge (D) and a measured thickness from the predetermined point from the working edge (T). For this study, similarly to Key and Lycett (2014), D was set at 4mm. See Figure 5.1 for a schematic representation of the 'Calliper Method'. For archaeological material, as microfracturing and mechanical damage can dull or modify the edge angle, a flattening index was calculated to suggest aspects of edge angle. However, as a correlative relationship was determined between flattening index and edge angle (see Chapter 6), a flattening index can be a proxy for edge angle and sharpness. The recording of edge angle in micron length was avoided as edge angle allows a direct comparison of studies investigation edge angle (e.g. Gould et al., 1971; Key and Lycett 2014), allowing a full integration of results within the thesis to the wider literature. *Éclats débordants* from the experimental blade assemblage were also examined to assess whether there are any differences in the cutting-edge between *éclats débordants* and Levallois recurrent (unidirectional/bidirectional) elongated material. Throughout these analyses, the importance of size and its allometric relationship between many of the attributes analysed (e.g. edge angle and shape) were analysed and considered where applicable.

In assessing shape variance/co-variance and the main influences of shape variance/co-variance, two-dimensional planform shape of unretouched whole technological blades were subject to Elliptical Fourier Analysis (EFA) in both archaeological and experimental datasets. This method of closed-outline analysis transforms semilandmarks into linear combinations of sinusoidal functions with appropriate multiplicators, i.e. amplitudes (Zahn and Roskies, 1972; Kuhl and Giardina, 1982; Ferson et al., 1985). Changes to the number of amplitudes, or harmonics, can increase or decrease the shape representation, dependent on the complexity of the shape needed (see Figure 5.2). Over the last decade, this method has become increasingly popular since it features several advantages over other Fourier-based approaches (Crampton, 1995).



$$\theta = 2\left[\tan^{-1}\left(\frac{0.5T}{D}\right)\right]$$

Figure 5.1. A schematic representation of determining edge angle through the Dibble and Bernard (1980) 'Calliper Method'. Edge angle is calculated through the thickness (T) derived from a known distance (D) from the working edge. A D of 4mm was adopted for this thesis (image sourced from Key and Lycett 2014).

Following similar practices (Costa, 2010; Serwatka, 2014, 2015; Picin et al., 2014), one-hundred equidistant semilandmarks were plotted around the outline of the blade shape, with the point of percussion as the starting point for all examples (see section 5.7). In contrast to the perception of EFA in previous analyses (e.g. Serwatka, 2014), Generalised Procrustes superimposition is unnecessary, as the first two harmonics account for size and rotation. Inspection of outline morphologies reconstructed from a series of different numbers of EFA harmonic amplitudes indicated that for this dataset that the main features of each outline could be captured using the first twenty to twenty-five normalised elliptic Fourier harmonics. This was undertaken by computing the cumulative sum of harmonic power, using the calibrate_harmonicpower function in Momocs for R (Bonhomme et al., 2014), where the first twenty-one harmonics accounted for 99.9% of all harmonic power and by proxy shape. Therefore, throughout all analyses the first twenty-one normalised elliptic Fourier harmonics were analysed. These were analysed through Principal Component Analysis of the Fourier harmonics, with 99.9% of all shape difference then analysed through further discriminant analyses (Lineal Discriminant/Canonical Variates Analysis) to assess whether different groups (technological blade strategies, raw materials, or periods) can be successfully discriminated. This was then statistically tested through a MANOVA/PERMANOVA of the canonical axes. Digitisation of the outlines were processed in tpsUtil v.1.69 (Rohlf, 2016a) and tpsDig2 v.2.19 (Rohlf, 2016b), and analysed in PAST v.3.11 (Hammer et al., 2001) and Momocs for R (Bonhomme et al., 2014). Stylistic and graphical modifications (typography and image quality) were made in CorelDraw X7 (Corel Corporation. Released 2016). Through this geometric morphometric approach the main sources in shape variation can be determined, groups can be tested for statistical difference, and tested for the degree of discrimination, allowing considerations of period, raw material and blade technique.

Through an investigation of artefact design among both experimental and archaeological blade strategies, the advantages and disadvantages of each technique are assessed, and the degree of difference in attributes of artefact design. The three aspects of artefact design investigated here (performance, standardisation, efficiency) are then examined overall, in conjunction with other attributes, and then studied in conjunction with the extensive technological analyses to assess through a goodness-of-fit, the extent which aspects of artefact design and functional morphology affect the relationship the temporal-spatial relationship between technological blade strategies and their use concurrently and in isolation. These analyses, in sum, address questions 2 and 3.

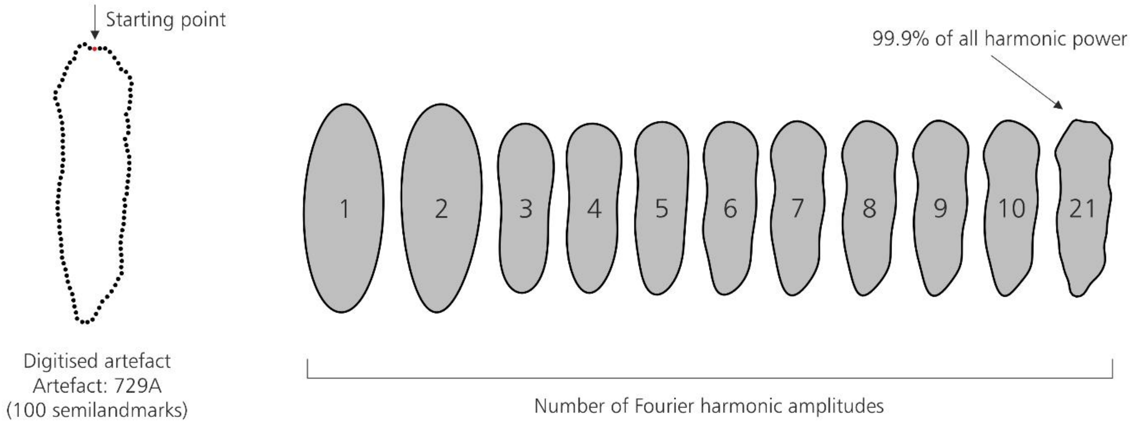


Figure 5.2. A schematic representation of Fourier harmonic amplitudes with increasing harmonic power and harmonic amplitudes resulting in a more complex shape.

5.5. Data Collection Procedure: Archaeological Material

As noted in Chapter 4, within the Middle Palaeolithic of north-west Europe there is a concentration of archaeological evidence for the existence of Laminar and Levallois technological blade strategies. To address the questions of this thesis, a large sample of material from a variety of contexts will be analysed. The archaeological sample:

- Was comprised of material from a variety of geographical regions in north-west Europe incorporating evidence from northern France, Belgium and southern England;
- Was comprised of material from both periods of the Middle Palaeolithic, with emphasis placed on material from the Early Middle Palaeolithic;
- Was comprised of material with a total equal weighting to both Levallois and Laminar technological blade strategies;
- Was comprised of material with contexts featuring both concurrent and individual technological blade strategies.

In terms of individual collections, preference was given to assemblages which:

- Originate from a secure stratigraphic record, recovered using modern excavation techniques;

- Are chronologically credible, with fine-scale resolution;
- Can be characterised in terms of their local environmental setting.

Limitations and considerations include:

- Availability of material for study (fragmentation of assemblages, duration of time, and inaccessibility of whole or part collections).

Throughout data collection, the presence of Levallois *éclats débordants* were noted and subjected to technological analyses, as they can represent a product of blade production and products which could have been utilised (Beyries and Böeda, 1983). While not all *éclats débordants* represent the product of Levallois recurrent blade production (see Chapter 2), their association (and possible) use with Levallois blade *débitage* is important to consider: are they equifinal in how they are transformed, for example? Combined with an assessment of working edge angle, their use as a blank and retouched tool can be hypothesised and elaborated.

MOIS	Country	Context	Quantity (n=)
8	France	Saint-Valéry-sur-Somme (MVR)	54
8	Belgium	Mesvin (IV)	133
8	Belgium	Le Rissori (IV)	18
8/7	United Kingdom	Baker's Hole (various)	40
8/7/6	United Kingdom	Crayford (various)	70
7	Belgium	Le Rissori (IIIA)	109
7	Belgium	Le Rissori (IIIB)	90
7/6	France	Therdonne (N3)	16
5 (5a)	France	Rocourt	110
5 (5a)	France	Fresnoy-au-Val (Série 1)	120
5 (5a)	France	Bettencourt-Saint-Ouen (N2B)	148
		Total:	908

Table 5.1. The archaeological dataset used throughout this thesis

There are a variety of definitions for elongation in the archaeological literature (see Chapter 2). Many of the original definitions of blade technology are defined on a 2:1 elongation index, which are typically soft-hammer/punch-based percussion in nature. With hard hammer percussion, feathering can occur to a greater length on a blade's lateral edges, and it would be invalid for a small abrupt extension on a position of the blade to not be classed as a blade as the intention was to produce elongated material. It was the author's opinion to allow for a margin of difference (c. ~12.5%) in its elongation index from the typical 2:1. Therefore, all material featuring an elongation index (L/W) of 1.75:1 was used as a classification for blade material. However, irrespective of this measure all mean elongation indices recorded throughout the contexts analysed was above 2:1.

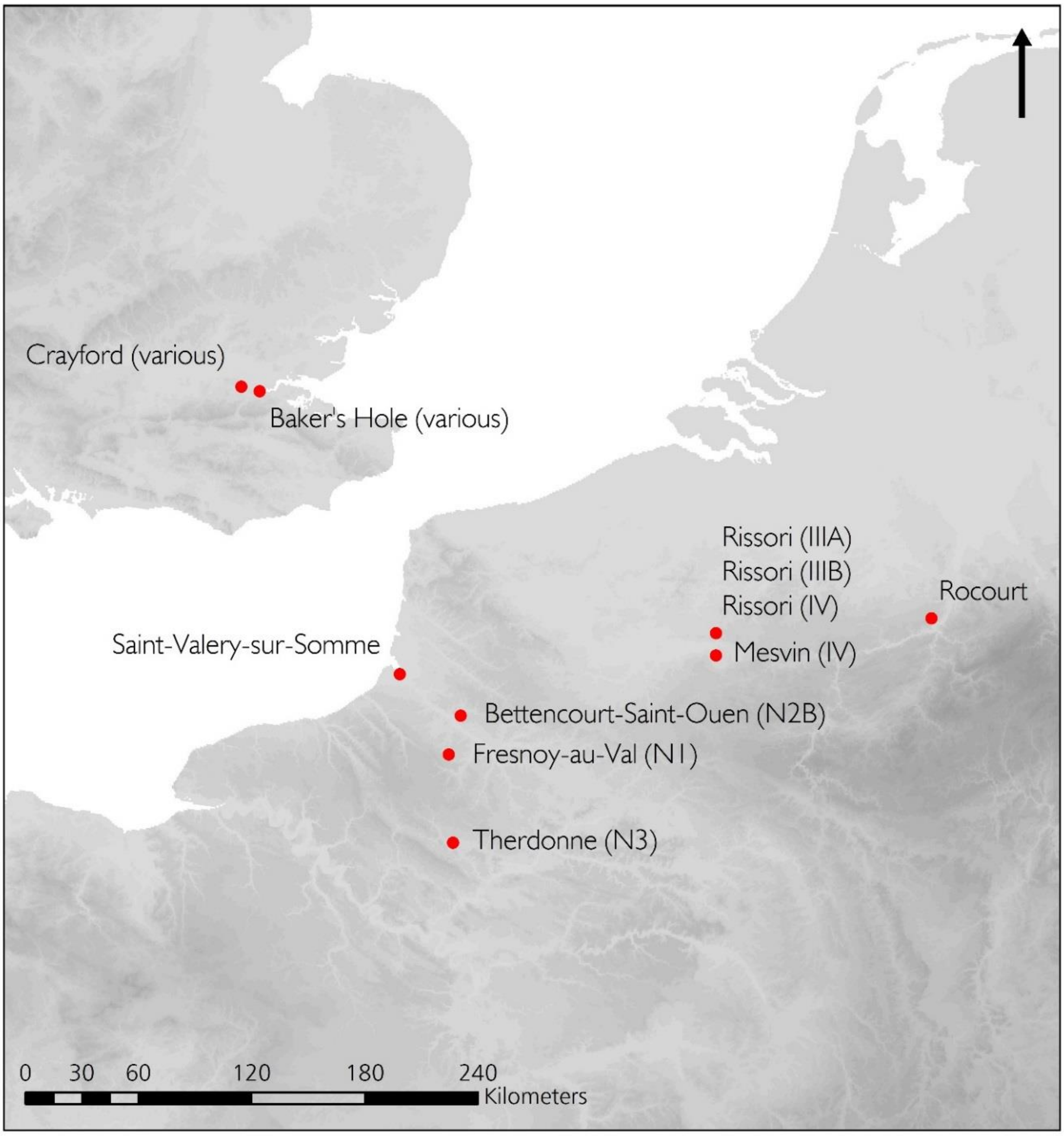


Figure 5.3. Location of contexts examined throughout the thesis

In total 908 archaeological examples of *éclats débordants,* blades and blade *débitage* were analysed throughout this thesis (Table 5.1, Figure 5.3). All examples originate from eleven contexts within the Middle Palaeolithic: three Late Middle Palaeolithic contexts, and eight Early Middle Palaeolithic contexts. Despite this unequal weighting, an equal weighting of Laminar and Levallois technological blades represented throughout the analyses, with 432 examples of Laminar technological blades and blade cores, and 408 examples of Levallois blades and blade cores. A further 68 examples of *éclats débordants* were considered.

5.6. Data Collection Procedure: Experimental Material

To address aspects of artefact design it was decided that an experimental framework should be adopted. For the experiment four different types of flint were knapped, all of them sourced and of known provenance (Table 5.2). In raw material selection, as flint is the most widely used knapping medium throughout European prehistory, emphasis was placed on contrasting and similar types of flint, to check for variation within an immediate region (materials situated less than 20km), in addition to more distant differing quality flint from a distant locale (materials situated greater than 20km). As such, three flints from different regions in Norfolk, eastern England, were contrasted against one type flint from Devon, south-west England. General descriptions of the material (appearance, fracturing qualities) can be viewed in Table 5.2.

Raw Material	Count (n=)		Flint description (structure/microstructure/comments)
	Laminar	Levallois	
Ingham Flint, Norfolk, UK.	75	42	Highly silicified with a homogeneous microstructure; some microfossils or anomalous structures; thin cortex layer
West Runton Flint, Nofolk, UK.	110	38	Highly silicified with a homogeneous microstructure; few microfossils or anomalous structures; thin cortex layer
Caistor St. Edmunds, Norfolk, UK.	60	11	Moderate silicification with some homogeneity; some microfossils or anomalous structures; iron-staining; thin cortex layer
Beer Head Flint, Devon, UK.	125	13	Highly silicified with some homogeneity; brittle cryptocrystalline structure; large geodes present; thin cortex layer

Table 5.2. The four different raw materials used throughout the experiment with characteristics noted

Figure 5.4. Examples of blade *débitage* produced using the four different materials comprising the experimental dataset

The raw material was weighed and measured, with similar dimensions of raw material used throughout the experiment (see Appendix). Emphasis was placed on equal amounts of raw material, rather than equal numbers of products, as to give an indication of how 'productive' each raw material is, and the amount of waste produced. Each of the materials sourced were subject to appropriate guidance from Natural England and the relevant County Councils (North Norfolk County Council and Dorset County Council). All flint sourced from quarries (Ingham and Caistor St. Edmunds) were collected from their primary resource, with material from Beer Head and West Runton sourced from shore collection and not cliff extraction, as this does not constitute as an 'Operation Like to Damage' on a Site of Special Scientific Interest (SSSI).

These raw materials were then knapped by a flintknapper proficient in the production of both technological blade strategies. All cores were knapped to exhaustion, where maintenance could not improve the productivity of a core of irregular and unproductive dimensions, and knapped using a bipolar technique, as a form of core maintenance and for consistency. The same hammerstones were used throughout the experiments to eliminate hammerstone weight as a variable and produced within the same environment (Department of Archaeology Flintknapping Shed, University of Southampton) under similar lighting conditions. In total, there were four experiments. Throughout the flintknapping process all artefacts were immediately collected, with blades produced immediately handed over, to avoid edge and artefact damage, following its removal. In total 474 experimental Laminar and Levallois blades were produced, in addition to 25 *éclats débordants*. For pictures of the blades produced see Figure 5.4.

5.7. Methodology for Recording Artefacts

All artefacts were recorded through their technological attributes, totalling ninety-one attributes in total. These groups can be categorised into eight groups in accordance with various technological components including their taphonomy, core strategy, blade attributes and retouch. All attributes were recorded for the archaeological artefacts, with only general and morphometric attributes recorded for the experimental artefacts.

All data was collected and recorded in Microsoft Excel (Microsoft. Released 2013), before being transposed into IBM SPSS Statistics 23 (IBM Corp. Released 2013) and PAST v.3.11 (Hammer et al., 2001) for data screening and further analyses. Measurements of thickness (blade thickness variation, core thickness) were measured using digital callipers and recorded to a hundredth of a millimetre. All other measurements, with the exception of edge circumference, were recorded using digital photographs and a superimposed grid system created through CorelDraw X7, and measured using tpsDig2 v.2.27 (Rohlf, 2016b). Edge circumference/maximum cutting edge was calculated using an outline function in tpsDig2. In more detail, the method for recording artefacts is as follows:

1. All artefacts were oriented with their longest axis positioned longitudinally, and photographed with a photographic scale in planform view;
2. All photographs were numbered, and renamed before being imported into CorelDrawX7, using the 'Import image' function;
3. A black line, one pixel thick, was drawn on the photographic scale, to represent ten millimetres. All artefacts were then traced using the 'Trace Outline' function, closed where necessary, and again set to one pixel thickness;
4. The outlines were then made solid (grey) through the 'Solid Fill' function, and saved as a .jpeg file for measurements of edge circumference;
5. A grid five columns and one pixel thick was superimposed over the solid object, and 'snapped' at the edges of the blade to ensure that all columns are equidistant from the tip and the bottom of the blade;
6. This was then saved as a .jpeg file for measurements of length, width, and width every 20% down the longitudinal axis of the blade;
7. Both types of files were then collated in tpsUtil 1.70 (Rohlf, 2016a), and measured through tpsDig2.27.

Primary resources including excavator's notes and diagrams were used throughout the data collection procedure, to better aid the context of the artefacts under investigation.

5.8. Catalogue of Attributes

5.8.1. Group One: General Attributes

Group one attributes pertain to general information about the artefact for cataloguing and organisation. In total, group one comprises of ten attributes:

1. Artefact count (#):	A count in relation to the overall database
2. Context:	The context the artefact derives from
3. Artefact type:	The type of lithic material as categorised into two types: a) Core: (see Chapter 2) b) Flake: (see Chapter 2)
4. Artefact number:	The artefact label at the time of excavation/post-excavation
5. Region:	A definable area, country, or department within a country
6. Country:	A region of land identified as a distinct entity in political geography
7. Photograph ID (#):	File name for the photograph taken (DSC________)
8. Refit presence:	If an artefact appears to reattach to any other artefacts: a) Yes b) No
9. Number of refits (#):	The number of refits in association with artefact
10. Refit ID(s):	Artefact number ID for the reattached artefacts

5.8.2. Group Two: Morphometric Attributes

Group two attributes pertain to continuous and categorical data obtained through traditional morphometric recording methods. In total, group two comprises of thirty-six attributes:

11. Weight (g):	A measure of the heaviness of an object
12. Length (mm):	Also known as the technological length; recorded in a direction correspondent to the axis of percussion
13. Width (mm):	Also known as the technological width; recorded perpendicular to the axis of percussion (and length)
14. Elongation Index:	The artefact's technological length divided by its technological width
15. Greatest thickness (mm):	The great thickness along the length of the flake on a flat surface
16. Core flattening index:	Measure of flatness; greatest thickness divided by length
17. Maximum cutting edge (mm):	The edge circumference of the blade (using tpsDig2)
18. Cutting edge per weight of stone (mm/g):	Measure of efficiency; calculated as the maximum cutting edge (edge circumference) divided by its weight
19. Curvature of convexity: (Bergman 1987; Tostevin 2012)	Measure of curvature and indicator of core convexity, which Tostevin (2012) notes as a behavioural proxy to exploit specific surfaces. Dependent on the distance between the mid-point of the length on the ventral surface of the piece to the top of the table on which the extremities rest: a) Straight: does not exceed 1/8 of the blank's total length; also chosen when the distal half twists less than 45 degrees twisting in either direction; b) Twisted: When the tip of the blank is twisted at least 45 degrees; c) Curved: When the curvature measurement exceeds 1/8 of the blank length, with less than 45 degrees twisting in either direction. Includes concord-type *sensu* Meignen and Bar-Yosef (1991).
20. Thickness at 0% length (mm):	Thickness at the proximal end of the blank
21. Thickness at 20% length (mm):	Thickness twenty percent along the blank from the proximal edge
22. Thickness at 40% length (mm):	Thickness forty percent along the blank from the proximal edge

23. Thickness at 60% length (mm):	Thickness sixty percent along the blank from the proximal edge
24. Thickness at 80% length (mm):	Thickness eight percent along the blank from the proximal edge
25. Thickness at 100% length (mm):	Thickness at the distal end of the blank
26. Mean thickness (mm):	Average thickness throughout the blade
27. Thickness variation (mm):	Calculated as the range of the inner four measurements
28. Width at 0% length (mm):	Width at the proximal end of the blank
29. Width at 20% length (mm):	Width twenty percent along the blank from the proximal edge
30. Width at 40% length (mm):	Width forty percent along the blank from the proximal edge
31. Width at 60% length (mm):	Width sixty percent along the blank from the proximal edge
32. Width at 80% length (mm):	Width eighty percent along the blank from the proximal edge
33. Width at 100% length (mm):	Width at the distal end of the blank
34. Mean width (mm):	Average width throughout the blade
35. Width variation (mm):	Calculated as the range of the inner four measurements
36. Blade flattening index:	Calculated by the mean thickness divided by the mean width
37. Edge angle (Left: 25%):	Measured in degrees; only calculated for experimental blade *débitage*; edge angle; calculated using (Dibble and Bernard, 1980)
38. Edge angle (Left: 50%):	Measured in degrees; only calculated for experimental blade *débitage*; edge angle; calculated using (Dibble and Bernard, 1980)
39. Edge angle (Left: 75%):	Measured in degrees; only calculated for experimental blade *débitage*; edge angle; calculated using (Dibble and Bernard, 1980)
40. Edge angle (Right: 25%):	Measured in degrees; only calculated for experimental blade *débitage*; edge angle; calculated using (Dibble and Bernard, 1980)
41. Edge angle (Right: 50%):	Measured in degrees; only calculated for experimental blade *débitage*; edge angle; calculated using (Dibble and Bernard, 1980)
42. Edge angle (Right: 75%):	Measured in degrees; only calculated for experimental blade *débitage*; edge angle; calculated using (Dibble and Bernard, 1980)
43. Mean lateral left edge angle (degrees):	Mean angle for the lateral left edge; used for *éclats débordants*
44. Mean lateral right edge angle (degrees):	Mean angle for the lateral left edge; used for *éclats débordants*
45. Overall edge angle (degrees):	Overall mean working edge;calculated as the mean of all measures
46. Artefact cross-section: (modified from Shimelmitz and Kuhn 2013)	The cross-section of the blade (see Figure 5.5): a) Flat b) Polyhedral c) Triangular d) Trapezoidal e) Irregular f) Plano-convex g) Trapezoidal (right) h) Trapezoidal (left) i) Triangular (right) j) Triangular (left) k) Semi-circular

Figure 5.5. Artefact cross-section categories for the artefacts recorded (modified from Shimelmitz and Kuhn 2013)

5.8.3. Group Three: Raw Material Attributes

Group three attributes focus on the nature and type of artefact in terms of material composition. In total, group three is composed of five attributes:

47. Raw material (general):	The general raw material e.g. flint, chert, sandstone
48. Raw material (specific):	If known, the specific type of raw material e.g. red rhyolite
49. Raw material quality:	Measure of quality through a qualitative assessment of homogeneity: a) Fine-grained with none or few (0-5) inclusions/micro-fossils/anomalies b) Fine-grained with some (5-10) inclusions/micro-fossils/anomalies c) Fine-grained with many (10+) inclusions/micro-fossils/anomalies d) Heterogeneous with none or few (0-5) inclusions/micro-fossils/anomalies e) Heterogeneous with some (5-10) inclusions/micro-fossils/anomalies f) Heterogeneous with many (10+) inclusions/micro-fossils/anomalies
50. Presence of cortex:	Measure of the presence of cortex on the dorsal surface (multiple choice): a) Proximal left b) Proximal right c) Medial left d) Medial right e) Distal left f) Distal right g) Complete h) Absent
51. Cortex coverage (%):	Percentage of cortex coverage on the dorsal surface: a) Absent b) 1-24% c) 25-49% d) 50-74% e) 75-99% f) Complete

5.8.4. Group Four: Artefact Condition

Group four is composed of attributes focusing on the condition and taphonomic history of the artefact, aiding assessments of technological contemporaneity. Additional comments were made for each site. In total, group four is composed of six attributes:

52. Degree of rolling:	Degree of damage caused by rolling; subjective description: a) Unrolled b) Lightly rolled c) Moderately rolled d) Heavily rolled
53. Degree of patination:	Degree of change to the surface through chemical changes in the soil and atmosphere, or through natural weathering (ionisation); See Hranicky (2013) for more information on patination; subjective description: a) Unpatinated b) Lightly patinated c) Moderately patinated d) Heavily patinated
54. Degree of edge damage:	Subjective description: a) No edge damage b) Lightly damaged c) Moderately damaged d) Heavily damaged

55. Degree of burning:	Subjective description: a) Unburned b) Lightly burned c) Moderately burned d) Heavily burned
56. Break type:	Type of lithic break: a) Complete b) Proximal fragment c) Medial fragment d) Distal fragment e) Siret break i.e. snapping along the *débitage* axis (Inizan et al. 1999)

5.8.5. Group Five: Technological Attributes (Percussion/Technological Morphology)

Variables within group five comprise the first collection of technological attributes. This group are focused on the percussion and blade form. In total, group five is comprised of eight attributes:

57. Percussion strategy: (Scott 2007)	The method for which the artefact was knapped: a) Hard: characterised by a pronounced bulb of percussion, a thick butt and clearly defined ripples down the technological axis; b) Soft: characterised by a diffused bulb and a thin, typically lipped, and wide butt; c) Mixed: characterised by the presence of features examined in hard and soft-hammer dorsal and ventral profiles; d) Indeterminate: where mode of percussion cannot be determined due to atypical characteristics or broken e.g. medial fragment.
58. Bulbar scar features:	Characteristics of the bulbar scar: a) Well-defined b) Diffused c) Absent d) Removed (through retouch)
59. Number of dorsal scars:	The number of dorsal scars larger than 10mm; excludes core scars a) 1-2 b) 3-4 c) 5-6 d) 7+
60. Number of elongated scars:	The number of dorsal scars larger than 10mm and feature an elongation index of 1.75 or greater: a) 1-2 b) 3-4 c) 5-6 d) 7+
61. Number of longitudinal arrises/ridges:	The number of ridges or arrises down the blank longitudinal axis: a) 1 b) 2 c) 3 d) 4 e) 5+
62. Arrise/ridge shape:	The spatial distribution of the arrises/ridges on the dorsal surface of the blade: a) Singular b) Parallel c) Irregular d) Regular converging e) Regular diverging f) Y-shape

	g) Inverted Y-shape h) Offset (left/right) i) Partial j) Central converging k) Absent i.e. cortical
63. Distal end-type:	The nature of detachment from the core: a) Feathered b) Stepped c) Hinged d) Overshot e) Present but Undeterminable (e.g. crushing) f) Missing e.g. proximal fragment
64. Butt type: (modified from Inizan et al. 1999 and Scott 2007)	Technological attribute regarding the butt of the blade: a) Plain/flat b) Dihedral c) Cortical d) Natural (but non-cortical) e) Marginal (from core edge, forming a narrow indeterminate butt) f) Mixed (combination of flaked and natural characteristics) g) Facetted h) Missing e.g. medial or distal fragment i) Trimmed (tiny preparatory flake scars adjacent to the dorsal surface) j) *'Chapeau de Gendarme'* (specific type of faceting; distinctive profile) k) Damaged/Undeterminable

5.8.6. Group Six: Technological Attributes (Core Data)

Group six pertains to attributes concerning technological data recorded from cores. In total, there are twelve attributes:

65. Number of platforms:	Number of platforms observed on the core (n=)
66. Number of core platform removals:	The number of removals greater than 10mm on the core platform(s)
67. Plane of platform(s):	Multiple if applicable: a) Convex b) Flat c) Concave d) Mixed
68. Distal end-types present:	The distal end-types recorded on the core; multiple if applicable: a) Feathered b) Stepped c) Hinged d) Reverse hinged e) Overshot
69. Confidence in core identification (modified from Scott 2007)	Measure of confidence in core assignment: a) Definite (c. 80-100%) b) Probable (c. 50-80%) c) Possible (c. < 50%)
70. Core strategy type:	See chapter two for definitions: a) Levallois recurrent (elongated unidirectional/bidirectional) b) Laminar
71. Laminar core shape:	General morphology of the Laminar blade core: a) Orthogonal (prismatic) b) Semi-orthogonal (semi-prismatic) c) Pyramidal
72. Laminar core strategy:	Exploitation strategy of the Laminar blade core: a) Facial

	b) Frontal c) Semi-rotational (*semi-tournant*) d) Full-rotation (*tournant*) e) Multiple (multiple techniques)
73. Laminar core volume utilised:	Percentage of core volume (edge circumference) utilised: a) 1-24% b) 25-49% c) 50-74% d) 75-100%
74. Laminar platform strategy:	Flake scar pattern for Laminar core platforms (multiple if opposed platform): a) Single unidirectional b) Multiple unidirectional c) Bidirectional d) 3-way centripetal e) Centripetal f) Lateral (left/right) g) Perpendicular (left/right)
75. Levallois core strategy:	Exploitation strategy of the Levallois recurrent core: a) Recurrent unidirectional (elongated) b) Recurrent bidirectional (elongated)
76. Levallois preparation strategy: (Scott 2007)	Flake scar pattern for the preparation of the Levallois recurrent blade core a) Unidirectional b) Bidirectional c) Convergent unidirectional d) Centripetal e) Unidirectional left f) Unidirectional right g) Bidirectional lateral h) Unidirectional distal

5.8.7. Group Seven: Technological Attributes (Blade Data)

Attributes in group seven concern technological attributes of the products detached. In total, there are seven attributes:

77. Confidence in blank type: (modified from Scott 2007)	Measure of confidence in product assignment: a) Definite (c. 80-100%) b) Probable (c. 50-80%) c) Possible (c. < 50%)
78. Blank type:	Artefact produced; only whole blades will be subject to extensive morphometric analyses: a) Laminar blade (unretouched) b) Laminar blade (retouched) c) Laminar blade fragment (unretouched) d) Laminar blade fragment (retouched) e) Laminar crested blade (unretouched) f) Laminar crested blade (retouched) g) Laminar crested blade fragment (unretouched) h) Laminar crested blade fragment (retouched) i) Laminar core tablet/rejuvenation flake j) Levallois blade (unretouched) k) Levallois blade (retouched) l) Levallois blade fragment (unretouched) m) Levallois blade fragment (retouched)

	n) Levallois *éclat débordant* (unretouched) o) Levallois *éclat débordant* (retouched) p) Levallois *éclat débordant* fragment (unretouched) q) Levallois *éclat débordant* fragment (retouched)
79. Crested blade scar percentage:	The percentage of crested blade exhibiting working: a) < 50% (*lame à crête partielle*) b) 50% > (*lame à crête*)
80. Crested blade scar regularity:	a) Regular b) Irregular
81. Number of faces knapped on the crested blade:	a) One (*lame à demi-crête/ lame à crête à un versant)* b) Two (*lame à crête/ lame à crête à deux versant*)
82. Average crested blade scar width:	Measure of average scar width: a) 25+ mm b) 25-20 mm c) 20-15 mm d) 15-10 mm e) < 10 mm
83. Flake scar pattern: (modified from Shimelmitz and Kuhn 2013)	Technological description of the flake scar pattern (Figure 5.6): a) Unidirectional b) Centripetal c) 3-way centripetal d) Bidirectional e) Lateral left f) Lateral right g) Convergent h) Convergent bidirectional i) Convergent and perpendicular j) Double perpendicular k) Straight and perpendicular l) Cortical m) Undeterminable

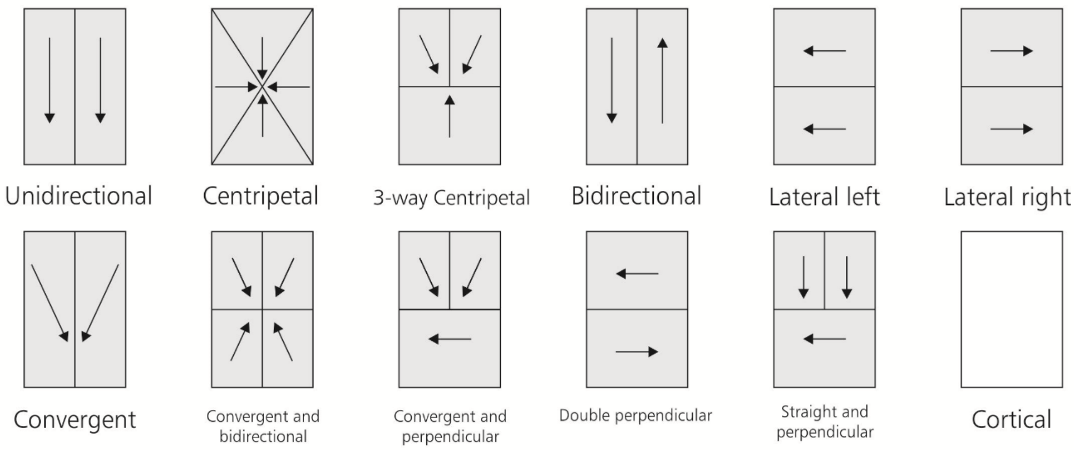


Figure 5.6. Schematic representation for recording dorsal scar pattern (modified from Shimelmitz and Kuhn 2013)

5.8.8. Group Eight: Technological Attributes (Retouch)

The final group of attributes pertain to transformation of the blank following detachment from the core. In total, there are eight attributes:

84. Presence of retouch:	a) Yes b) No
85. Location of retouch:	Location of retouch; multiple may be applicable: a) Proximal left b) Proximal right c) Medial left d) Medial right e) Distal left f) Distal right g) Complete or continuous
86. Position of retouch: (modified from Inizan et al. 1999 and Scott 2007)	Position on the blank: a) Direct (retouch from the ventral surface) b) Inverse (retouch from the dorsal surface) c) Alternate (e.g. right edge of each face) d) Bifacial (worked on both faces of the same edge) e) Crossed (worked on both faces creating a steep backing-type ridge)
87. Retouch coverage (%):	Percentage of the edge circumference which features retouch: a) No retouch b) 1-24% c) 25-49% d) 50-74% e) 75-99% f) Complete retouch
88. Presence of burination:	a) Yes b) No
89. Distribution of retouch (modified from Inizan et al. 1999 and Scott 2007)	a) Continuous b) Discontinuous c) Partial
90. Form of retouched edge (modified from Inizan et al. 1999 and Scott 2007)	a) Rectilinear b) Concave c) Convex d) Single removal i.e. notch or burin e) Denticulate (multiple notches in a continuous sequence) f) Multiple
91. Morphology of retouch (modified from Inizan et al. 1999 and Scott 2007)	a) Scaled b) Stepped c) Sub-parallel d) Parallel e) Notch/denticulate f) Burin

5.9. Methodological Considerations: Measurement Error and Assessments of Normality

Measurement error i.e. the percentage value representing the total variance accredited to within-individual variance resulting from the imprecision of measurements can occur from a number of sources, including error: 1) due to the measurement device (e.g. issues of sensitivity and precision), 2) due to the quality of measured material (i.e. preservation), 3) due to definition of the measure in question, 4) due to the measurer, 5) due to the environment (e.g. lighting), 6) due to measurement protocol (camera focus and position) and, 7) due to the number of observers (inter-observer error). Throughout, a methodology was adopted where all measurements were of a standardised measure with these errors actively minimised where possible. In all parts of this thesis, measurements were recorded by one person, the author.

Measurement error, for the recording of lineal measurements (lengths, widths), and the creation of two-dimensional closed outlines were calculated using repeated measures and a Model II ANOVA (Bailey and Byrnes, 1990; Yezerinac et al., 1992). Measurement Error is calculated as:

$$\text{Measurement Error (\%)} = \frac{s^2_{within}}{s^2_{within} + s^2_{among}} \times 100$$

s^2_{within} : within-individual component of variance
s^2_{among} : among-individual component of variance

In calculating measurement error a sample of fifty experimental blades were used with six different measurements taken on each of the blades. This was repeated four times over an extended period (1 week); each time, the sequence was randomised to reduce the predictability of measurements. Intra-observer measurement error for the recording of lineal measurements was recorded at 0.16%. This low percentage is expected given the superimposition of an equidistant grid over the *débitage* photograph throughout the measurement process. Intra-observer measurement error for digitisation of the outlines, following the same protocol and experiment was recorded at 3.24%.

Normality distributions of measurements, principal component scores, discriminant function/canonical variate scores, and other distributions were assessed through an examination of skewness and kurtosis, and statistically examined through a variety of tests for normality. This includes Anderson-Darling and Shapiro-Wilk tests for univariate data, and Mardia's skewness test and kurtosis test (Mardia, 1980) and the Doornik-Hansen test (Doornik and Hansen, 2008) for multivariate normality.

Chapter Six
Understanding Technological Blade Production through an Experimental Approach

6.1. Introduction

To assess the extent to which aspects of artefact design and desirability account for the relationship between Laminar and Levallois technological blade strategies throughout the Middle Palaeolithic, a thorough assessment of artefact design is essential. This chapter details analyses of the experimental dataset through the three categories of artefact design strategy: 1) properties regarding the shape and nature of the cutting edge (performance), 2) raw material economisation (efficiency), and 3) aspect of product regularity (standardisation). Throughout, variables of size (allometry) and raw material are also investigated to assess their importance in artefact design. These will be cross-compared with archaeological examples in Chapter 10.

6.2. Artefact Design Strategy #1: Properties Regarding the Shape and Nature of the Cutting Edge

This section focuses on aspects of usable cutting edge, including its sharpness, and the general shape of the blanks produced. It details the degree of difference in cutting edge and shape between the two strategies, and how factors of raw material and size affect the shape and nature of the cutting edge. Aspects of *éclats débordants* are also considered.

6.2.1. Two-dimensional Planform Shape: A Geometric-Morphometric (GM) Approach

Geometric morphometrics is utilised here to: a) examine differences in end-product shape between both technological blade strategies, irrespective of raw material, b) examine differences in end-product shape, with respect to the raw material, and c) to examine the role raw material plays on the individual technological blade strategies. These are discussed in detail below.

PC #	Eigenvalue	Variance (%)	Cumulative Variance (%)
1	0.008291	49.794	49.794
2	0.002717	16.317	66.111
3	0.002453	14.729	80.840
4	0.000669	4.016	84.856
5	0.000531	3.190	88.047
6	0.000277	1.664	89.711
7	0.000272	1.633	91.344
8	0.000248	1.489	92.833
9	0.000165	0.990	93.824
10	0.000157	0.945	94.769
11	0.000128	0.768	95.536
12-80	0.000743	4.460	100.000

Table 6.1. Percentage shape variance attributed to the first eighty principal components (shaded: variance analysed)

Elliptical Fourier Analysis (EFA) of the first twenty-one harmonics (amplitudes) reveal that both technological strategies irrespective of raw material can be statistically discriminated and distinguished. Analyses of 474 experimental blades (370 Laminar blades and 110 Levallois blades) highlight that the first two main sources of shape variance (i.e. the first two principal components) account for 66% (66.111%) of cumulative shape variance, with the first eleven cumulative principal components accounting for at least 95% (95.536%) percent of all shape variance, and the first fifty-three cumulative principal components accounting for 99.9% (99.918%) of all shape variance (see Table 6.1). The first main source of shape variation (PC1) accounting for 49.794% of variance extends from wider, more convex edges, to narrower blades that are slightly wider on the proximal surface (Figure 6.1). The second main source of shape variation (PC2), accounting for 16.317% of variance, extends from proximal-heavy (wide-proximal) to distal-heavy (wide-distal) specimens. The third axis (PC3), of similar value to PC2 (14.729%) and not noted on Figure 6.1, is attributed to planform curvature along the lateral/longitudinal edges, from convex left/concave right lateral edges to convex right/concave left lateral edges. Visual analyses of principal component axes one and two reveal that there is difference in the 95% ellipses, and differing group centroid sizes, and as such are of differing variance. Laminar blades tend to negative PC1 values, suggestive of narrower more elongated planform shapes and Levallois blades tending towards positive PC1 values, suggestive of wider and rounder more convex planform shapes. Similar ranges in PC2, and a convergence to the mean shape (i.e. 0,0) highlight that both blade strategies feature some degree of constant width (explored below).

Bivariate Orthogonal Least Squares (OLS) Regression of the first principal component against a log-transformation of Elongation Index (Figure 6.2) further suggests that elongation is one of the main sources of variation (*r*: -08859, r^2: 0.78482, *permutated p:* 0.0001).

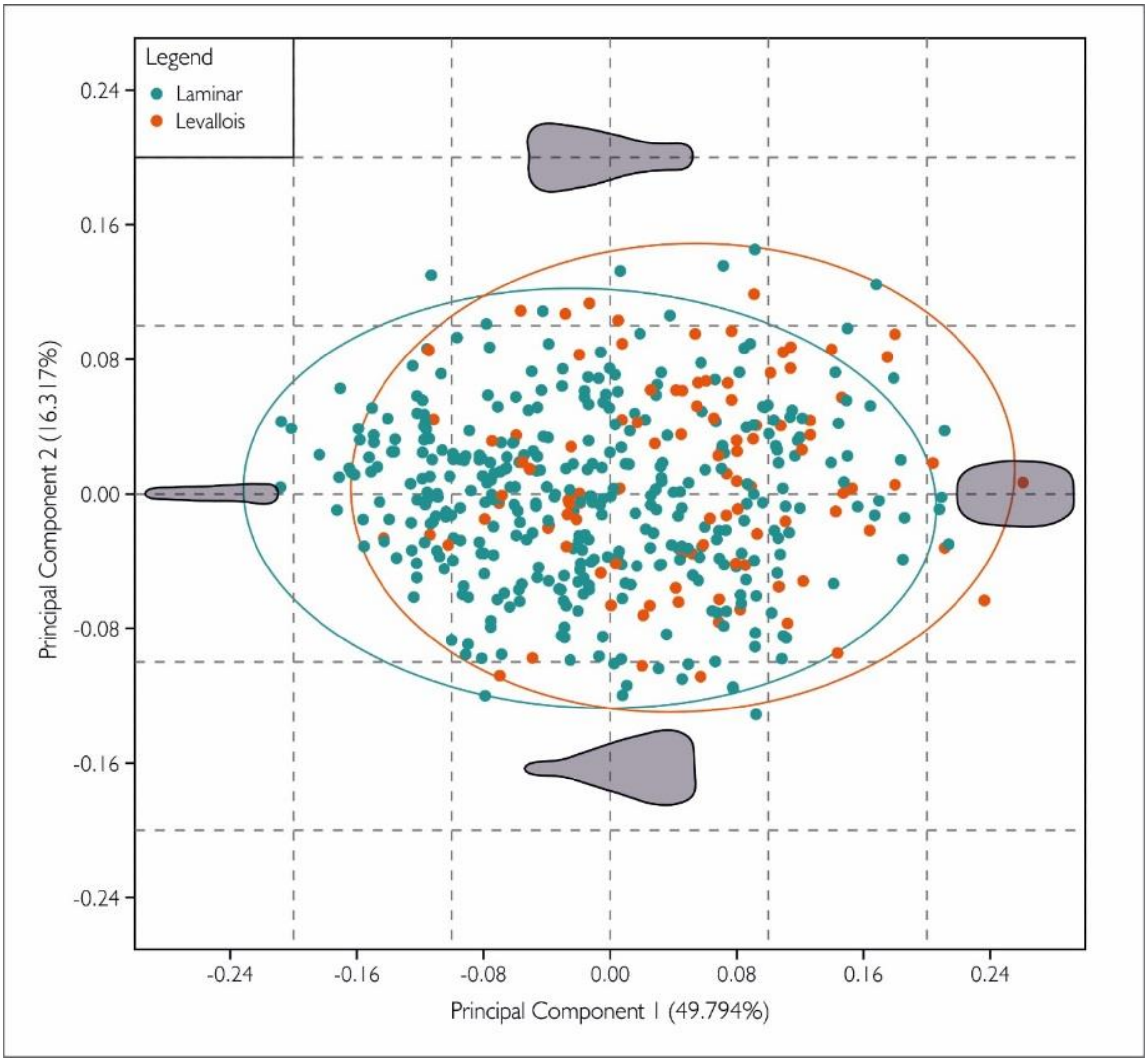


Figure 6.1. Principal Component Analysis (PCA) of the first two axes (66.111% cumulative shape variance)

While the PCA demonstrates that there is some distinction between the groups, it is only an ordination method, and not a statistical measure of discrimination or significance. Furthermore, this method does not take groups into consideration. The first fifty-three principal components (which comprise of 99.9% of shape variance) were therefore subject to MANOVA and a Lineal Discriminant Analysis with the axis further tested for statistical significance. A MANOVA in this instance examines the statistical significance between the groups, while Lineal Discriminant Analysis (termed Canonical Variate Analysis for more than two groups of data) describes differences between known and classified groups, and the direction with which these groups are most different. LDA then computes the axes that optimise between-group difference relative to within-group variation. Two classification scores are then obtained, an initial percentage outlining how successful the two (or more) groups can be discriminated, and a jackknifed value (using leave-one-out cross-validation) to answer whether discriminant functions can serve as reliable identifiers of unknown specimens. MANOVA of the first fifty-three principal components highlight that the two technological strategies can be statistically separated through differences in shape variance (*Wilks' lambda:* 0.7663, *F*: 2.416, *p*: < 0.0001; *Pillai trace*: 0.2337, *F*: 2.416, *p*: < 0.0001). LDA (Figure 6.3) and confusion matrices (see Appendix) highlight that the two groups can be discriminated with 75.32% success, with a jackknifed value (using leave-one-out cross-validation) of 68.78%. As the dataset is more unstable when jackknifed, we can conclude that while the groups can be discriminated successfully it is more difficult to assign random shapes to a group. A test for significance between Canonical Variate axis scores further exemplifies this discrimination between the two technological strategies (*t*: -11.997, *permutated p*: 0.0001).

Analyses also highlight that when individual raw materials are investigated, Laminar and Levallois technological blade strategies can be discriminated, to varying levels of success, possible resulting from varying sample sizes. In all four examples the main source of shape variance among differing raw materials relates to the elongation index and lateral edge convexity (Figure 6.4).

With respect to Beer Head flint (n=138), the first two cumulative principal components account for 69% (69.730%) of cumulative shape variance, with the first nine cumulative principal components accounting for 95% (95.657%) of total shape variance and the first forty-five cumulative principal components accounting the 99.9% (99.914%) of total shape variance. The first axis accounts for 54.639% of cumulative shape variance, and, extends from wider, squatter planform end-product shapes to narrower elongated end-product shapes. The second axis, accounting for 15.091% of cumulative shape variance features changes seen in PC2 and PC3 of the overall shape analysis, with the second axis reflecting changes in convexity and in irregular thickness of the planform shape. The large number of positive PC1 scores for Laminar technological blades suggests that these are more akin to being narrower and elongated, as previously seen. Differences in 95% confidence ellipses can be seen, with a larger group centroid size for Levallois technology indicative of greater variation among the first two axes.

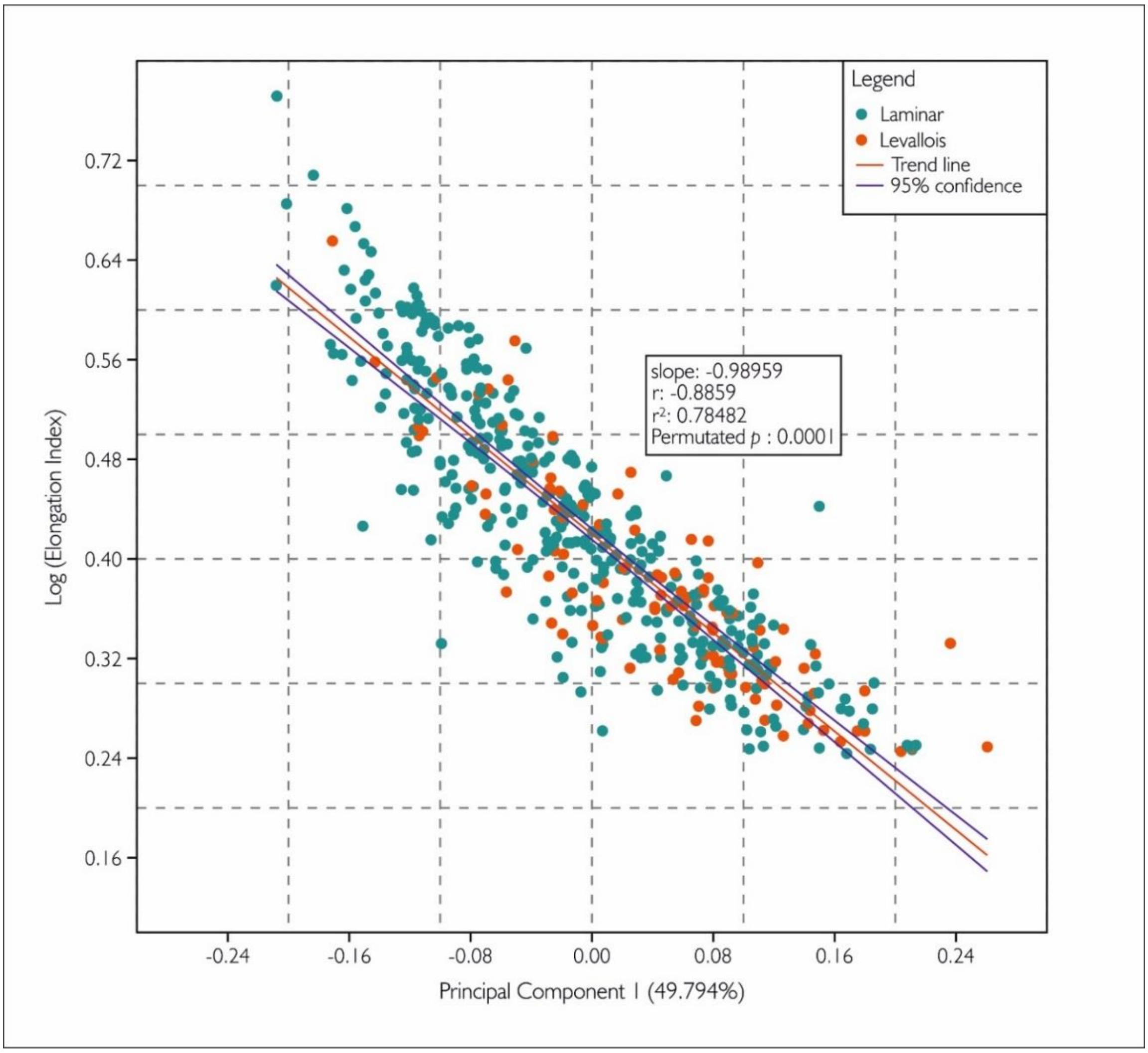


Figure 6.2. Bivariate Orthogonal Least Squares (OLS) regression of PC1 (47.794% shape variance) against log(Elongation Index)

In the analysis of Caistor St. Edmunds flint (n=71), the first two cumulative principal components of shape variance account for 61% (61.740%) of cumulative shape variance, with the first ten cumulative principal components accounting for 95% (95.710%) of total shape variance, and the first thirty-nine cumulative principal components for 99.9% (99.901%) of total shape variance. The first axis, accounting for 41.189% of cumulative shape variance, as noted above, mirrors previous PC1 scores, with the second axis, accounting for 20.551% of cumulative shape variance mirroring previous PC2 scores. A consideration of the 95% confidence ellipses highlight greater variation among Laminar blades in comparison to

Levallois blades, however clustering in negative PC1 values highlight the degree of difference between the two technological strategies.

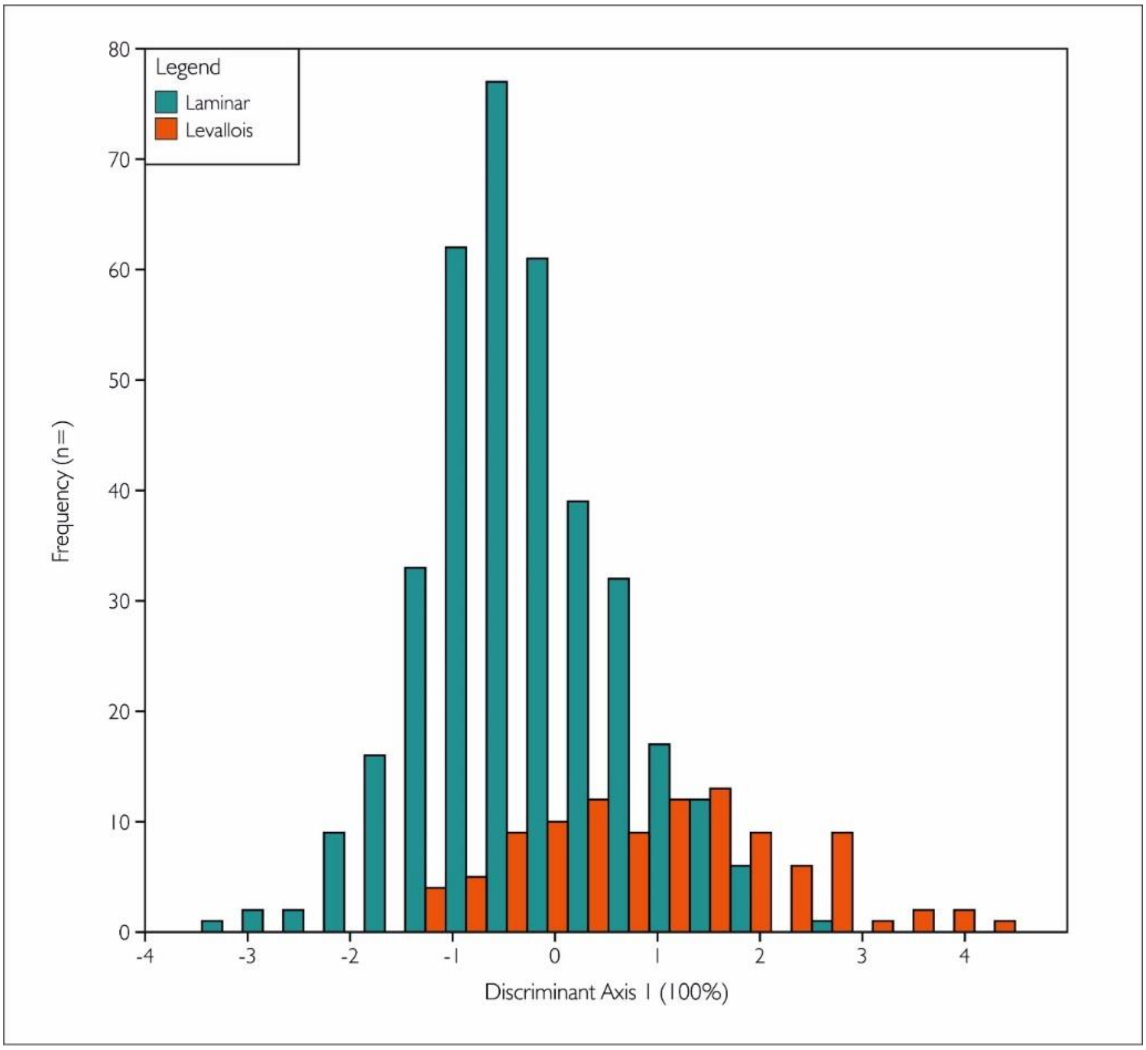


Figure 6.3. Lineal Discriminant Analysis (LDA) for Levallois and Laminar two-dimensional Fourier outlines (experimental dataset)

Ingham Flint (n=117) features a more even balance of both technological blade strategies with 75 Laminar and 42 Levallois examples of complete unretouched end-products. In their analysis, the first two cumulative principal components account for 64% (64.177%) of total shape variance, with the first eleven cumulative principal components accounting for 95% (95.517%) of total shape variance, and the first forty-six cumulative principal components accounting for 99.9% (99.924%) of total shape variance. The first two main sources of shape variance are direct parallels with the first two sources of shape variance within the overall dataset. Again, Laminar technological blade strategies feature a higher number of negative PC1 scores, with Levallois technological blade strategies featuring a higher number of positive

PC1 scores. Both groups feature the same degree of variation in PC2 scores, and similar sizes of 95% confidence ellipses, with the latter suggestive of similar degrees of variability in planform shape for the first two main sources of shape variance. The distribution and difference between the two technological blade strategies is therefore evident, even when sample sizes are similar.

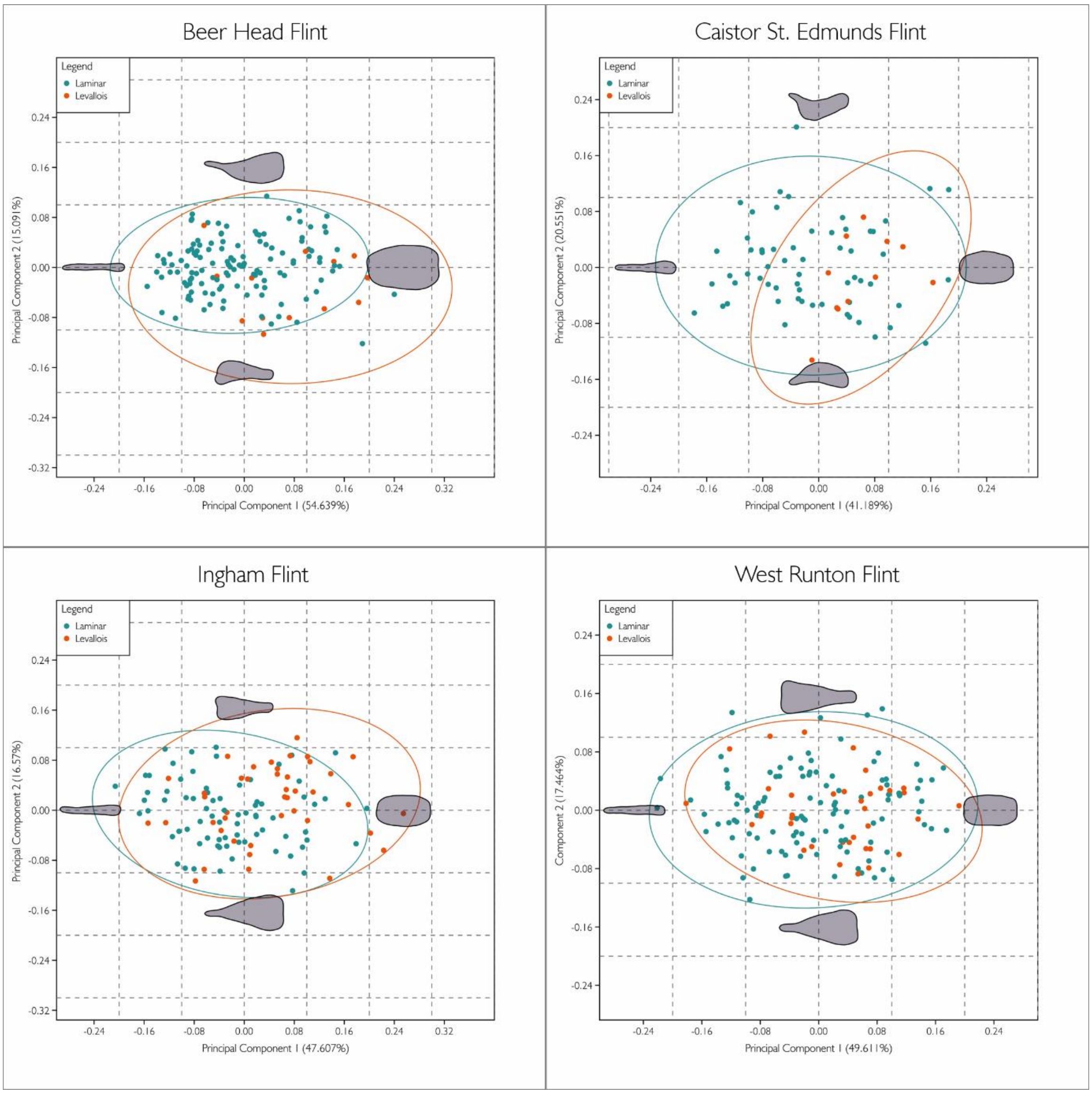


Figure 6.4. Principal Component Analysis (PCA) for the first two principal components of each raw material considered (sample sizes are noted throughout the text)

Finally, with respect to West Runton Flint (n=148), the first two cumulative principal components account for 67% (67.257%) of total shape variance, with the first eleven cumulative principal components account for 95% (95.644%) of total shape variance, and the first forty-nine cumulative principal components accounting for 99.9% (99.931%) of total shape variance. In this, the two first PC axes again echo results from the overall data-set, however a more even distribution of PC1 scores for both Levallois and Laminar technological blade strategies. Despite this, 95% confidence ellipses are spatially distinguishable with clustering evident. These are however visual descriptors and do not take into consideration between-group difference. To assess such, LDA of technological blade strategies for each raw material to account for between-group variance, and provide a framework grounded on statistical analyses of difference (Figure 6.5). 99.9% of cumulative shape variance is used for each MANOVA and LDA.

MANOVA of the first forty-five principal component scores (99.9% shape variance) for Beer Head flint highlights that there is statistical significance between the two technological blade strategies, when their shape variance is considered (*Wilks' lambda*: 0.5091, *F*: 1.971, *p*: 0.0030, *Pillai trace*: 0.4909, *F*: 1.971, *p*: 0.0030). LDA demonstrates that the two groups (Levallois and Laminar) could be correctly discriminated with 93.48% success, dropping to 80.43% once jackknifed. This is considerably higher than the jackknifed correction classification percentage for raw material overall (68.78%), suggestive of a higher degree of shape difference between the two technological blade strategies. A t-test of the Discriminant axis further exemplifies the discrimination between the two technological strategies (*t*: -11.451, *permutated p*: 0.0001).

MANOVA of the first thirty-nine principal component scores (99.9% shape variance) for Caistor St. Edmunds flint, highlights that there is, similarly to Beer Head, statistical significance between the two technological blade strategies with respect to shape variance (*Wilks' lambda*: 0.1693, *F*: 3.9010, *p*: <0.0001, *Pillai trace*: 0.8307, *F*: 3.901, *p*: <0.0001). LDA also demonstrates that end-products from both technological blade strategies can be correctly discriminated, with 98.59% success, dropping to 85.92% once jackknifed. Again, this is higher than the overall analysis, and higher than the previous discrimination on Beer Head Flint. A further t-test of the Discriminant axis further exemplifies the discrimination between the two technological strategies (*t*: -11.451, *permutated p*: 0.0001).

MANOVA of the first forty-six principal component scores (99.9% shape variance) for Ingham flint highlights, similarly to others, that there is statistical significance between the technological blade strategies with respect to their shape variance (*Wilks' Lambda*: 0.428, *F*: 2.034, *p*: 0.0036, *Pillai trace*: 0.572, *F*: 2.034, *p*: 0.0036). LDA demonstrates that end-products from both strategies can be correctly discriminated to a lesser degree than other types of raw material, with a correction classification percentage of 85.47%, and a less stable jackknifed classification score of 58.97% (note: 50% is the minimum as there are two groups). A t-test of the Discriminant axis further exemplifies the discrimination between the two technological strategies (*t*: 12.398, *permutated p*: 0.0001). With a more balanced dataset, in comparison to other techniques, and a much lower jackknifed classification percentage, this may represent a more 'true' value of the success in assigning random shapes to a particular group.

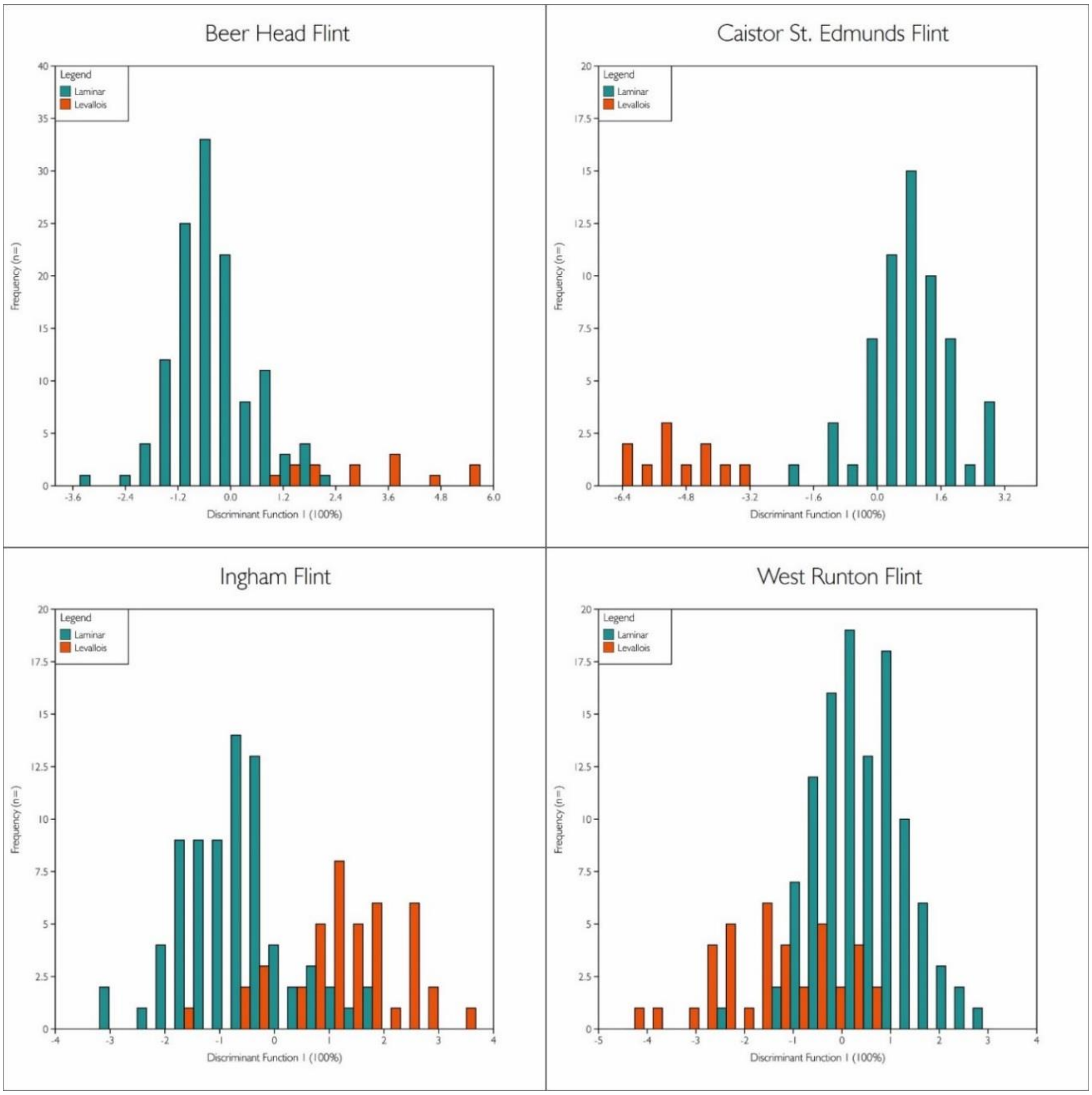


Figure 6.5. Lineal Discriminant Analysis (LDA) of Levallois and Laminar two-dimensional outlines for each raw material

Interestingly, MANOVA of the first forty-nine principal component scores (99.9% shape variance) for West Runton flint highlights that there is trending significance but no statistical significance to a 99% confidence interval (*Wilks' lambda*: 0.5968, *F*: 1.3510, *p*: 0.1043, *Pillai* *trace*: 0.4032, *F*: 1.351, *p*: 0.1043). This was noted in Figure 6.4, with both groups similar in distribution. This is also supported through LDA where a lower correction classification of 82.43% was calculated, and a jackknifed classification of 62.16%. A t-test of the Discriminant Axis highlights that the two technological strategies can be differentiated statistically (*t*: 9.9311, *permutated p*: 0.0001). The MANOVA therefore highlights that the two strategies can be distinguished to some degree by their shape variation, and when between-group difference is optimised to within-group variation through an LDA, the strategies can be separated. It is, however, less clear and subtler than the previous three raw materials. Plots of all four Lineal Discriminant Analyses can be seen in Figure 6.5.

Analyses therefore demonstrate that both technological blade strategies can be differentiated through their two-dimensional planform profile. As both West Runton and Ingham flints feature a more balanced quantity of both technological blade strategies, the percentages obtained from LDA may be more representative of the overall pattern among flint types. As these two groups are from neighbouring areas it is inconclusive whether this pattern would hold true for flint further afield (Beer flint), when Levallois and Laminar quantities are equal.

Finally, analyses were undertaken to examine if both individual technological blade could be distinguished through their raw material, as to answer issues of whether raw material effects the shape of the end-products. This was undertaken in the same process as above.

Geometric morphometric analyses highlight that Laminar blades are not statistically significant and cannot be discriminated through their two-dimensional planform shape. Principal Component Analysis calculates that the first two cumulative axes account for 66% (66.696%) of total shape variance, with the first ten cumulative axes accounting for 95% (95.087%), and the first fifty-two cumulative axes for 99.9% (99.918%) shape variance (Figure 6.6). As before, the first two main axes are parallel to sources of shape variance, documented earlier, extending from wider, convex-edged planform end-products to narrower, straight-edged planform end-products (50.300%), and from distal-heavy to proximal-heavy planform end-products (16.396%). However, visual inspection of the distribution and group centroids highlights there are minor differences (more positive PC1 values for West Runton flint, for example). Irrespective, all four flint types feature similar distributions and 95% confidence ellipses.

Pair-wise MANOVA of the four different raw materials (Table 6.2) further highlight that while there is slight variation, raw materials cannot be discriminated (*Wilks' lambda*: 0.5959, *F*: 1.142, *p*: 0.1287, *Pillai trace*: 0.4734, *F*: 1.142, *p*: 0.1285). Canonical Variates Analysis further supports this. When 99.9% of all shape variation (principal components) was analysed a correction classification percentage of 52.16% (note: four groups, 25% minimum), and a jackknifed classification percentage of 27.03%, highlighting that there is low between-group variance, and that the raw material does not have a considerable influence on Laminar technological end-product shape.

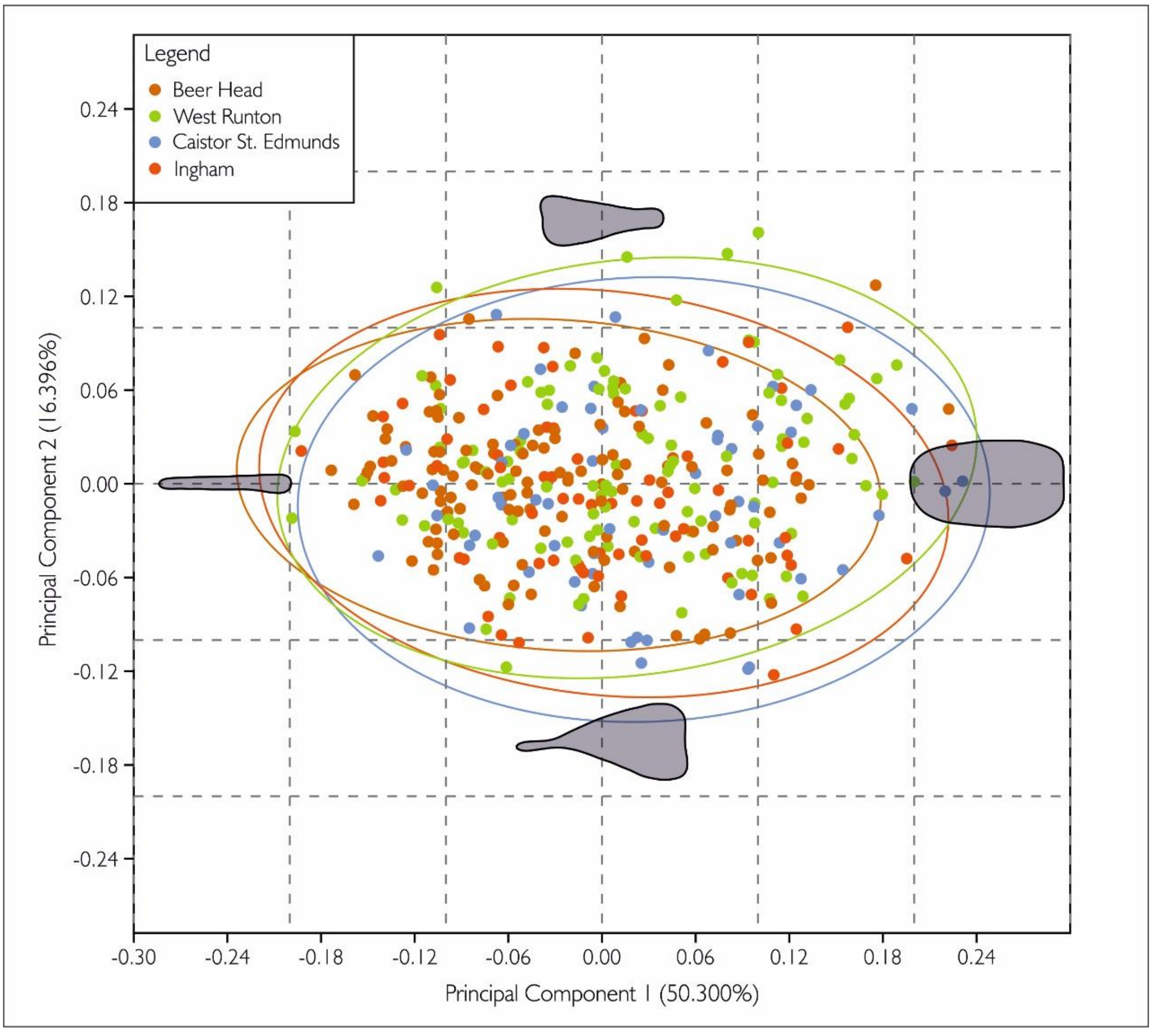


Figure 6.6. Principal Component Analysis (PCA) of the first two principal components (cumulative shape variance: 66.696%) for all Laminar technological blades grouped through their raw material

Similarly, geometric morphometric analyses demonstrate that Levallois technological blade strategies produced on different raw materials cannot be differentiated through their shape variance. Principal Component Analysis of Levallois technological blades highlight that the first two cumulative axes account for 59% (59.830%) of shape variance, with the first twelve cumulative axes accounting for 95% (95.004%) of shape variance, and the first forty-six cumulative axes accounting for 99.9% of all shape variance (Figure 6.7). Again, the first two axes extended from similar morphological changes within previous analyses, with elongation, and unequal width in planform end-product shape influencing the main sources of shape variance. Through visual inspection, no clustering occurs, with similar distributions among all raw materials.

MANOVA of the first forty-six axes (99.9% shape variance) demonstrates that the blades cannot be discriminated through their raw material (*Wilks' lambda*: 0.6532, *F*: 0.9513, *p*: 0.561, *Pillai trace*: 0.3912, *F*: 0.9533, *p*: 0.5577). Pair-wise MANOVA (Table 6.3) further exemplifies that the individual materials cannot be discriminated from other types. A correctional classification percentage of 75.96% is recorded, and when jackknifed a much lower classification percentage of 28.85% is recorded highlighting, that a random shape cannot be randomly assigned to a raw material.

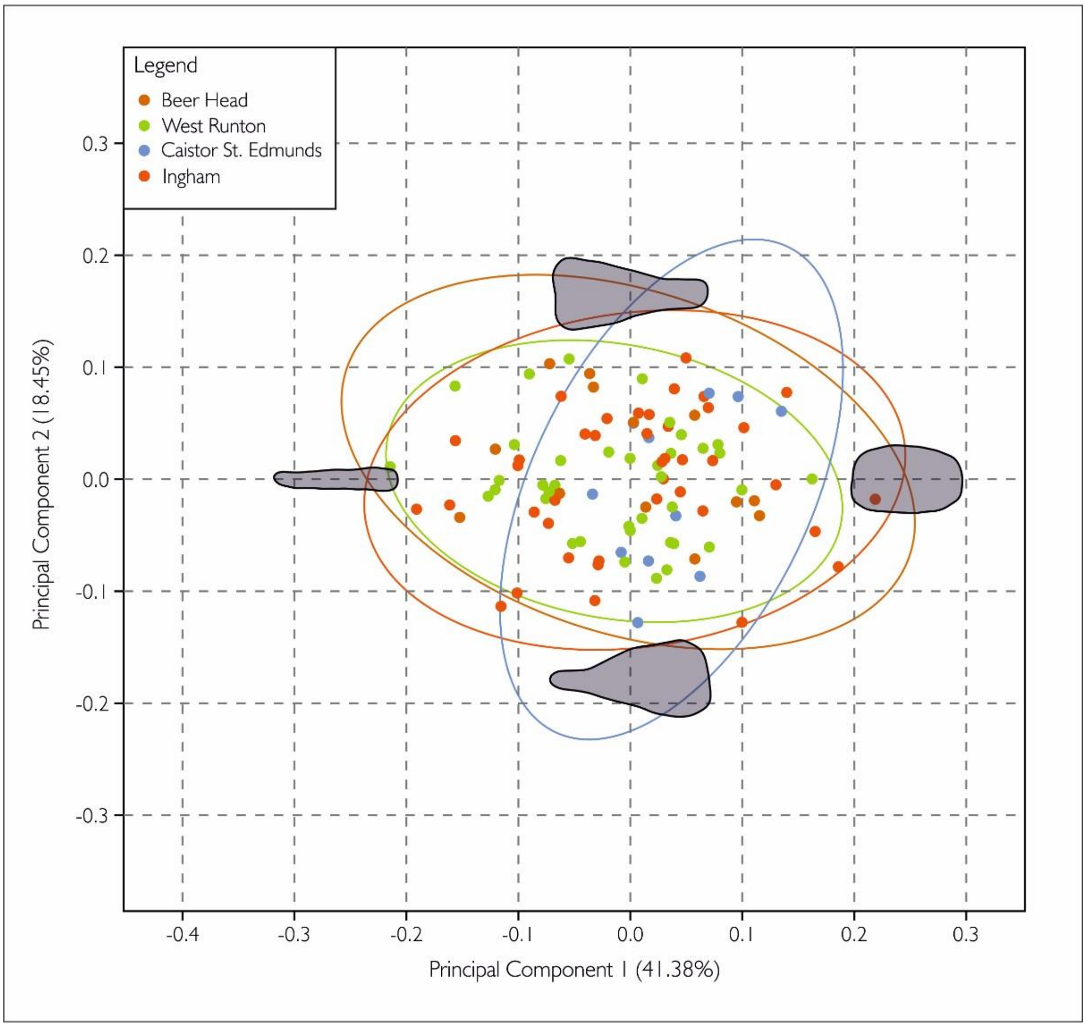


Figure 6.7. Principal Component Analysis (PCA) of the first two principal components (cumulative shape variance: 59.830%) for all Levallois technological blades grouped through their raw material

Raw Material	Beer Flint	Caister St. Edmunds Flint	Ingham Flint	West Runton Flint
Beer Flint		0.6557	0.9444	0.1741
Caister St. Edmunds Flint	0.6557		0.8135	0.3784
Ingham Flint	0.9444	0.8135		0.4418
West Runton Flint	0.1741	0.3784	0.4418	

Table 6.2. Pair-wise MANOVA of 99.9% shape variation for Laminar technological blades produced through their raw material/flint type

Raw Material	Beer Flint	Caister St. Edmunds Flint	Ingham Flint	West Runton Flint
Beer Flint		0.9824	0.7007	0.7659
Caister St. Edmunds Flint	0.9824		0.2870	0.6115
Ingham Flint	0.7007	0.2870		0.6404
West Runton Flint	0.7659	0.6115	0.6404	

Table 6.3. Pair-wise MANOVA of 99.9% shape variation for Levallois technological blades produced through their raw material/flint type

6.2.2. Aspects of Edge Sharpness: Working Edge Angle and Flattening Index

The concept of sharpness has long been discussed by archaeologists interested in understanding aspects of an artefacts morphology (Wilmsen, 1968; Bowler et al., 1970; Nance, 1971; Gould et al., 1971; Specht and Koettig, 1981; Key and Lycett, 2014). As noted in Chapter 5 this is calculated through two methodologies: 1) calculate the mean edge angle of an experimental assemblage, as determined using the Dibble and Bernard (1980) 'Calliper Method' (D: 4mm), and 2) through a flattening index (mean thickness/mean width) of archaeological and experimental examples. As noted below, a correlation was observed when edge angle and flattening index are examined and, as such, provides a non-invasive method of investigating edge sharpness through a calculation of two variables (thickness and width). Below, the working edge angle for Levallois and Laminar technological blade strategies is investigated with variables of raw material and size examined. *Éclats débordants* are investigated against Levallois blades, knowing their use on archaeological contexts (see Chapter 2), and the flattening index for the experimental assemblage is then discussed.

6.2.2.1. Working Edge Angle

Aspects of working edge angle were first examined to check for statistical difference between Laminar and Levallois technological blades, irrespective of raw material. Using the Dibble and Bernard (1980) 'Calliper Method', six measurements were taken for each blade (see Chapter 5) on all 474 examples of complete undamaged technological blade strategies (Lam: 370, Lev: 104). The mean edge angle for Laminar blades was recorded as 42.94° ± 13.09°, with a median of 41.13° (Figure 6.8). For Levallois blades the mean edge angle was recorded as 36.73° ± 9.82°, with a median of 35.48. The difference between means was therefore recorded as 6.21° with the difference between medians recorded as 5.65°. Medians are documented as normal distribution could not be assumed (see Appendix). The boxplot in Figure 6.8 documents the difference between medians but also highlights a variety of other interesting results. It notes the tighter variation as documented by the first and third quartiles, and bar size for Levallois blades. This is further demonstrated through their Coefficients of Variation (CV) values (Laminar CV: 29.16, Levallois CV: 25.89) and the platykurtic nature of the Laminar edge angle distribution (as seen in the boxplot). Statistical analyses, through a testing of equal medians concluded that both technological blade strategies are statistically different with respect to edge angle (*Mann-Whitney U*: 12895, *z*: 5.1407, *permutated p*: 0.0001).

Allometric analyses of mean edge angle demonstrate that there is a relationship between size, here noted as length, and the edge angle (see Appendix for correlative analyses highlighting the use of length as a proxy for size). Bivariate OLS regression of log(length) and edge angle (Figure 6.9) suggests that there is a 'medium' correlation (following guidelines from Cohen 1988) for Laminar (r: 0.4686, r^2: 0.2196, *permutated p*: 0.0001), Levallois (r: 0.3683, r^2: 0.1356, *permutated p*: 0.0004), and irrespective of the technological blade strategy (r: 0.40042, r^2: 0.1603, *permutated p*: 0.0001). The data suggests that the longer the blade the larger the difference in mean edge angle between the two technological blade categories (Table 6.3). For example, if the blades produced are between 25.00-49.99mm in length then the difference between mean edge angles is 5.89° (Lam: 36.57°, Lev: 30.68°), whereas blades which are 125.00-149.99mm in length feature a difference in edge angles of 14.88° (Lam: 55.01°, Lev: 40.13°). Furthermore, in all instances the standard deviation is tighter for all Levallois blades within each of the size categories in Table 6.4. Interestingly, no Levallois blades produced were smaller than 25mm, hindering inter-technology comparisons of working edge for bladelets (a point discussed in detail in the main discussion). Analyses however suggest that the difference between edge angles is minimal when blades are smaller.

A more complex picture of edge angle variation occurs when raw material is investigated (Figure 6.10 and Figure 6.11).

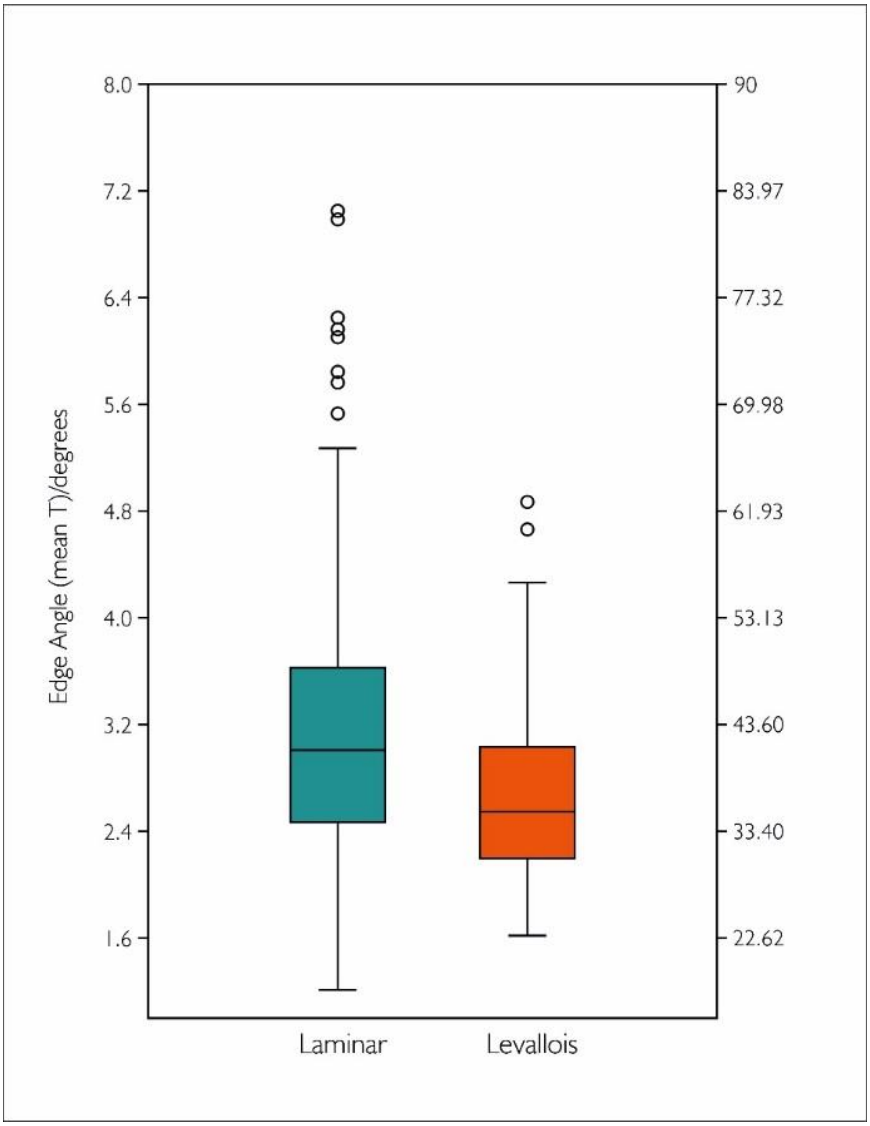


Figure 6.8. A boxplot of mean edge angle for the different technological blade strategies with the thickness at the predetermined point (T) and the working edge (degrees) displayed on the vertical axis

In the three flints sourced from eastern England, Levallois technological blade strategies produce a more acute edge angle, in comparison to Laminar strategies. This is however to varying degrees either side of the original mean difference, with Caistor St. Edmunds flint producing a mean difference in edge angles of 13.8°, and West Runton producing a mean difference in edge angles of 4.84°. In all three instances, significance values indicate both technological blade strategies can be discriminated (Table 6.5).

		Length (mm)							
		0.00-24.99	25.00-49.99	50.00-74.99	75.00-99.99	100.00-124.99	125.00-149.99	150.00-174.99	175.00-199.99
Edge angle (degrees)	Levallois	-	30.68	33.51	34.80	37.24	40.13	-	-
	SD	-	4.82	7.24	6.35	6.47	11.64	-	-
	Laminar	26.05	36.57	41.56	45.29	47.23	55.01	54.81	54.91
	SD	3.90	6.77	9.97	10.47	9.72	13.00	7.57	5.14
	Difference	-	5.89	8.05	10.49	9.99	14.88	-	-

Table 6.4. Mean cutting angle in different size categories (SD: Standard Deviation)

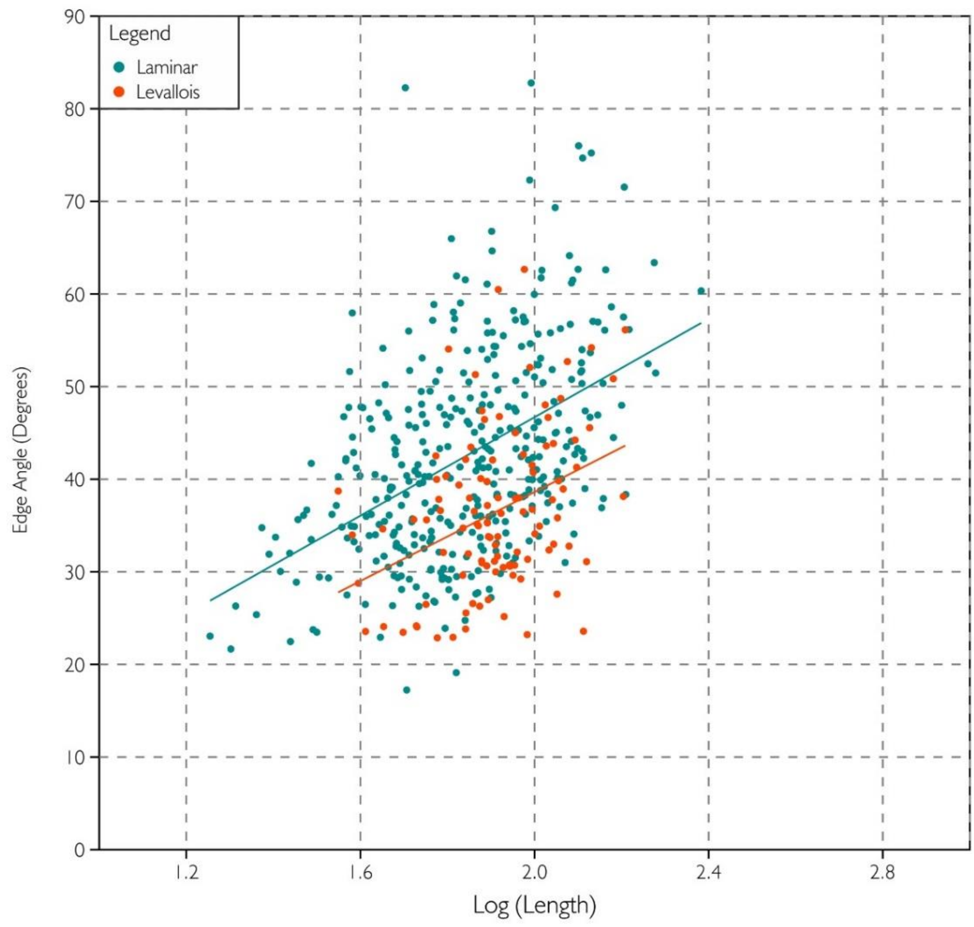


Figure 6.9. Bivariate Orthogonal Least Squares (OLS) regression of edge angle (degrees) and Log(Length)

While similarities can be seen throughout flints sourced in eastern England, Beer Head flint, sourced from south-west England, contradicts the normal pattern above with Laminar technological blade strategies producing more acute edge angles. This can be attributed to the brittleness of the raw material, as noted in Chapter 5. A high amount of breakages occurred during the reduction process, and Levallois blades from Beer Head flint could not be 'peeled' off the convex surface as easily as other materials. With a more invasive reduction, this may help to explain similarities in edge angles between the two technological blade strategies produced on Beer Head flint.

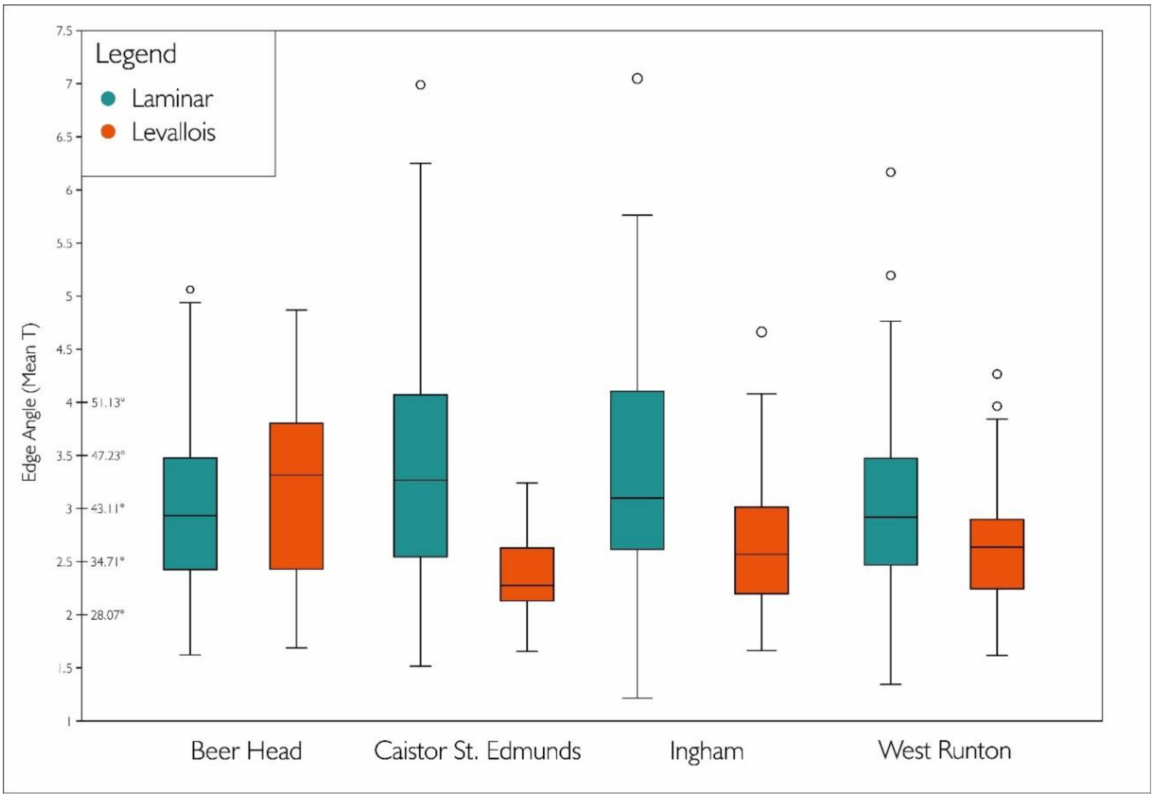


Figure 6.10. A box-plot of mean edge angle categorised by the different raw material sources

Raw Material	Levallois edge angle (°)	Laminar edge angle (°)	Difference between means (°)	Difference between medians (°)	*perm. p*
Caistor St. Edmunds*	32.93 ± 7.30	46.73 ± 16.98	13.80	12.84	0.0003
Ingham*	36.16 ± 7.31	45.24 ± 16.95	9.08	6.91	0.0001
West Runton*	36.53 ± 7.19	41.37 ± 10.91	4.84	3.96	0.0068
Beer Head	42.26 ± 13.62	41.07 ± 10.63	1.19	4.00	0.7510

Table 6.5. The recorded mean edge angles for the different blade strategies and raw materials (shading: lower edge angle; *similar geographical region)

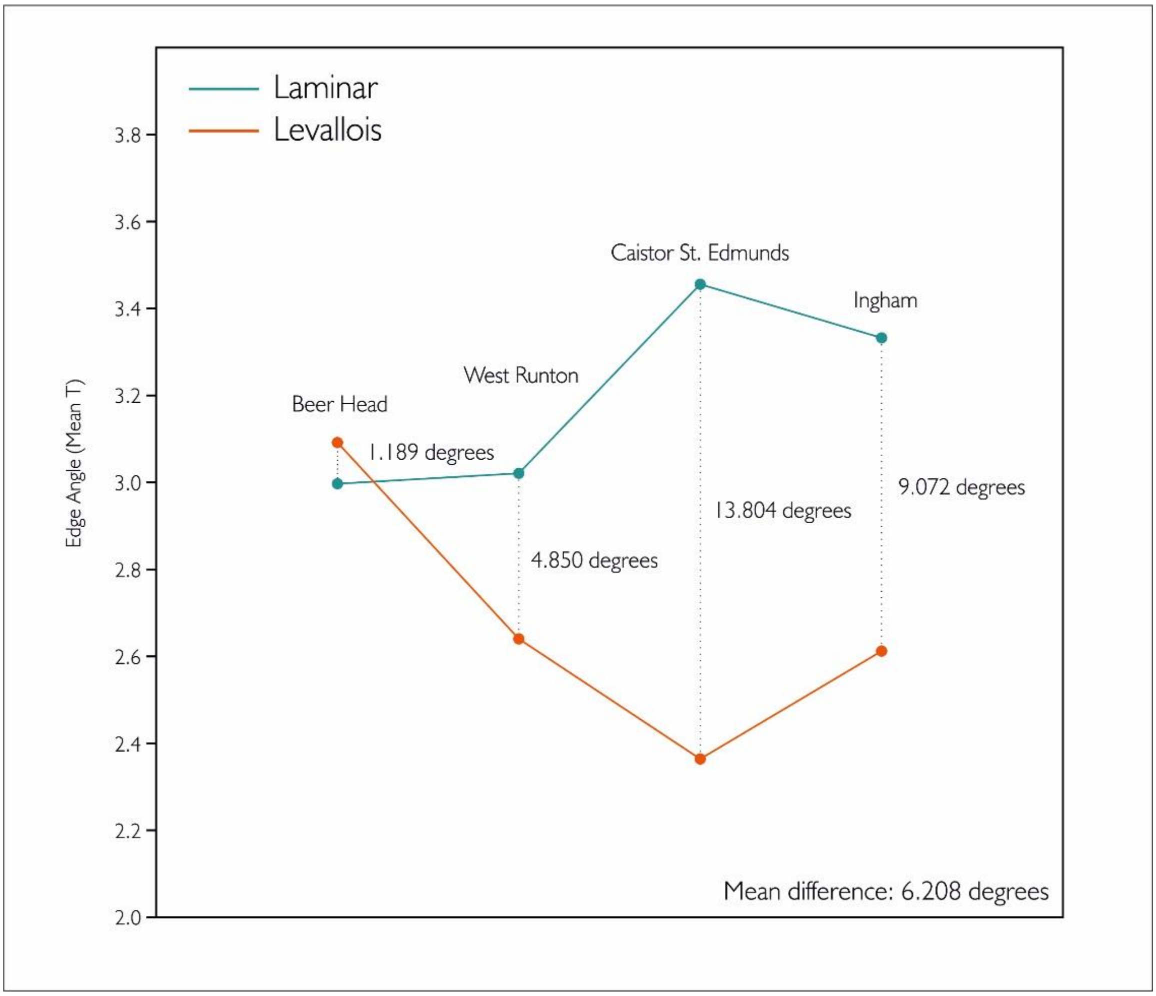


Figure 6.11. A visual comparison of mean edge angles considering both technological blade strategies and the different raw materials used

6.2.2.2. Assessing Levallois 'Wastage': Levallois Blades vs. Levallois Éclats Débordants

With archaeological examples highlighting the use of core-edge flakes produced from both preferential and recurrent Levallois technological blade strategies (see Chapter 2), the non-backed edge of *éclats débordants* (n=25) was tested for statistical difference with Levallois blades (n=104). The mean edge angle for *éclats débordants*, using the 'Calliper Method' was calculated as 35.65° ± 12.47°, similar to that for Levallois blades (36.73° ± 9.82°). Non-parametric testing, through a test of equal medians, further demonstrated the lack of difference, with both types of products not statistically different in edge angle (*Mann-Whitney U*: 1189, *z*: -0.6548. *permutated p*: 0.5129).

6.2.2.3. Flattening Index (Relative Sharpness)

In order to extend the conversation of edge angles onto archaeological material, where edges can become dull to mechanical damage, use and other factors, it was hypothesised that the flattening index could serve as a proxy for edge angle i.e. the flatter the blank the more acute the angle. Flattening index also serves as an indicator of 'retouch potential', with flatter blades corresponding to greater retouch potential (Turq, 1992) and under Kuhn's (1994) model will be of greater utility. The flattening index here is calculated as the mean thickness divided by its mean width, so a smaller index results in a larger width:thickness ratio and as such was hypothesised to be more acute (as blanks of blades conform to specific lateral edge shapes). This was, therefore tested and undertaken before aspects of the flattening index were to be examined on archaeological and experimental examples of both technological blade strategies.

A Bivariate OLS regression was undertaken to test for correlation between edge angle and flattening sharpness. Analysis of between-group variance (Figure 6.12) highlights that a 'large correlation' (Cohen, 1988) is observed between edge angle and relative sharpness (*r*: 0.514, r^2: 0.264, *permutated p:* 0.0001). Flattening index was, therefore, used as a proxy for cutting edge angle throughout archaeological and experimental studies.

When examined, flattening index reveals a similar relationship to edge angle when comparing technological blade strategies, and with respect to raw materials and within-group variance.

When both technological strategies are compared (Figure 6.13), the distribution, number of outliers, and difference in medians is almost identical to that of edge angle. For Laminar technological blades a flattening index of 0.359 ± 0.120 (median: 0.343) was recorded, with Levallois technological blades recording a flattening index of 0.292 ± 0.109 (median: 0.256). This represents a 19% decrease in flattening index, almost mirroring the 14% decrease in edge angle when both technological strategies are compared. Again, similarly to edge angle, both strategies were statically different (*Mann-Whitney U*: 11612, *z*: 6.1800, *permutated p*: 0.0001).

When the strategies are differentiated by their raw material, blades produced from a Levallois recurrent technique typically feature a lower flattening index in comparison to Laminar techniques (Figure 6.14, Table 6.6). Interesting, Levallois blades produced from Beer Flint are flatter than their Laminar component, despite featuring a larger edge angle. In this instance, the difference between groups are not statistically different to a 99% confidence interval, but do trend significance (*Mann-Whitney U*: 500, *z*:-2.2740 *permutated* p: 0.022). Conversely, Laminar blades produced from West Runton flint are not statistically different from Levallois blades (*Mann-Whitney U*: 1991, *z*: -0.43236, *permutated p*: 0.6653) despite featuring significantly different edge angles.

So, while flattening index can be a proxy for edge angle as the pattern overall reflects a similar pattern to that seen in edge angle studies, a degree of caution is needed. This may result from differences in cross-section geometry and the edge angle. The general pattern however demonstrates that Levallois blades are flatter, with more acute edges. This is discussed in more detail towards the end of the chapter.

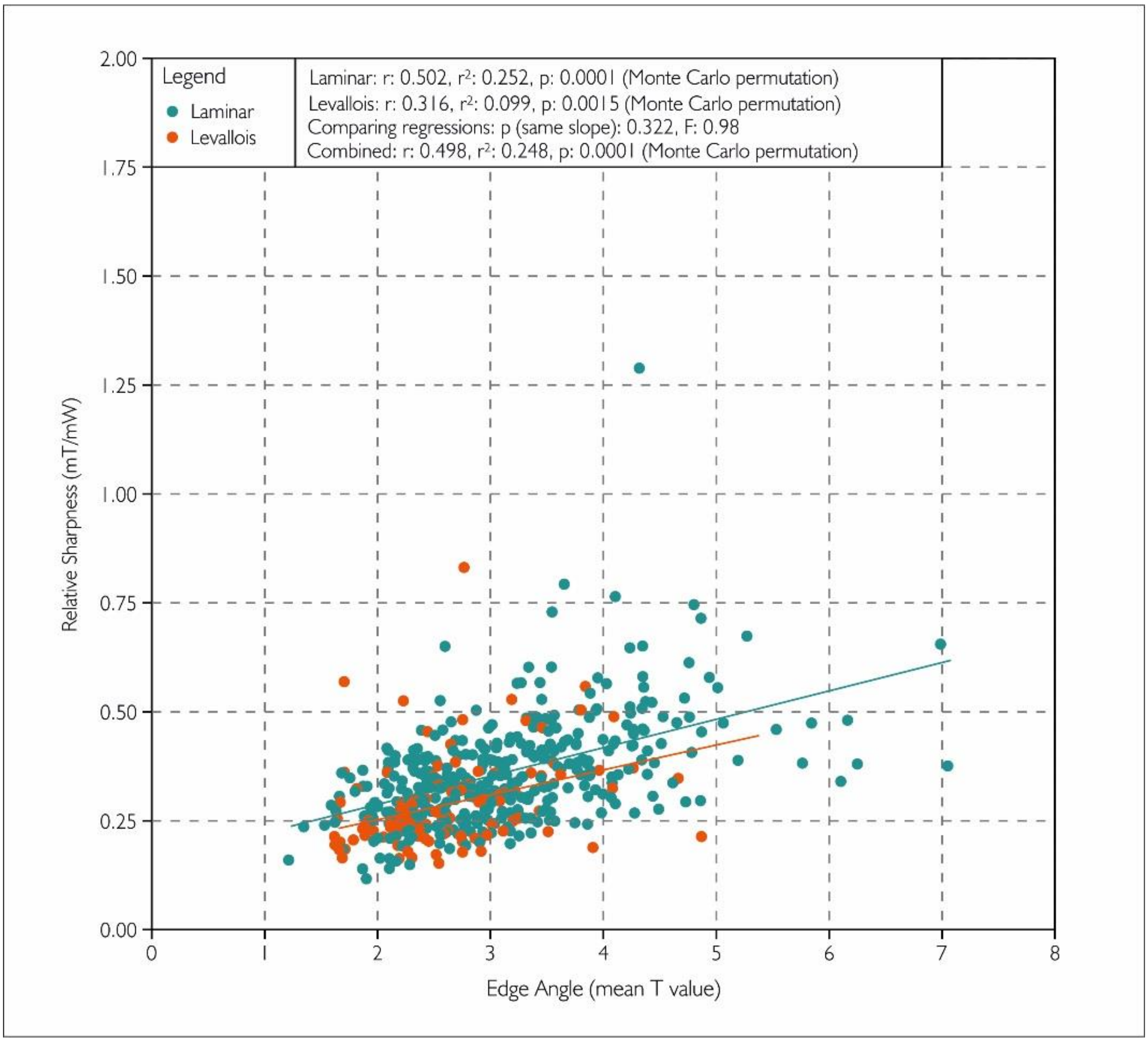


Figure 6.12. Bivariate OLS regression for edge angle (mean T value) and flattening index/relative sharpness (mean thickness divided by mean width)

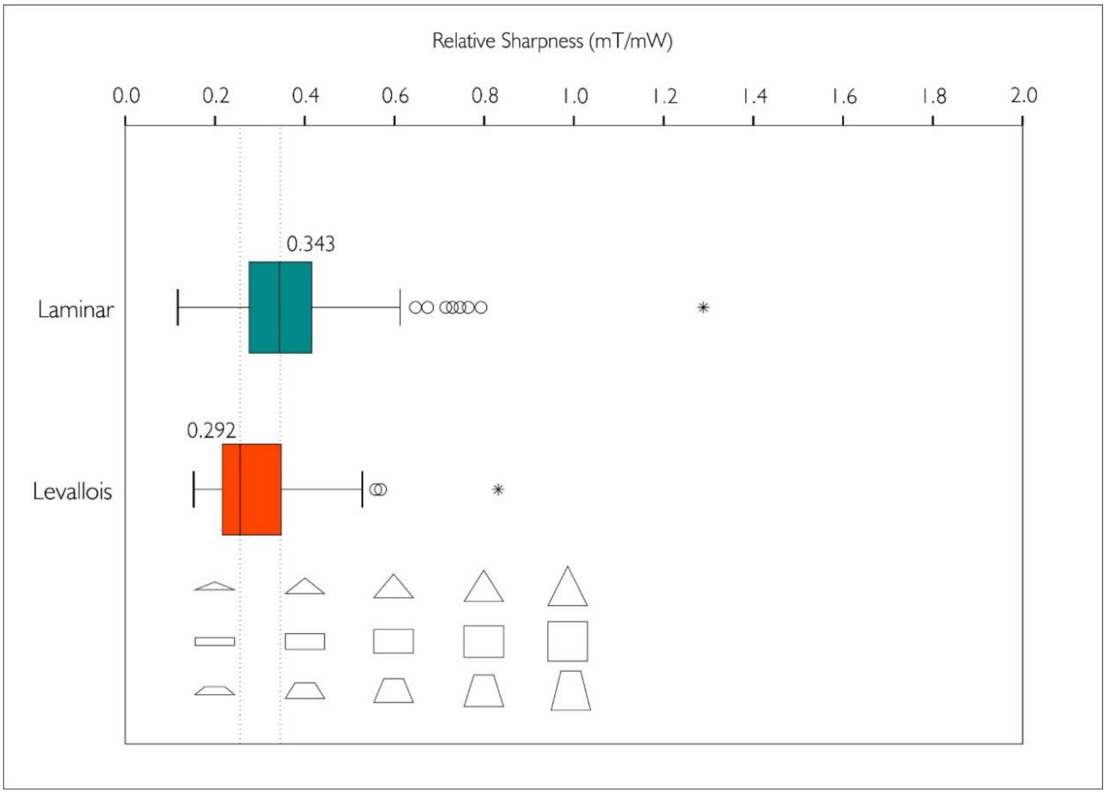


Figure 6.13. A boxplot of flattening index/relative sharpness for both Levallois and Laminar technological blade strategies

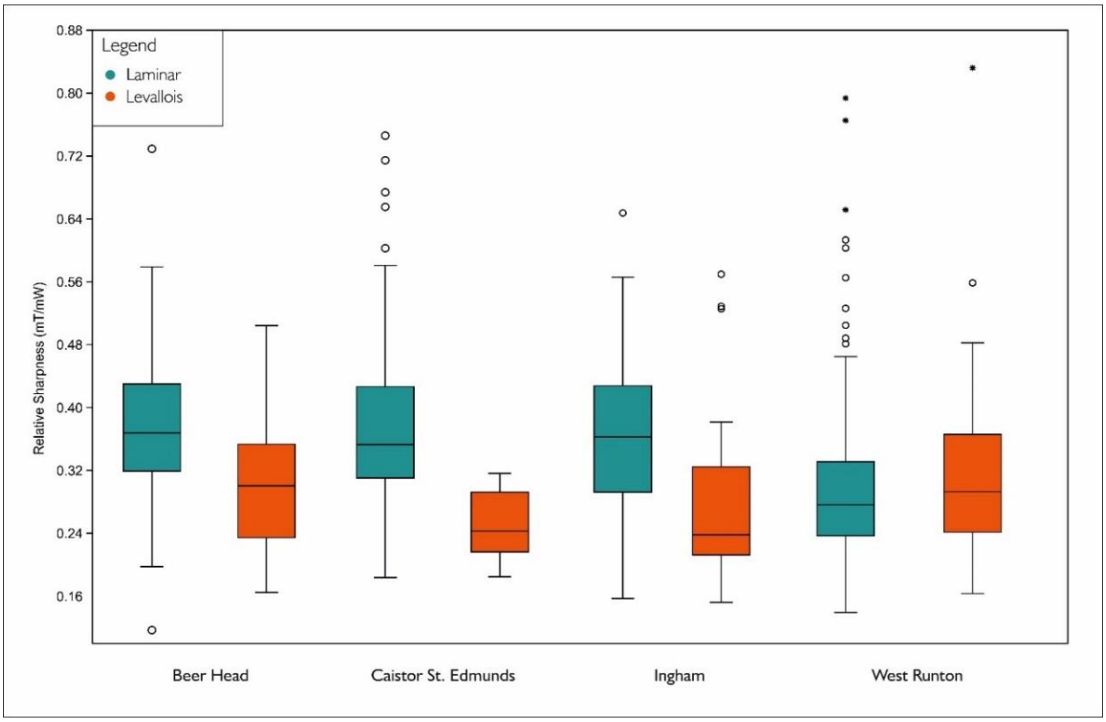


Figure 6.14. A boxplot of flattening index/relative sharpness for each different technological blade strategy and raw materials used (for examples with a Relative Sharpness less than 1.0)

Raw Material	Levallois FI	Laminar FI	*perm. p*	Levallois edge angle (°)	Laminar edge angle (°)	*perm. p*
Caistor St. Edmunds*	0.247	0.385	0.0001	32.925	46.729	0.0003
Ingham*	0.272	0.363	0.0001	36.164	45.236	0.0001
West Runton*	0.319	0.320	0.6653	36.526	41.376	0.0068
Beer Head	0.314	0.378	0.0220	42.263	41.074	0.7510

Table 6.6. Flattening Indices (FIs) and equivalent edge angles categorised by the technological blade strategy and raw material used (shaded: smallest; *similar geographical region)

6.2.3. Edge Regularity (Width Variation)

Another important aspect of cutting edges to consider is their regularity and how much of the usable edge is hypothetically in contact with the material during an activity e.g. scraping. This is here calculated through constant width/width variation, the range of the inner four width measurements. Geometric morphometric analyses have already highlighted that the shape of edges appear to differ, with Laminar technological blades producing more rectilinear edges, and Levallois blades producing more convex edges. This, therefore, provides another complimentary approach to edge analysis, explicitly focussing on the cutting edge and not shape, in contrast to geometric morphometrics.

Analyses of width variation supports evidence viewed through the geometric morphometric framework that Laminar technological blades produce more standardised edges (Figure 6.15). Analyses suggest that Laminar blades are, through a consideration of the means and medians, twenty percent more standardised in comparison to Levallois blades. Mean Laminar edge variation was recorded at 8.57mm, and 10.57mm for Levallois blades (7.19mm median for Laminar, 9.37mm median for Laminar). Non-parametric analyses highlight that these are statistically significant to a 99.99% confidence interval (*Mann-Whitney U*: 14436, *z*: -3.8921, *permutated p*: 0.0001)

When raw material is investigated, a similar pattern appears with lower means and medians for Laminar blades produced in all four raw materials, to varying degrees, with Beer Head the only raw material to feature statistical significance (*Mann-Whitney U*: 371, *z*: -3.2144, *permutated p*: 0.0017). This picture is further confused when the allometric relationship is assessed. While there is a correlation between the size (length) of the blade and its width variation (see Appendix), bigger blades feature greater width variation (r: 0.5331, r^2: 0.2842, *permutated p*: 0.0001). Given similar ranges, and the difference in the means and medians, despite being statistically significant, it is highly unlikely that this represents real functional difference. Further experimental work is needed to assess the degree that this alters, if any, the performance of blade edges, in a variety of cutting or scraping-based tasks.

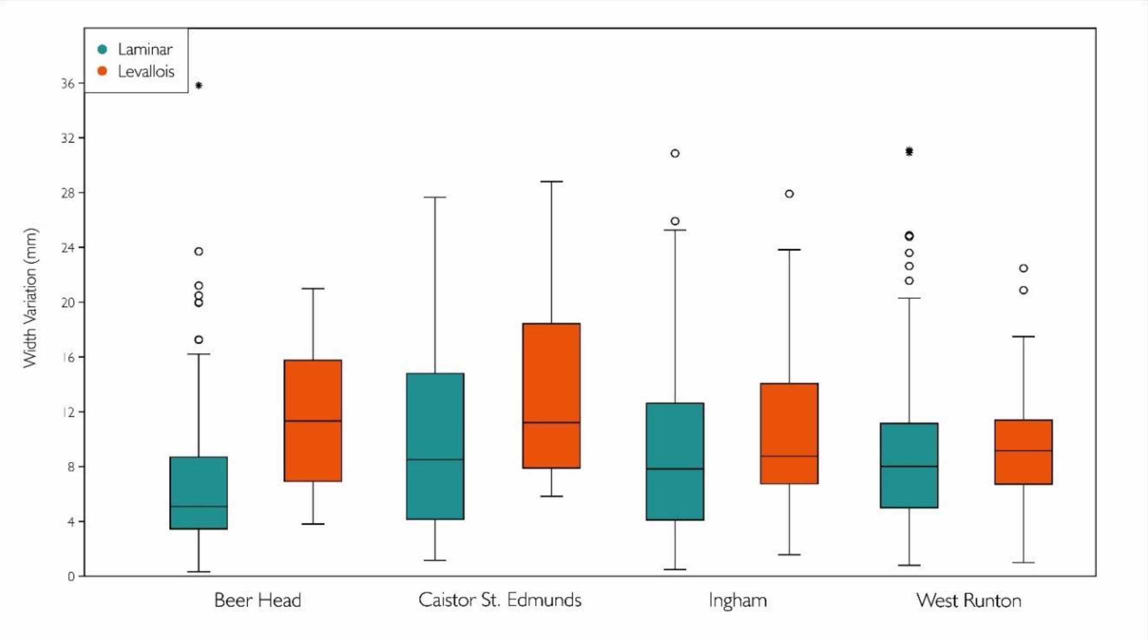


Figure 6.15. A boxplot displaying width variation (mm) categorised through technological blade strategies and the different raw materials used

6.2.4. A Consideration of Elongation

The final way blade edge is investigated is through an investigation of how much of an artefact cutting edge can be used in a hypothetical activity at one time. It can be assumed that for products of similar length, elongated forms would allow for a greater percentage of the overall edge to be utilised in a slicing/cutting activity and vice versa for shorter artefacts. Additionally, elongation has been much discussed within archaeological literature pertaining to lithic strategies (see Chapter 2), and this experiment provides an opportunity to investigate elongation within a robust, replicable experiment.

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Additionally, elongation has been much discussed within archaeological literature pertaining to lithic strategies (see Chapter 2), and this experiment provides an opportunity to investigate elongation within a robust, replicable experiment.

Investigations of elongation (length/width) can be seen in Figure 6.16 and Figure 6.17. Analyses highlight that Laminar technological blade strategies (n=370) feature a mean elongation index of 2.79, with a maximum elongation index of almost 6 (5.91), and a median of 2.69. This contrast Levallois technological blade strategies (n=104) feature a mean elongation index of 2.40, with a maximum elongation index of 4.5 (4.52), and a median of 2.30. Normality could not be assumed and a test for equal medians was adopted - this highlighted that they both technological strategies are statistically significant (*Mann-Whitney U*: 12481, *z*: -5.4762, *permutated p*: 0.0001).

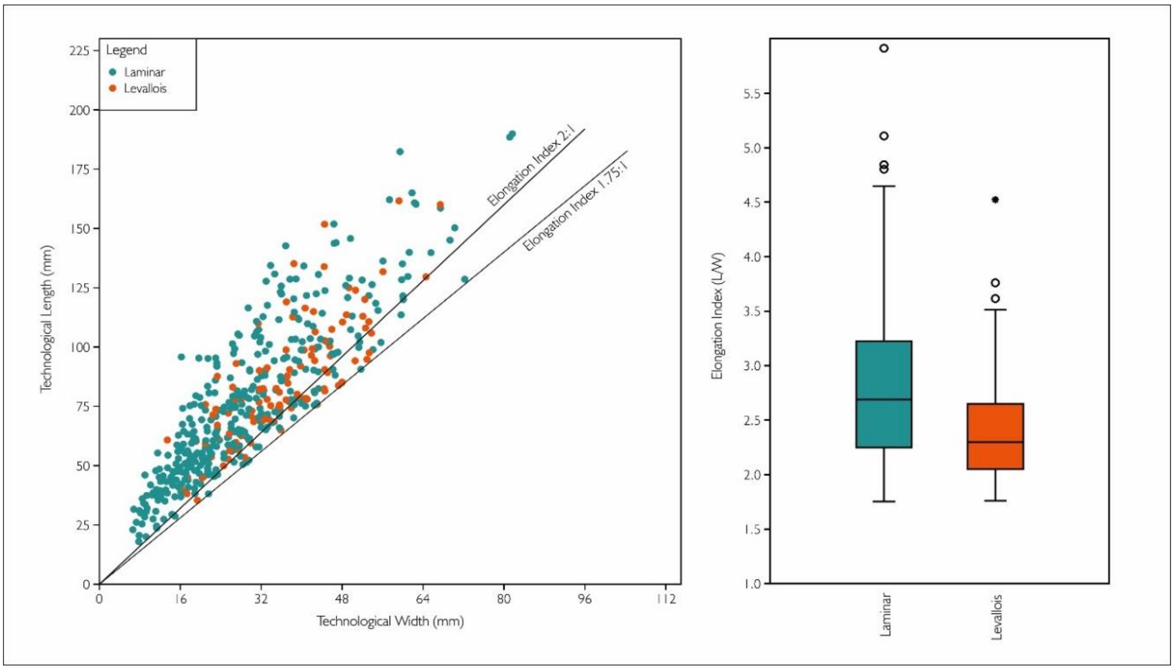


Figure 6.16. A scatterplot and boxplot displaying differences in elongation index between both technological blade strategies

In all four material groups, the medians and means for Laminar technological blades are higher, with greater ranges in comparison to Levallois technological blades. Further examination through a Kruskal-Wallis test for equal medians, highlights that different raw materials produced through Laminar technological blade strategies, feature differing degrees of elongation index, and are distinguished through a MANOVA (*p*: <0.0001). This is, however, not true for Levallois technological blades (*p*: 0.3352).

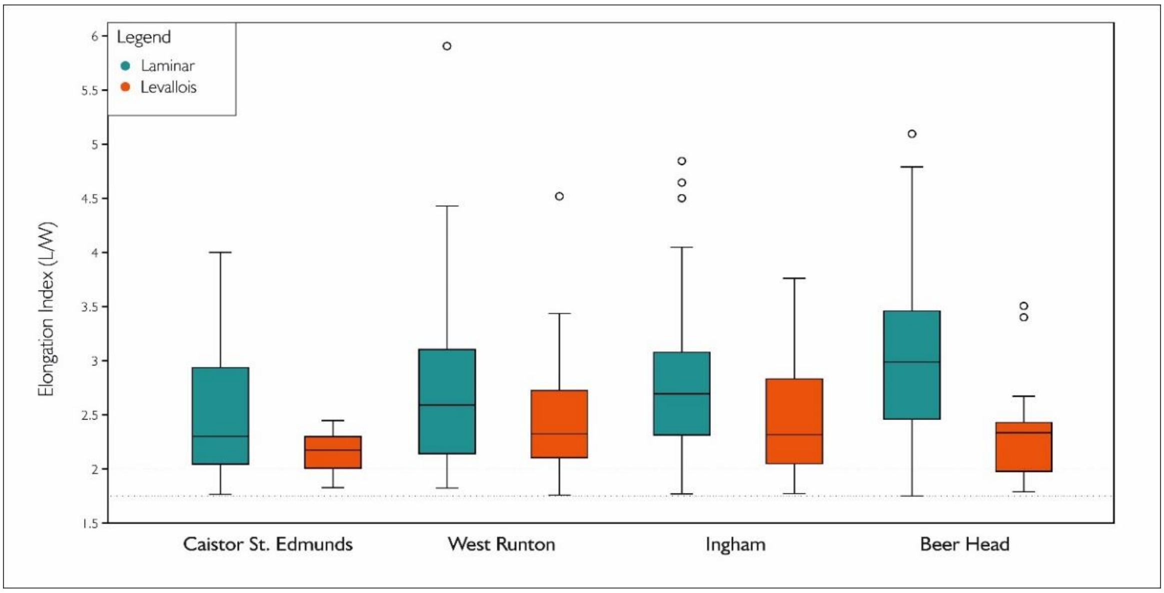


Figure 6.17. A boxplot highlighting differences in
Elongation Index (L/W) with respect to raw material utilised

6.2.5. Summary

Through studies into the nature and shape of the cutting edge, this section has highlighted:

- Geometric morphometric methodologies can statistically discriminate and distinguish between technological blade strategies through their two-dimensional planform shape variance, with elongation and edge convexity contributing to the main sources of shape variation.

- Geometric morphometric methodologies can statistically discriminate and distinguished between technological blade strategies on differing flint, in terms of two-dimensional planform shape.

- Geometric morphometric methodologies highlight that differences between within-group variance of each technological blade strategy are negligible, and cannot be discriminated by raw material i.e. raw material does not influence two-dimensional planform shape.

- Flattening index can be used as an indicator of edge angle, as studies suggest similarities between the flattening index of technological blade strategies, and raw materials, and edge angles.

- Studies of edge angle and flattening index demonstrate that Levallois blades are flatter and produce more acute edge angles to greater standardisation, in comparison to Laminar technological blade strategies, with a mean difference of six degrees.

- Studies of edge angle demonstrate that there is an allometric relationship, with differences in edge angle decreasing when technological blade strategies decrease in size. This difference, when size is considered, can be as high as thirteen degrees.

- Studies of edge angle demonstrate that raw material composition may influence the working edge angle, depending on the brittleness and invasiveness of the blades produced.

- Studies suggest there is little or no difference in edge angle between Levallois blades and core-edge blades (*éclats débordants*).

- Laminar technological blades produce a smaller degree of width variation to a certain length; however, ranges are quite equal. Further work is needed to determine this relationship.

- Laminar technological blades are more elongated than Levallois technological blades, with different raw materials influencing the elongation index of Laminar technological blades.

6.3. Artefact Design Strategy #2: Aspects of Raw Material Economisation

This section details aspects relating to the efficiency, and how raw material is best utilised. This is divided into two aspects: aspects of reduction, and cutting edge per weight of stone and per blade. A defence of these aspects is outlined in Chapter 5.

6.3.1. Aspects of Reduction (Breaks, Blanks and Core Exhaustion)

As noted previously, the raw materials used throughout the experiment were of similar dimensions (see Appendix). In understanding the technological process of the blades produced, from initial modification to exhaustion, differences can be seen relating to their economisation and efficiency.

Excluding *éclats débordants,* Levallois cores varied in productivity from 3 to 31 blades on raw material of similar size, with the average core producing 18 blades before exhaustion. Laminar cores varied in productivity from 8 to 112 blades on raw material of similar size, with the average core producing 62 blades per core, almost three and a half times (3.44) more blades per core, in contrast to Levallois blade cores.

Throughout their production, the typical Levallois blade core produced just under two broken blades (1.7), with 13 broken blades (artefacts that could not be refitted, and are intentionally produced as blades) recorded in total. The average Laminar blade core produced almost ten broken blades (9.8), with 59 broken blades recorded in total. Despite the difference in sizes, this equates to a similar breakage rate with Laminar and Levallois blade strategies featuring a 16% and 13% breakage rate irrespective.

Exhaustion was determined when there were no viable blades which could be exploited, with insufficient material to prepare the core adequately to exploit further blades. The average Levallois core at the point of exhaustion weighed 332.60g, with a maximum weight of 791.5g and a minimum weight of 120.4g. In contrast, the average Laminar core at the point of exhaustion, weighted 54.87g with a maximum weight of 101.3g (three times lower than the average exhausted Levallois core), and a minimum weight of 10.1g. Statistical analysis further highlighted their difference with a test for equal means (*t*: -2.353, *permutated p*: 0.0019). Levallois strategies can therefore be more wasteful both in the number of blades per core, and in the average weight of exhausted cores despite a slightly lower breakage rate.

6.3.2. Cutting Edge Per Blank and Per Weight of Stone

Of all raw materials, it was highlighted above that Laminar technological strategies produced almost three and a half times more blades, per core. When the maximum cutting edge is calculated for all blade strategies it is apparent that Laminar technological strategies also produce thrice the amount of cutting edge, with 71672.18mm of cutting edge produced through a Laminar strategy, and 23800.40mm of cutting edge produced through a Levallois strategy. However, when an average is recorded for the amount of cutting edge per blank, a different pattern occurs. In fact, Levallois blades produce 18% more cutting edge with the average Laminar blade featuring 193.71mm (± 84.72 mm) of cutting edge length, and the average Levallois blade featuring 228.85mm (± 85.46mm) of cutting edge length.

When cutting edge per weight of stone is considered, irrespective of raw material, Laminar technological blade strategies produce more cutting edge per weight of stone. Overall, Laminar strategies produce 1.76 times more cutting edge than Levallois strategies, with 12.52mm more edge per gram of flint typically produced (Figure. 6.18). The mean Laminar blade produces 28.86mm/g, in comparison to Levallois blades which produce 16.34mm/g. Normality could not be assumed and a Mann-Whitney test highlighted that this relationship is statistically significant (*Mann-Whitney U*: 15266, *z*:-3.2196, *permutated p*: 0.0018).

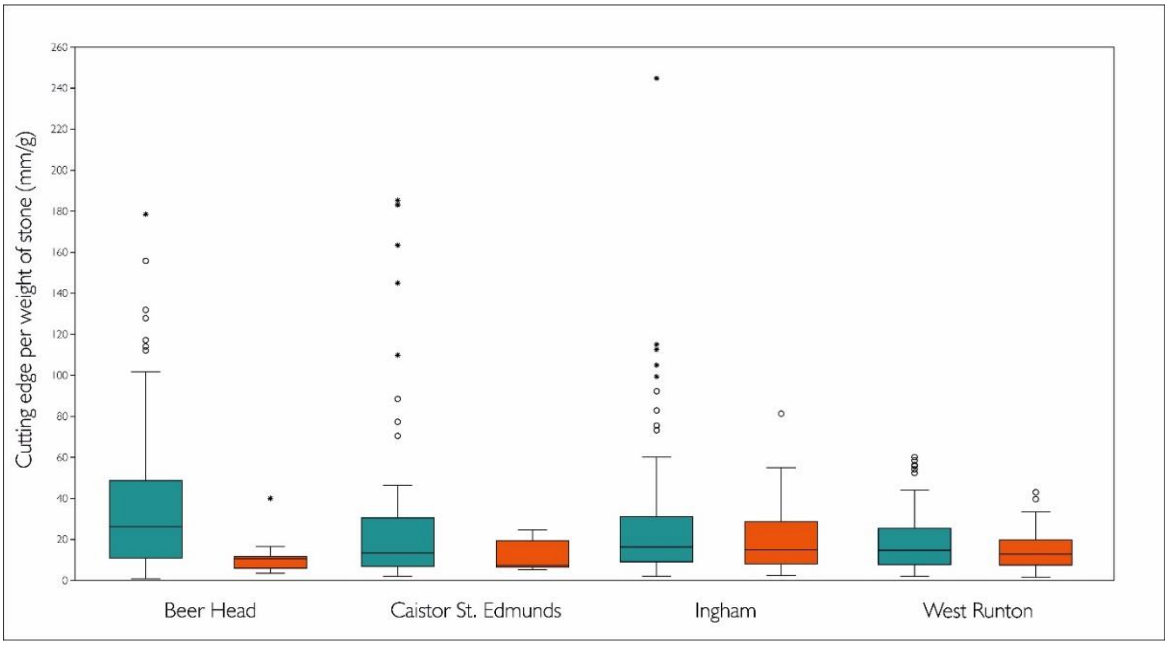


Figure 6.18. A boxplot of cutting edge per weight of stone in terms of the different raw materials used (Dark Cyan: Laminar, Orangered: Levallois)

When raw material is considered, Laminar blades are more efficient in utilising raw material for cutting edge. This is, however to varying degrees Beer Head flint, producing three (3.19) times more cutting edge per weight of stone, and the lowest, West Runton flint, producing just under one a half (1.26) times more cutting edge per weight of stone (see Figure 6.19). So, while Laminar technological blade strategies are more efficient, raw material does play a role in the degree of efficiency. This factor may be attributed to the issue of invasiveness, previously discussed. In the successful exploitation of Levallois blades a more invasive approach was used; this invasive approach results in heavier Levallois blades, and an overall larger ratio in cutting edge per weight of stone when Laminar and Levallois strategies are compared. For flint that is not brittle, a slightly smaller overall mean should then be expected.

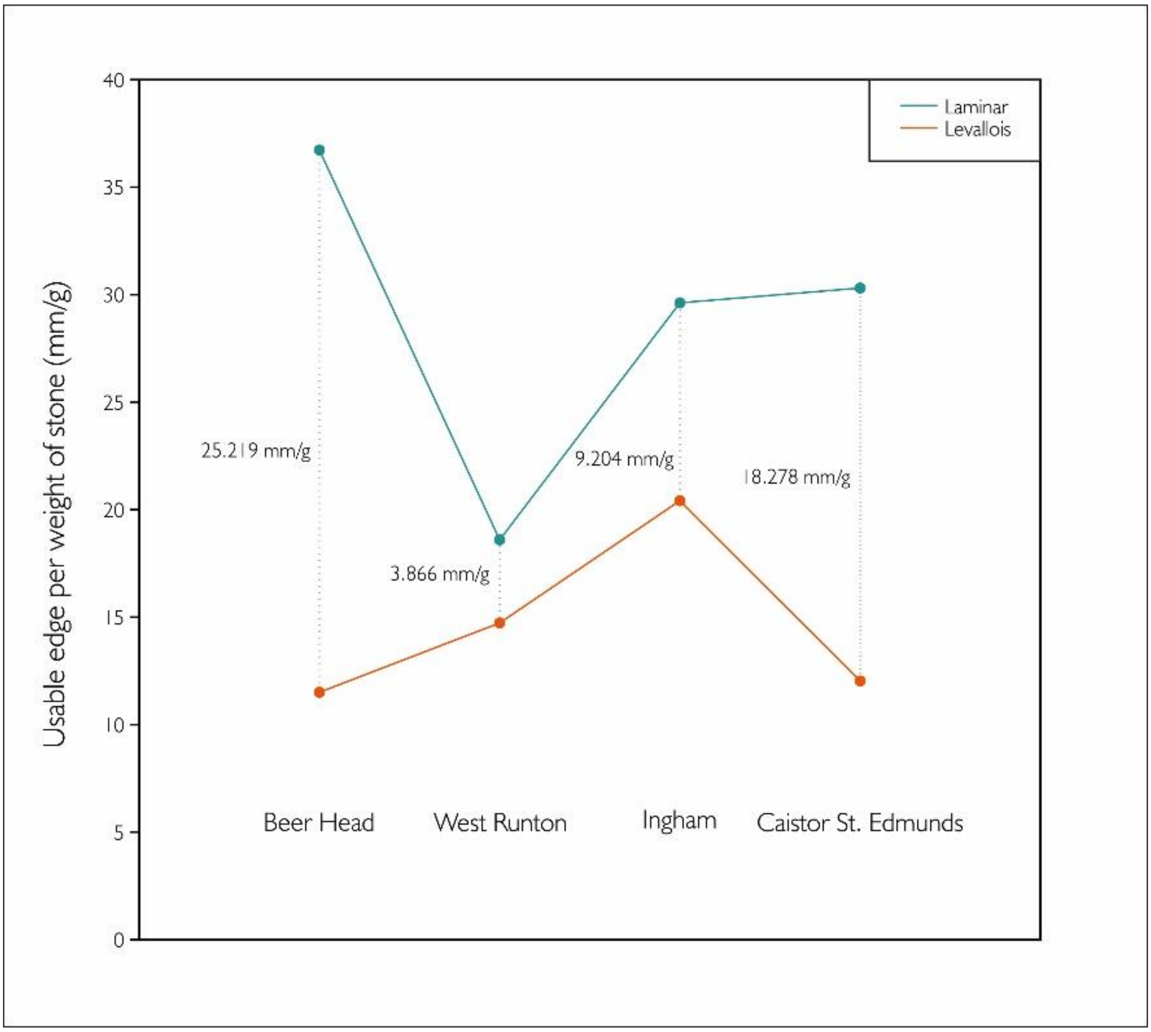


Figure 6.19. Mean cutting edge per weight of stone for each raw material used throughout the experiment

An important aspect to note is the relationship between the amount of cutting edge per weight of stone and its allometric relationship. A Bivariate OLS regression of cutting edge and size (length) reveals, under guidelines by Cohen (1988), a 'large correlation' (combined strategies: *r*: -0.6362, r^2: 0.4048, *permutated p*: 0.0001), with an exponential relationship exemplified for smaller blades (see Figure 6.20 for individual regressions). A Bivariate OLS regression of log-log transformed variables (Figure 6.21) highlights a more representative regression and demonstrates a strong relationship (combined strategies: *r*: -0.8503, r^2: 0.0.7230, *permutated p*: 0.0001).

Closer examination of size and cutting edge per weight of stone (Table 6.7) highlights that larger blades in both blade strategies feature similar amounts of cutting edge, with the difference increasing as the size of the blade decreases. For the more 'average sized' blades in the middle size categories, the difference is negligible, with major difference on the smaller size categories. However, as no Levallois blades produced in this experiment were smaller than 25mm (an important consideration to note), it is difficult to compare efficiency in cutting edge at the lowest size categories. The table and data therefore highlights that size plays an important role in the relationship between technological blades produced and their efficiency in cutting edge per weight of stone.

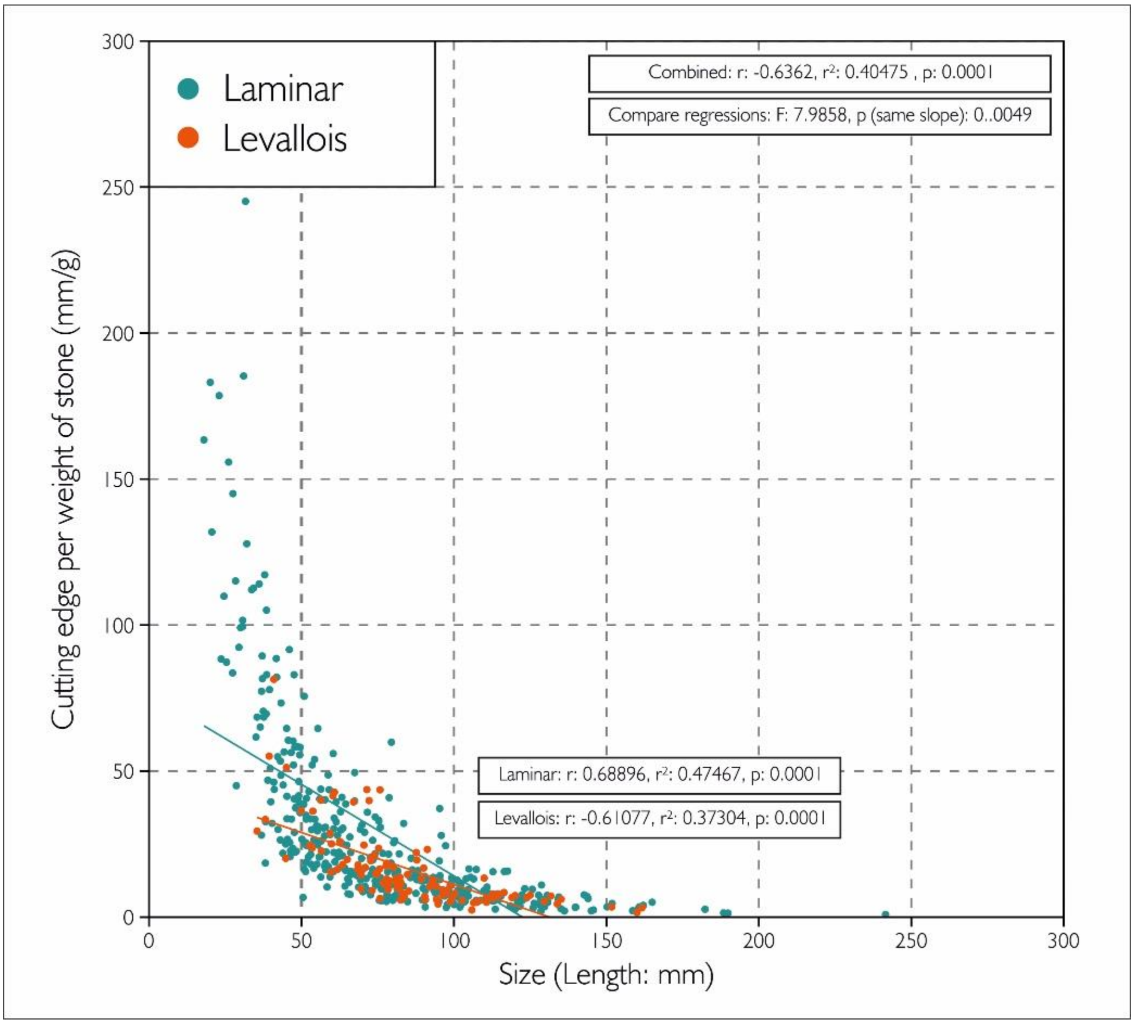


Figure 6.20. Bivariate Orthogonal Least Squares (OLS) regression of cutting edge per weight of stone and size (length)

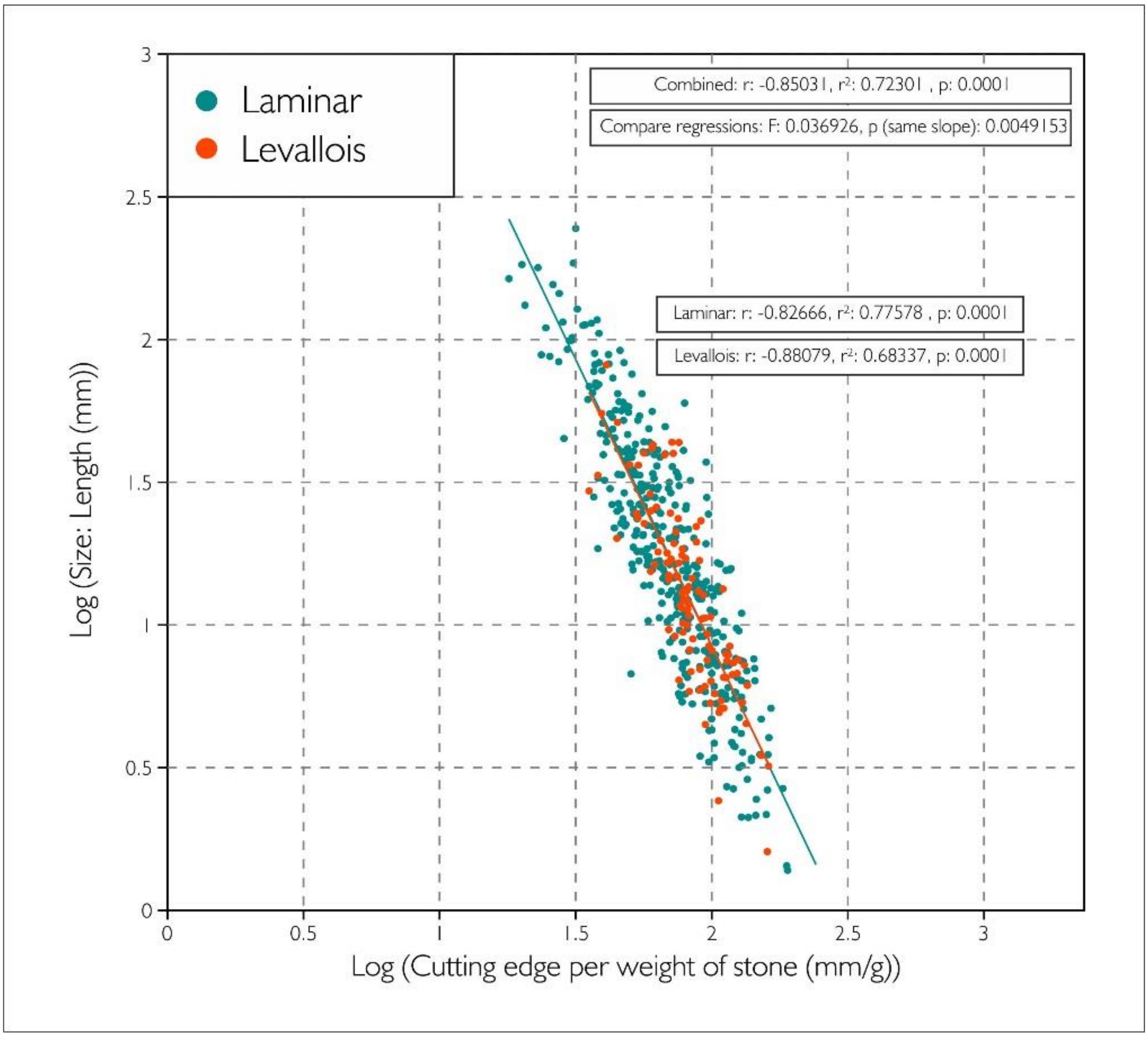


Figure 6.21. Bivariate Orthogonal Least Squares (OLS) regression of log-log transformed cutting edge per weight of stone and length

		Length (mm)							
		0.00-24.99	25.00-49.99	50.00-74.99	75.00-99.99	100.00-124.99	125.00-149.99	150.00-174.99	175.00-199.99
Cutting edge per weight of stone (mm/g)	Levallois	-	35.34	19.71	11.81	6.32	5.84	-	-
	SD	-	12.16	11.03	6.16	1.70	1.32	-	-
	Laminar	346.37	63.56	23.29	12.03	8.13	4.75	3.46	1.83
	SD	249.43	54.29	15.45	7.57	4.76	2.59	1.07	0.73
	Lam:Lev	-	1.80	1.18	1.02	1.29	0.81	-	-

Table 6.7. Cutting edge per weight of stone (mm/g) categorised by size variables and the different technological strategies

6.3.3. Summary

Studies into aspects of raw material economisation and efficiency have highlighted that:

- Laminar cores can be exhausted to much smaller dimensions, allowing the production of significantly more technological blades.
- Both technological blade strategies produce similar breakage percentages.
- Laminar technological blade strategies are more efficient in producing more cutting edge per weight of stone, in comparison to Levallois blades strategies irrespective of raw material.
- The level of efficiency, in terms of within-group variance (not between-group variance), is possibly influenced by raw material composition and invasiveness.
- Levallois blades produce more cutting edge per blade despite not producing more cutting edge per weight of stone.

Size plays an important role in working edge efficiency with smaller blades producing more cutting edge per weight of stone in an exponential relationship, with the ratio of efficiency favouring Laminar technological blades as size decreases.

6.4. Artefact Design Strategy #3: Aspects of Product Regularity

Aspects of product regularity are examined through a consideration of shape, through the geometric morphometric framework above, and through aspects of cutting edge.

6.4.1. Aspects of Shape (Shape Regulation)

Geometric morphometric methodologies above suggest that Laminar technological blade strategies are more standardised in two-dimensional shape, through: 1) size of the 95% ellipses for Laminar technological blade strategies, 2) convergence towards the mean shape (0,0), 3) the leptokurtic nature of Laminar CVA scores and platykurtic nature of Levallois CVA scores, and 4) tighter clustering (despite similar group centroid sizes e.g. Caistor St. Edmunds).

This is apparent in raw materials where sample sizes are more balanced (Ingham and West Runton).

6.4.2. Aspects of Cutting Edge

Many of the analyses throughout this chapter have suggested differences in the degree of standardisation. Analyses have highlighted that:

- Levallois blades feature greater regularity in elongation, irrespective of raw material, despite Laminar blades featuring a higher elongation index.
- Levallois blades feature greater regularity in edge angle, with the exception of blanks produced from Beer Head flint.
- Levallois blades feature greater regularity in flattening index, with the exception of blanks produced from West Runton flint.
- Levallois blades feature greater regularity in their maximum cutting edge/circumference, irrespective of raw material.
- Levallois blades feature greater regularity in the cutting edge per weight of stone, despite Laminar producing more efficient blanks.
- Laminar blades feature greater regularity in width variation/constant width, irrespective of raw material.

In sum, while Laminar technological blade strategies provide a more regular two-dimensional shape, as suggested through width-variation/edge regularity and geometric morphometric methodologies, Levallois blade strategies provide a more standardised cutting edge angle, cutting edge length and ratio of cutting edge per weight of stone.

6.5. Artefact Design Strategy: An Overview

This chapter has highlighted a variety of commonalities and differences between the morphological characteristics of both blade strategies. These are summarised in Text Box 6.1. The cumulative sum of three aspects (performance, efficiency and standardisation) suggest that both technological blade strategies can be viewed as desirable and offer potential practical benefits to different Neanderthal populations.

For Levallois technology, many of the morphological advantages noted (edge angle, flattening index, amount of cutting edge, and standardisation in all three characteristics) lend themselves to featuring a greater capacity for retouch, re-use, and curation following notions argued by many academics (Turq, 1992; Kuhn, 1994; Eren and Lycett, 2012). If Levallois blades are to be deemed desirable because of these advantages, the archaeological record would demonstrate greater presence in the amount of transformation/retouch on Levallois blades, with a large amount of Levallois blades featuring continuous retouch of high-coverage. The associated technological repertoire may also be suggestive of a more curated toolkit, with more curated forms, e.g. handaxe technologies and retouched flakes. Archaeological evidence suggestive of an extended site-life may also be apparent. This model does not exclude the possibility that Levallois blades were used immediately, unretouched, but rather what their intent may be through a consideration of their 'performance attributes' and artefact design (see Chapter 4).

Analyses have also highlighted that Levallois *éclats débordants* possess a similar working edge angle akin to other Levallois blades, both sharper than Laminar examples. Assessments of Levallois technological blade strategies should therefore consider the *éclat débordant* with similar merit to that of Levallois blades.

For Laminar technology, many of the morphological and technological advantages noted, including a standardisation in shape, the amount of blade produced, degree of core exhaustion, and increased cutting edge per weight of stone, lends itself to more expedient and efficient behaviour, offering greater portability and carrying capacity (see Chapter 4). If Laminar blades are deemed to be desirable because of their morphological and technological advantages, retouch may be fortuitous and minimal. Associated technologies may include those considered more expedient and include point technology (Goval, 2008; Goval et al., 2015). The ephemeral nature of the site could also be considered.

For an extended discussion on these considerations see Chapter 11.

6.6. The Role of Raw Material in Artefact Design Strategy

This chapter has also highlighted that many morphological attributes are influenced by the type of flint used. This is expected to be more influential when other raw materials, e.g. cherts and basalts, are considered.

Analyses suggest that raw material (flint type) does not influence two-dimensional planform shape, and that the main morphological changes are almost universal to all blades, irrespective of the four raw materials used. Raw material does however influence: a) the elongation index, b) the cutting-edge angle, c) the flattening index, d) cutting edge per weight of stone and e) thickness variation. At present, due to issues of the overall sample size it is difficult to determine the extent raw material influences the number of blanks produced throughout the technological strategy.

Summary: differences in blank morphology

Levallois:

1. More convex edges and wider two-dimensional planform shape
2. More acute edges (equivalence with *éclats débordants*)
3. Flatter blade morphologies
4. Greater standardisation in edge angle and flattening index
5. Greater standardisation in cutting edge per weight of stone
6. Greater amount of cutting edge per blank
7. Greater standardisation in elongation

Laminar:

1. More rectilinear elongated edges in two-dimensional planform shape
2. More standardised two-dimensional planform shape
3. Greater amount of blades produced per raw material
4. Greater degree of core exhaustion
5. More cutting edge per weight of stone

Text Box 6.1. A summary of findings from experimental analyses undertaken in this thesis

In almost all instances, the difference is not reflected in the general overall relationship. Perhaps, as important as the raw material used is the degree of invasiveness when blades were exploited. The brittle nature of Beer Head flint required a more invasive reduction in the production of Levallois blades, and may explain results seen in both the edge angle, and the amount of cutting edge per weight of stone.

This is elaborated and discussed in more detail in Chapter 11.

6.7. Summary

Extensive morphometric and broad technological analyses were undertaken to examine commonalities and differences in the morphology of Levallois and Laminar technological blade strategies through an experimental approach. Undertaking this framework allows a discussion on the differing 'performance attributes' and behavioural potential of each technique (Chapter 4). These, in turn, will be assessed alongside the technological data for both blade strategies to examine whether working hypotheses based on function can account for the relationships we see in the Middle Palaeolithic. Analyses emphasise attributes which point to hypotheses emphasising Levallois strategies as having a greater capacity for retouch and extended use-life, while being a more wasteful technique, and Laminar strategies as a strategy design for portability and increased carrying capacity, used expediently and when required. Differences in edge angle, and flattening index, also highlight that Levallois blades may perform better in activities associated with slicing and cutting, and similarities between Levallois blades and core-edge flakes highlight the equivalent use of 'wastage' products. Analyses have also highlighted the role raw material composition, and the degree of invasiveness while extracting blades, within aspects of blade morphology.

Chapter Seven
Technological Blade Strategies in France: Selected Contexts

7.1. Introduction

The next three chapters outline extensive technological analysis for a number of blade-bearing contexts within north-west Europe (see Chapter 5 for a list of contexts examined). The chapters briefly review the history of the context in question, and the extent of investigations and research on that specific context, before documenting technological data for each context - this includes a consideration of their taphonomic history, morphometric considerations, and refit analyses, where possible. These, in conjunction with the existing literature, provide the basis of discussing technological blade variability throughout the European Middle Palaeolithic in Chapter 10. Extensive morphometric analyses of each context is also documented in Chapter 10.

This chapter investigations archaeological material gathered from contexts throughout the French Early and Late Middle Palaeolithic. In understanding changes in technological and social behaviour, the four sites examined are of critical importance for understanding the adoption of blade strategies, commonalities and differences in their use throughout both periods of the Middle Palaeolithic, and the nature of Neanderthal social behaviour. Their different context sizes, ages, and associative archaeological material provide a holistic method of examining the true nature of technological variability associated with blades and blade technology. This chapter starts with a consideration of data from Saint-Valery-sur-Somme (Moulin de la Veuve Rignon), one of the earliest contexts discovered known to feature Laminar technology, before examining the Early Middle Palaeolithic context of Therdonne (N3), and its technological behaviour for blade production. Following this, two fine-scale Late Middle Palaeolithic contexts are discussed: Bettencourt-Saint-Ouen (N2B) and Fresnoy-au-Val (Série 1). These two contexts are often discussed with reference to blade behaviour in MOIS 5 (Locht et al. 2010a, 2016) and provide a framework for examining cultural affinities.

Analyses highlight the proceduralisation of Laminar technology towards the beginning of the Middle Palaeolithic, the existence of Levallois flaking strategies, with some hint towards a Levallois blade strategy.

7.2. Saint-Valery-sur-Somme (Moulin de la Veuve Rignon)

7.2.1. Introduction and Overview of Investigations

Artefacts were first discovered during geological prospection in December 1977 by Jean de Heinzelin, Paul Haesaerts, and Robert Devisme (Dupuis et al., 1977). Despite archaeological literature referring to the material as originating from 'Saint-Valery-sur-Somme', the material derives from the nearby Molin de la Veuve Rignon, in the *Croix-l'Abbé* region of the lower Somme Valley, Nord-Pas-de-Calais-Picardie, France (Figure 7.1). Following these initial discoveries, permission was granted for a rescue excavation in February 1978 following agreement from the landowner; this was in the form of a series of short visits over five months, with work finishing in July 1978 (de Heinzelin and Haesaerts, 1983). Subsequently, analyses of material from Molin de la Veuve Rignon (n=133), including refit analyses, were undertaken at the *Institut Royal des sciences Naturelles de Belgique* (IRSNB) under the supervision of Daniel Cahen. This includes the drawings of 'Remontage A' and 'Remontage B', which are commonly reproduced in literature on Middle Palaeolithic blade strategies (e.g. Révillion, 1995, Mellars, 1999; Koehler, 2011b), illustrated by Suzanne Jansen. Following initial analyses all material from Saint-Valery-sur-Somme was deposited within its local department, in the Musée Boucher-de-Perthes, in Abbeville, France.

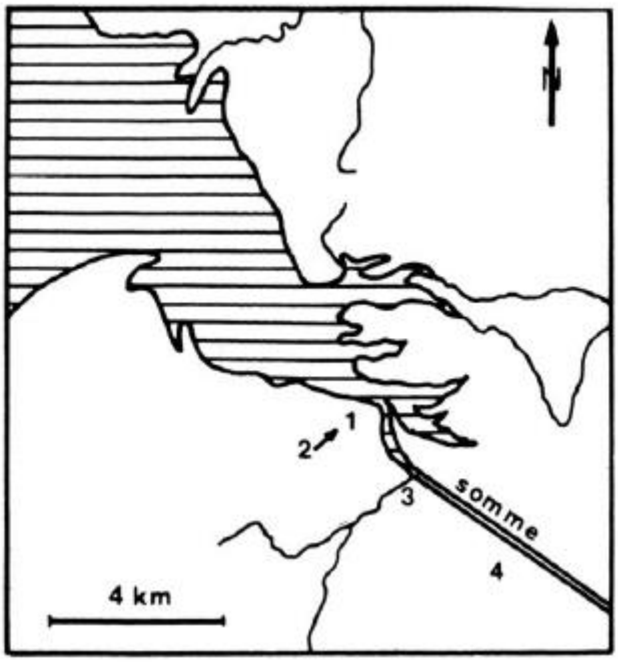


Figure 7.1. A map highlighting the location of material recovered from Moulin de la Veuve Rignon (2) in relation to Saint-Valery-sur-Somme (1), and two nearby sequences: Pinchefalise (3) and Boismont (4). Map sourced from de Heinzelin and Haesaerts (1983).

The report from Moulin de la Veuve Rignon was published in 1983 (de Heinzelin and Haesaerts, 1983) and represents the most extensive documentation of the site, featuring an account of all material present, the 11 examples of refits discovered and details including limited morphometric analyses (lengths and widths). De Heinzelin and Haesaerts (1983: 200) note that while sophisticated: "…*il subsiste des traits archaïques plus habituels au Paléolithique ancien qu'au Paléolithique supérieur.*", including the lack of preparation and modification of the core's geometry, including angles of exploitation.

Overviews of the strategy undertaken were subsequently detailed by Révillion (1995). Through Révillion's (1995) overview of Middle Palaeolithic blade technology, material from Moulin de la Veuve Rignon/Saint-Valery-sur-Somme was classified as *débitage non-levallois direct bipolaire*, given the noted lack of preparation on the cylindrical nodule. Since this, publications have continued to stress its importance in discussing the existence of Laminar technological blade strategies among the earliest Neanderthal populations (Mellars, 1999; Bringmans, 2006; Koehler, 2011b). Despite this, extended technological analyses are absent, with narrative-based interpretations representing the bulk of documentation on blades at Moulin de la Veuve Rignon, including the original report (de Heinzelin and Haesaerts, 1983).

7.2.2. Geological and Chronostratigraphic Background

Moulin de la Veuve Rignon occupies a former gravel pit within the Croix l'Abbé Formation gravel sheet, a formation deposited at height of c.25m during a cold climatic episode of the Lower Pleistocene, in the 'Basse Somme' alluvial complex (Dupuis et al., 1977). Noted by Dupuis et al. (1977) the Basse Somme shows characteristics typical of a marine influence, and features a lithological relationship with terraces of the Somme between Pinchefalise and Saigneville (de Heinzelin and Haesaerts, 1983).

Artefacts were collected from the western wall of the gravel pit, two metres below ground level, and were recovered from a 3m^2 area, spread half a metre in height through the sandy deposits (de Heinzelin and Haesaerts, 1983). Through two profiles, a complex local stratigraphy was observed (de Heinzelin and Haesaerts, 1983) and can be summarised as follows:

- R: A dark brown sandy loam embankment (10YR 4/3) featuring flint pebbles and fragments of chalk and brick;

- SJ: A light brown homogenous loamy sand (10YR 7/4). Noted by de Heinzelin and Haesaerts (1983) as Aeolian in nature. Base of the deposit intersects with units ZL and ZH and is underlined by discontinuous gravel associated with deep freezing;
- ZL: A compact yellow-brown loamy sand/sandy loam (10YR 6/6). Horizon of leached soil, noted by de Heinzelin and Haesaerts (1983) as comparable to alfisols (a soil formed in semiarid to humid areas, typically under a hardwood forest cover) in north-west Europe;
- ZH: A grey-brown loamy sand (10YR 5/2) underlying units SP and SG;
- SC/SP: An ochre sand with a high pebble composition (7.5-10YR 6/8) and pockets of sealed white sand (SP) (10YR 8/2). SP is divided into: SP1 (pale yellow silty sand), SP2 and SP3 (greyish white sand), and SP4 and SP5 (local powdered white sand). Noted by de Heinzelin and Haesaerts (1983) as a complex sequence resulting from cryoturbation;
- SO: A homogenous ochre silty sand (7.5YR 6/8) incorporating flint pebbles. The upper levels of this ochre sand contain the majority of artefacts, with smaller quantities in the SC and SP). Penetrated by slight illuvial action with slight soil leaching;
- ZM: Brown loamy sand (7.5YR 5/6) with small localised oxidation stains. Attributed to a truncated illuvial horizon of a highly leached degraded soil.

See Figure 7.2 for more information.

De Heinzelin and Haesaerts (1983) note that all artefacts derive from slow-accumulating sand deposits between the illuvial horizons, in the SO, SC and SP units. No radiometric dates exist, however chronostratigraphic comparisons elsewhere within the Somme Valley (Boismont), loess sequences at Saint-Pierre-lès-Elbeuf (Lautridou et al., 1974), and similarities in other regions (Zagwijn, 1973) led de Heinzelin and Haesaerts (1983: 194) to determine that the lithics recovered originate from the first half of the Saalian glaciation. While a date of MOIS 8 is accredited to the archaeological material recovered at Saint-Valery-sur-Somme, caution must be taken as to its precise substage, given the use of dating by association.

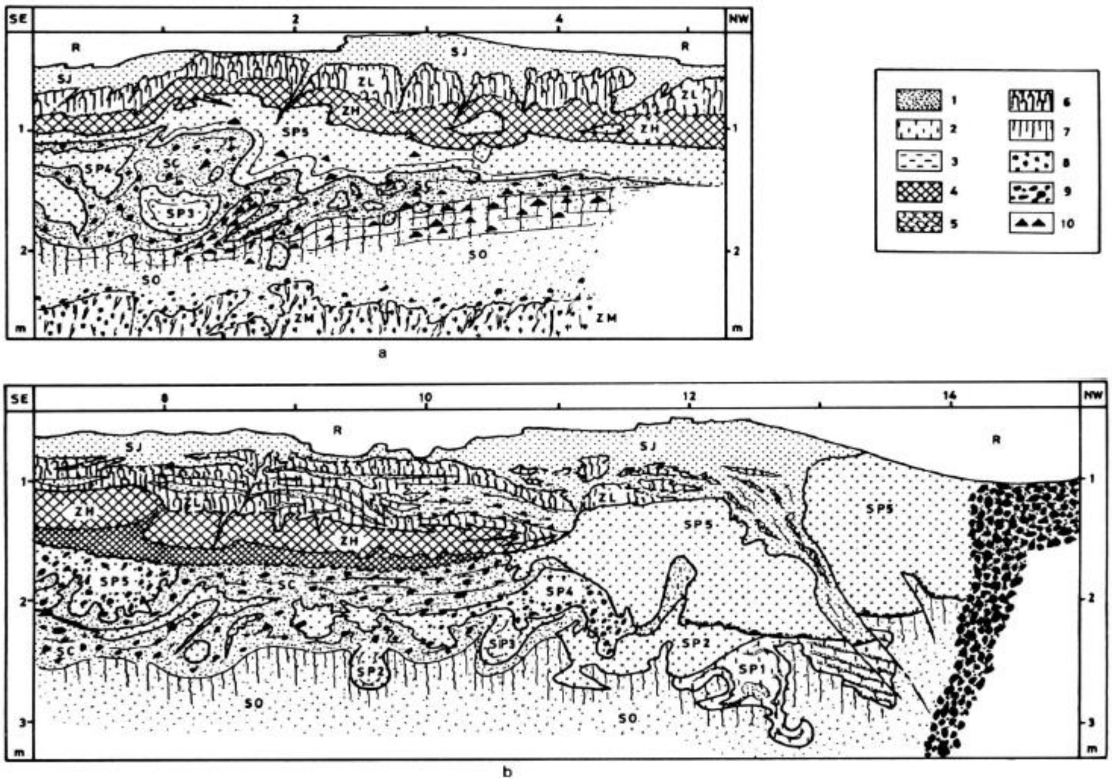


Figure 7.2. Profile of the western wall of the Moulin de la Veuve Rignon gravel pit (de Heinzelin and Haesaerts, 1983)

Legend: sand (1), silt (2), clay (3), humiferous sediments (4), reduced sediments (5), leached soil (6), leached brown soil (7), oxidation/degradation spots (8), gravels (9), and artefacts (10)

7.2.3. Artefact Analysis

7.2.3.1. Treatment and Selection of the Collection(s)

All material analysed was studied in the Musée Boucher-de-Perthes, Abbeville, in early 2016. All 133 artefacts noted in de Heinzelin and Haesaerts (1983) were present upon analysis, in addition to a further 21 associated artefacts from geological prospection prior to excavations. All blade *débitage* which was labelled and catalogued as originating from associated deposits described above was analysed and assumed to be originating from the excavations by de Heinzelin and colleagues. As all refits were stuck with adhesive, only a small number of samples featured within these refits were deemed suitable for geometric morphometric analyses. In total, a large number of artefacts were digitised and suitable for geometric morphometric analyses (see Chapter 10).

7.2.3.2. Technological Overview

Of all artefacts within the collection, fifty-four were identified as products from a Laminar technological blade strategy. In more detail, forty-nine (90.74% of the sample) artefacts were confidently defined as Laminar *débitage*, with a further five examples (9.26%) exemplifying characteristics as 'probable' Laminar artefacts; this contrasts forty-four artefacts, as determined by Paul de Heinzelin (de Heinzelin and Haesaerts, 1983). Decoritification and platform rejuvenation flakes, associated with Laminar technology was also documented through refit analysis. No Levallois technological blade *débitage* was present, with one broken Levallois point representing the sole evidence for Levallois technology. Artefacts catalogued as '*debris inferieur*' were also recorded among the assemblage.

Artefact	n	Percentage
Laminar blade (unretouched)	23	42.59%
Laminar blade (retouched)	5	9.26%
Laminar blade fragment (unretouched)	26	48.15%
Laminar blade fragment (retouched)	0	0.00%
Laminar crested blade (unretouched)	0	0.00%
Laminar crested blade (retouched)	0	0.00%
Laminar crested blade fragment (unretouched)	0	0.00%
Laminar crested blade fragment (retouched)	0	0.00%
Laminar blade core	0	0.00%
Levallois blade (unretouched)	0	0.00%
Levallois blade (retouched)	0	0.00%
Levallois blade fragment (unretouched)	0	0.00%
Levallois blade fragment (retouched)	0	0.00%
Levallois *éclat débordant* (unretouched)	0	0.00%
Levallois *éclat débordant* (retouched)	0	0.00%
Levallois *éclat débordant* fragment (unretouched)	0	0.00%
Levallois *éclat débordant* fragment (retouched)	0	0.00%
Levallois recurrent blade core	0	0.00%
Total:	54	100.00%

Table 7.1. Technological overview of the artefacts studied

Confidence	Laminar core	Levallois core	Laminar product	Levallois product
A (definite)	-	-	49 (90.74%)	-
B (probable)	-	-	5 (9.26%)	-
C (possible)	-	-	-	-

Table 7.2. Confidence categories for the artefacts studied

No cores were recorded, however extensive refit analyses (see below) demonstrate the exact nature of the raw material utilised, with the core volume management strategy hypothesised (see below).

7.2.3.3. Taphonomic History

Among the artefacts analysed, material can be viewed as having been minimally subject to a variety of different taphonomic characteristics, agreeing with de Heinzelin and Haesaert's (1983) view that artefacts documented throughout the SO and SP/SC units originate from a low energy environment with some illuvial penetration (Table 7.3). Despite their presence, effects including cryoturbation, as documented within the SP/SC units, and low illuvial action in the SO unit, have had minor impact to the condition of the artefacts examined.

Saint-Valery-sur-Somme: artefact condition (n=54)									
	Levallois (0)		Laminar (54)			Levallois (0)		Laminar (54)	
Whole/broken:					Degree of patination:				
Whole	0	0.00%	31	57.40%	Unpatinated	0	0.00%	2	3.70%
Broken	0	0.00%	23	42.60%	Lightly patinated	0	0.00%	40	74.07%
					Moderately patinated	0	0.00%	12	22.22%
					Heavily patinated	0	0.00%	0	0.00%
Degree of edge damage:					Degree of burning:				
No edge damage	0	0.00%	42	77.78%	Unburned	0	0.00%	54	100.00%
Lightly damaged	0	0.00%	12	22.22%	Lightly burned	0	0.00%	0	0.00%
Moderately damaged	0	0.00%	0	0.00%	Moderately burned	0	0.00%	0	0.00%
Heavily damaged	0	0.00%	0	0.00%	Heavily burned	0	0.00%	0	0.00%
Degree of rolling:					Portion/break:				
Unrolled	0	0.00%	54	100.00%	Complete	0	0.00%	31	57.40%
Lightly rolled	0	0.00%	0	0.00%	Proximal fragment	0	0.00%	12	22.22%
Moderately rolled	0	0.00%	0	0.00%	Medial fragment	0	0.00%	1	1.85%
Heavily rolled	0	0.00%	0	0.00%	Distal fragment	0	0.00%	10	18.53%
					Siret	0	0.00%	0	0.00%
Other observations: Minimal abrasion, scratching and staining present.									

Table 7.3. Detailed taphonomic characteristics of material analysed at Saint-Valery-sur-Somme

In more detail, little evidence for mechanical damage is present with forty-two artefacts (77.78% of the sample) featuring no damage on the blade edges, with only twelve artefacts (22.22% of the sample) featuring slight edge damage. This is also demonstrated through the lack of evidence for rolling throughout the assemblage, and the lack of scratching present which Scott (2006) often notes as resulting in part from the pressure of coarse grains in the sediments passing across the artefacts.

Patination was recorded on the majority of artefacts recorded with over 95% (96.29%) of the sample featuring some degree of change in surface and/or granularity. This may be the result of the upper homogenous ochre silty sands of the SO unit with minor soil leaching documented. No other staining or chemical alteration is noted, however a slightly worn context highlights some fluvial disturbance. The fluvial nature of the Basse Somme, and penetration of illuvial processes documented (de Heinzelin and Haesaerts, 1987) may account for many of the changes present.

It is unknown whether sieving was undertaken and, there, whether the assemblage size reflects the true extent of material excavated. Given the dimensions of many of the artefacts documented throughout the assemblage (see below), some care in recovering artefacts was observed.

Recording of taphonomic characteristics also highlight that no material recorded features tracing of burning.

7.2.3.4. Raw Material

No exhausted or worked cores were detailed throughout the analyses, however given the dimensions of the refits, similarities in the type of raw material used throughout and the nature of the reduction sequence between 'Remontage A' and 'Remontage B' (see below), it is here hypothesised that most (if not all) of the material originates from one elongated cortical nodule (see later sections).

Varying levels of cortex (both unrolled and fresh in nature) indicate that all stages of blade production were present, with cortex present on just under a third of artefacts to varying degrees of coverage. In its quantity, cortex coverage is largely minimal with only three blades featuring more than 50% cortex on their dorsal surface (Table 7.4). Thirty-seven blades and blade fragments feature no cortex, indicative of the exhaustive process undertaken throughout the reduction of the elongated flint nodule.

7.2.3.5. Technology: Extended Analysis

The predominant strategy at Saint-Valery-sur-Somme is oriented towards the production of elongated stereotyped material through an initial bidirectional, and subsequently unidirectional, system of Laminar core volume management. Throughout, hard-hammer percussion dominates, with most artefacts featuring pronounced and well-defned bulbar scar features (Table 7.4). In their condition, just over half of all blades are complete (57.41%) with many examples of proximal and distal fragments. Many of these fragments could not be refitted to other examples within the assemblage, possibly due to the incomplete nature of the reduction sequence, however all phases of the sequence are present.

Analyses of dorsal scar direction highlights a predominantly unidirectional blade production strategy, with only nine examples and the core refit exemplifying the use of a bidirectional method. A bidirectional method is therefore hypothesised to have been used in the initial stages of core reduction, with a unidirectional sequence following. Blades are straight in their morphology (straight: 83%, curved: 13%, twisted: 4%), highlighting the lineal nature of the raw material used (this is further supported through refits). Blades typically feature a singular ridge (66.67% of sample), with a relatively standardised scar and ridge count, exemplifying the proceduralisation of Laminar blade production.

Despite the extensive reduction sequence, no evidence for cresting/semi-cresting is apparent, whether as a form of initiating the blade sequence or as a subsequent maintenance technique. In its initiation, the natural convexities of the nodule's morphology exploited highlight the lack of preparation as documented previously (de Heinzelin and Haesaerts, 1983). Despite this, in eight cases preparation of the platforms through facetting is documented. This, coupled with evidence for platform rejuvenation (see below), demonstrates a great degree of control and predetermination within a direct Laminar sequence. Interestingly, while the majority of blades produced are triangular, instances of more Levallois-like cross-sections including polyhedral and plano-convex cross-sections are noted (Figure 7.3). Coupled with a flattening index akin to Levallois strategies (Table 7.5), and the evidence for facetting, the material at Saint-Valery-sur-Somme highlights the fusion of Levallois behaviours within a Laminar technique.

It may be possible given the nature of the technological sequence, and following similar hypotheses made at Crayford (Scott, 2006, 2011), that the core produced deeper was Laminar, and taken off-site. However, given the morphology of the absent material it is most probably Laminar in shape, in contrast to the hypothesised Levallois core morphology at

Stoneham's Pit, Crayford (Scott, 2006, 2011). This is also highlighted in the lack of lateral flaking on blade products and the nodules, and the lack of Levallois-like *débitage.*

Saint-Valery-sur-Somme: technological analysis (n=54)									
Percussion strategy:	Levallois (0)		Laminar (54)		Bulbar scar features:	Levallois (0)		Laminar (54)	
Hard	0	0.00%	41	75.93%	Well defined	0	0.00%	36	66.67%
Soft	0	0.00%	0	0.00%	Diffused	0	0.00%	6	11.11%
Mixed/Indeterminable	0	0.00%	2	3.70%	Absent/missing	0	0.00%	12	22.22%
Absent	0	0.00%	11	20.37%	Removed	0	0.00%	0	0.00%
Cortex percentage:					Number of dorsal scars:				
Absent	0	0.00%	37	68.52%	Absent	0	0.00%	1	1.85%
1-24%	0	0.00%	9	16.67%	1-2	0	0.00%	23	42.60%
25-49%	0	0.00%	5	9.26%	3-4	0	0.00%	27	50.00%
50-74%	0	0.00%	1	1.85%	5-6	0	0.00%	2	3.70%
75-99%	0	0.00%	2	3.70%	7+	0	0.00%	1	1.85%
Complete	0	0.00%	0	0.00%					
Number of elongated scars:					Number of ridges/arrises:				
Absent	0	0.00%	1	1.85%	Absent	0	0.00%	1	1.85%
1-2	0	0.00%	31	57.41%	1	0	0.00%	40	74.08%
3-4	0	0.00%	21	38.89%	2	0	0.00%	12	22.22%
5-6	0	0.00%	1	1.85%	3	0	0.00%	1	1.85%
7+	0	0.00%	0	0.00%	4	0	0.00%	0	0.00%
					5+	0	0.00%	0	0.00%
Dorsal ridge/arise shape:					Flake scar pattern:				
Singular	0	0.00%	36	66.67%	Unidirectional	0	0.00%	27	50.00%
Parallel	0	0.00%	4	7.41%	Centripetal	0	0.00%	0	0.00%
Irregular	0	0.00%	1	1.85%	3-way centripetal	0	0.00%	1	1.85%
Regular converging	0	0.00%	1	1.85%	Bidirectional	0	0.00%	9	16.67%
Regular diverging	0	0.00%	0	0.00%	Lateral left	0	0.00%	0	0.00%
Y-shape	0	0.00%	6	11.11%	Lateral right	0	0.00%	0	0.00%
Inverted Y-shape	0	0.00%	1	1.85%	Convergent unidirectional	0	0.00%	9	16.67%
Offset left/right	0	0.00%	2	3.70%	Convergent bidirectional	0	0.00%	2	3.70%
Partial	0	0.00%	0	0.00%	Convergent and perpendicular	0	0.00%	1	1.85%
Central converging	0	0.00%	2	3.70%	Double perpendicular	0	0.00%	0	0.00%
Absent	0	0.00%	1	1.85%	Straight and perpendicular	0	0.00%	3	5.56%
					Cortical	0	0.00%	1	1.85%
					Indeterminable	0	0.00%	1	1.85%
Distal end-type:					Butt type:				
Feathered	0	0.00%	33	61.11%	Plain/flat	0	0.00%	8	14.81%
Stepped	0	0.00%	1	1.85%	Dihedral	0	0.00%	4	7.41%
Hinged	0	0.00%	6	11.11%	Cortical	0	0.00%	2	3.70%
Overshot	0	0.00%	1	1.85%	Natural (but non-cortical)	0	0.00%	0	0.00%
Present but indeterminable	0	0.00%	0	0.00%	Marginal	0	0.00%	7	12.97%
Missing	0	0.00%	13	24.08%	Mixed	0	0.00%	14	25.93%
					Facetted	0	0.00%	8	14.81%
					Missing (proximal missing)	0	0.00%	11	20.37%
					Trimmed	0	0.00%	0	0.00%
					Chapeau de Gendarme	0	0.00%	0	0.00%
					Damaged/unidentifiable	0	0.00%	0	0.00%

Table 7.4. Technological observations from Saint-Valery-sur-Somme (blade attributes)

Weight (g)	Min.	Max.	Mean	S.D.	Med.	CV
Complete Laminar blade	2.30	39.40	13.27	10.19	11.30	76.77
Complete Levallois blade	-	-	-	-	-	-
Broken Laminar blade	0.90	19.70	4.87	4.72	3.10	97.09
Broken Levallois blade	-	-	-	-	-	-
Length (mm)	Min.	Max.	Mean	S.D.	Med.	CV
Complete Laminar blade	38.95	141.00	79.11	25.24	79.63	31.91
Complete Levallois blade	-	-	-	-	-	-
Broken Laminar blade	16.91	66.88	33.99	11.98	32.35	35.26
Broken Levallois blade	-	-	-	-	-	-
Width (mm)	Min.	Max.	Mean	S.D.	Med.	CV
Complete Laminar blade	12.20	43.80	30.03	8.54	31.79	28.44
Complete Levallois blade	-	-	-	-	-	-
Broken Laminar blade	12.05	37.06	22.84	7.17	24.49	31.40
Broken Levallois blade	-	-	-	-	-	-
Elongation Index (L/W)	Min.	Max.	Mean	S.D.	Med.	CV
Complete Laminar blade	1.84	4.15	2.71	0.54	2.63	19.81
Complete Levallois blade	-	-	-	-	-	-
Broken Laminar blade	0.78	2.11	1.52	0.35	1.52	23.20
Broken Levallois blade	-	-	-	-	-	-
Thickness (mm)	Min.	Max.	Mean	S.D.	Med.	CV
Complete Laminar blade	2.88	10.82	5.95	2.13	5.90	35.76
Complete Levallois blade	-	-	-	-	-	-
Broken Laminar blade	2.98	15.10	6.32	3.18	5.34	50.29
Broken Levallois blade	-	-	-	-	-	-
Working edge/edge circum. (mm)	Min.	Max.	Mean	S.D.	Med.	CV
Complete Laminar blade	108.11	272.26	175.40	56.03	162.96	31.95
Complete Levallois blade	-	-	-	-	-	-
Broken Laminar blade	54.80	164.92	100.92	30.10	93.52	29.83
Broken Levallois blade	-	-	-	-	-	-
Cutting edge per weight (mm/g)	Min.	Max.	Mean	S.D.	Med.	CV
Complete Laminar blade	3.52	47.00	18.15	13.85	12.77	76.29
Complete Levallois blade	-	-	-	-	-	-
Broken Laminar blade	8.37	82.60	34.13	20.50	26.07	60.09
Broken Levallois blade	-	-	-	-	-	-
Flattening index (mT/mW)	Min.	Max.	Mean	S.D.	Med.	CV
Complete Laminar blade	0.16	0.59	0.38	0.10	0.38	27.24
Complete Levallois blade	-	-	-	-	-	-

Table 7.5. Metric data for complete and broken Laminar blades analysed (n=54)

Of all artefacts examined, only five artefacts feature retouch (Table 7.6) with three instances of a notched removal, one featuring a denticulated edge (of limitated invasiveness), and one example featuring continuous concave retouch with scaled morphology (Figure 7.4). Two of these examples originate from the outer sections of the elongated nodule (see below), exemplifying the use of artefacts throughout the technological sequence on-site. Most examples (n = 3) feature direct retouch on the dorsal surface, and are discontinuous in nature. In all examples, retouch coverage is low with only one example featuring retouch greater than 25%.

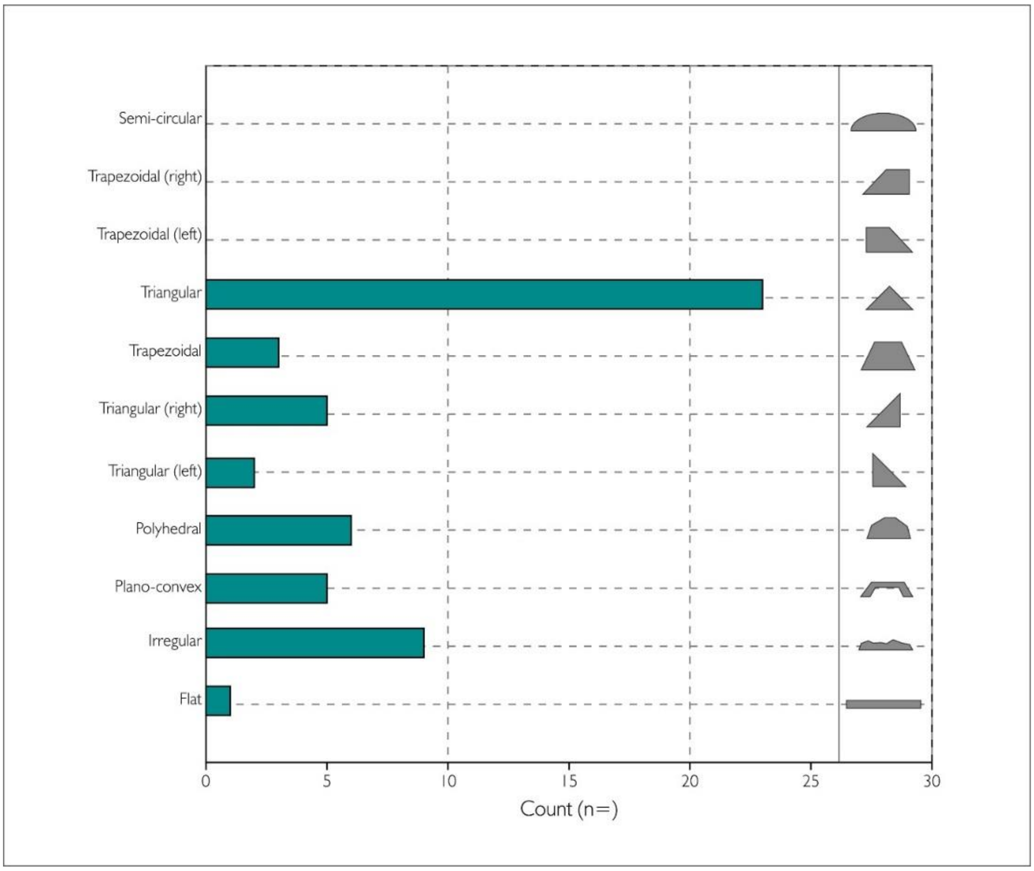


Figure 7.3. A bar-chart of the different cross-sections documented throughout Saint-Valery-sur-Somme (Dark Cyan: Laminar)

7.2.3.6. Refit Analysis

Eleven different refits are recorded throughout the assemblage. Five refits feature explicit evidence for technological blade products, with a further three (Remontage C/E/F) appearing to be in association. These five explicit refits (Remontage A/B/H/I/J) are discussed in detail below.

Remontage A: Remontage A (Figure 7.5) comprises of sixteen artefacts and represents the outer part of an elongated flint nodule and the initial stages of the blade sequence, including the removal of maintenance flakes. The inner core is not represented within the assemblage and may be absent for reasons noted above, or through redeposition (taphonomic factors). There is no evidence from thr morphology of the raw material, or the scar patterns exhibited that the core produced originates from a Levalloisian recurrent strategy. As no pieces exemplify ridge modification/cresting, it is assumed that following the removal of large flakes (TAB 1 and TAB19) the removals permitted the continuous exploitation of raw material around the circumference of the nodule. On the other extremity, a platform was created for the exploitation of at least five blades. As these are of relative depth it can be hypothesised that platform rejuvenation occurred. Two pieces on this refit exemplify retouch. The first (TAB 9), a complete blade, features cortex on its distal extremity, and ventral retouch with small flake removals on its distal right portion. This piece is the only piece within the sequence to feature facetting with all other pieces flat/plain in design exemplifying intent to produce and reduce through retouch. A further piece (TAB 2), another complete blade, also features ventral retouch, as a notch, on the medial left portion of the blade.

Saint-Valery-sur-Somme: retouch analysis (n=54)									
Presence of retouch:	Levallois (0)		Laminar (54)		Location of retouch:	Levallois (0)		Laminar (54)	
Yes	0	0.00%	5	9.26%	Proximal left	0	0.00%	0	0.00%
No	0	0.00%	49	90.74%	Proximal right	0	0.00%	0	0.00%
					Medial left	0	0.00%	1	1.85%
					Medial right	0	0.00%	2	3.70%
					Distal left	0	0.00%	1	1.85%
					Distal right	0	0.00%	3	5.56%
					Complete/continuous	0	0.00%	0	0.00%
Position of retouch:					Retouch coverage (%):				
Direct (dorsal)	0	0.00%	3	5.56%	No retouch	0	0.00%	0	0.00%
Inverse (ventral)	0	0.00%	2	3.70%	1-25%	0	0.00%	4	7.41%
Alternate	0	0.00%	0	0.00%	26-50%	0	0.00%	1	1.85%
Bifacial	0	0.00%	0	0.00%	51-75%	0	0.00%	0	0.00%
Crossed	0	0.00%	0	0.00%	76-99%	0	0.00%	0	0.00%
Proximal (i.e. burin)	0	0.00%	0	0.00%	Complete retouch	0	0.00%	0	0.00%
Presence of burination:					Distribution of retouch:				
Yes	0	0.00%	0	0.00%	Continuous	0	0.00%	2	3.70%
No	0	0.00%	54	100.00%	Discontinuous	0	0.00%	3	5.56%
					Partial	0	0.00%	0	0.00%
Form of retouched edge:					Morphology of retouch:				
Rectilinear	0	0.00%	0	0.00%	Scaled	0	0.00%	1	1.85%
Concave	0	0.00%	1	1.85%	Stepped	0	0.00%	0	0.00%
Convex	0	0.00%	0	0.00%	Sub-parallel	0	0.00%	0	0.00%
Single removal (notch/burin)	0	0.00%	3	5.56%	Parallel	0	0.00%	0	0.00%
Denticulate	0	0.00%	1	1.85%	Notch/Denticulate	0	0.00%	4	7.41%
Multiple	0	0.00%	0	0.00%	Burin	0	0.00%	0	0.00%

Table 7.6. Technological observations from Saint-Valery-sur-Somme (retouch attributes)

Remontage B: Remontage B is represented by eleven blades and blade fragments, and is from a deeper section of the technological sequence. This is assumed given the absence of cortex on any artefacts within the refit, and their relative diminished size. In contrast to Remontage A, all blades feature flaking on their butts with facetting clearly demonstrated on the majority (n=10) of examples. The facetting and small platforms further exemplify the fusion of Levalloisian techniques on a distinctly Laminar core volume management strategy. No evidence of retouch can be determined on any pieces throughout Remontage B. Further work through photogrammetric and algorithmic testing is essential to determine whether

Remontage B and Remontage A are from the same nodule. This would be the more parsinominous reason, given the evidence presented.

Remontage H: Remontage H (Figure 7.7) comprises of two unretouched artefacts, a short Laminar blade (TAB 81) and a medial fragment (TAB 37), corresponding to the dorsal surface of TAB 81. TAB 81 features a plano-convex cross-section, facetting on its butt and a bidirectional dorsal scar pattern. The medial fragment features a unidirectional dorsal scar pattern and an irregular cross-section.

Figure 7.4. Examples of retouched blades from Saint-Valery-sur-Somme

Remontage I: Remontage I (Figure 7.7) comprises of two unretouched blade fragments (TAB101/127, forming the reconstruction of a single cortical blade. The blade features a mixed platform, a feathered distal end, and a convergent unidirectional scar pattern. The breakage results from an anomalous quartz structure on the upper third portion of the blade's dorsal profile.

Remontage J: Remontage J (Figure 7.7) comprises of two unretouched blades, both featuring cortex on their dorsal surface. They appear to correspond with the main nodule, however this is through visual examination only and cannot be proven at this point. One blade (TAB 73) features a dihedral butt-type with a convergent bipolar flake scar pattern. The other (TAB 78) features facetting and exemplifies a convergent unidirectional flake scar pattern.

Figure 7.5. Refit 'Remontage A' from Saint-Valery-sur-Somme (for details see text)

Figure 7.6. Refit 'Remontage B' from Saint-Valery-sur-Somme (for details see text)

7.2.4. Hominin Behaviour at Saint-Valery-sur-Somme

The material at Saint-Valery-sur-Somme provides a snapshot of hominin behaviour within the landscape of northern France during the Early Middle Palaeolithic. The clear use of a Laminar core volume management strategy is documented, representing an ephemeral visit within the landscape to reduce an elongated nodule, transforming blanks for on-site use, and transporting reduced raw material off-site. In its reduction, the material highlights a proceduralised and extended use of a Laminar blade core with stereotyped elongated blades produced in number. Behaviours including the creation of platform maintenance flakes and the use of a bidirectional technique highlight the degree of core maintenance invested into the core, despite the lack of cresting, and casting doubt on its classification as unprepared. This core also highlights the use of Levallois-like behaviour and the plasticity of both sets of behaviour, through facetting and the 'peeling off' of material.

The lack of artefacts deeper in the technological sequence draws parallels with Core G of Stoneham's Pit (Scott, 2007, 2011). In-depth comparative studies and analyses may highlight further commonalities in the transformation of raw material, the fusion of both Levallois and Laminar techniques, and Neanderthal behaviour at the beginning of the Early Middle Palaeolithic. Further work on the configuration of refits, through three-dimensional recording and analyses, and further analyses incorporating the 'Levallois point' are necessary to test whether all material on-site does originate from one elongated nodule, or a series of nodules or blocks. Behavioural considerations of unretouched artefacts through use-wear analyses, strengthened may also further our understanding in Neanderthal behaviour within this ephemeral context.

Figure 7.7. Refits 'Remontage H' (left) and 'Remontage I' (right) from Saint-Valery-sur-Somme

7.3. Therdonne (N3)

7.3.1. Introduction and Overview of Investigations

The Middle Palaeolithic context of Therdonne (N3) is located in the Oise department, four kilometres south-east from the Late Middle Palaeolithic (MOIS 4) context of Beauvais 'La Justice' (Locht et al. 1995; Locht, 2004), and twelve kilometres north of Auteuil (Swinnen et al. 1996). Like many Middle Palaeolithic contexts in northern France, these contexts are relatively recent in their discovery, uncovered in 1998 during commercial archaeological work on the Route National 31 (RN31). The site itself is located at the foot of the Mont de Bourguillemont tertiary hill, and is within proximal distance of the Thérain River (Figure 7.8). The geographical position is, as Hérisson and Locht (2014) note, advantageous given its immediate access to the Oise valley.

Excavations revealed four different archaeological levels (classified N1 to N4), with the objective of the subsequent August-November 1999 rescue operation to document and record the N3 level, the densest and best preserved archaeological layer; it is this layer which is discussed in detail here. The N3 context is reliably dated to the end of MOIS 7 and early stages of MOIS 6, and is represented by 46,163 lithic artefacts (Hérisson and Locht, 2014). This context features a high concentration of Levallois points, however a variety of different core volume management systems are represented including bifacial, Pucheuil-type, discoidal, and importantly for this thesis the presence of Levallois technology, and the presence of technological blade strategies (Hérisson and Locht, 2014).

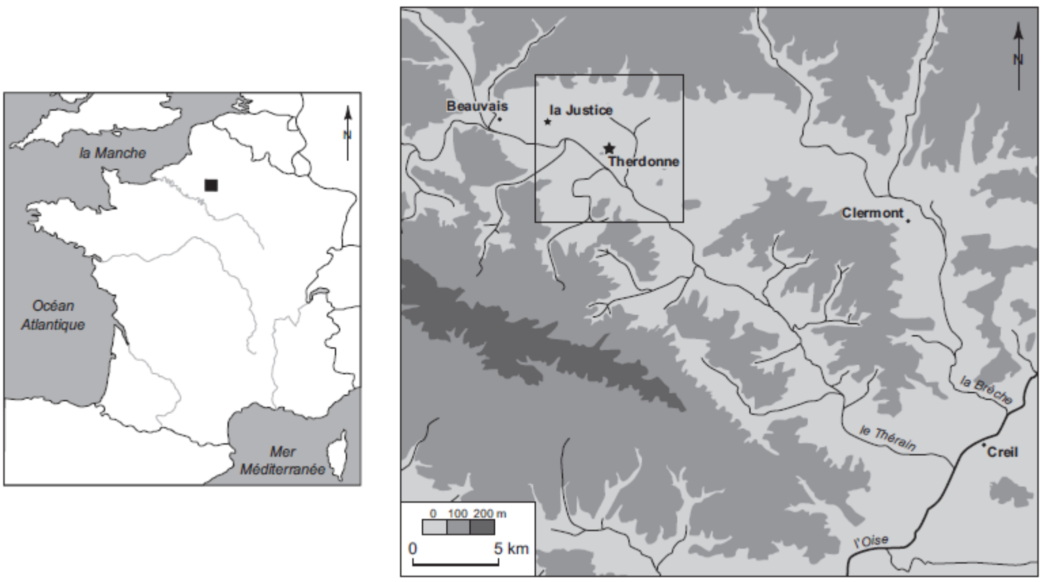


Figure 7.8. The geographical positioning of the Therdonne locale with other nearby Middle Palaeolithic contexts noted (Locht, 2010b)

Due to the nature of preservation within the N3 context, in part to the Eolian sands, a fine-scale archaeological record survives featuring a variety of other archaeologies. This includes the identification of five zones rich in micro-charcoal (Locht et al., 2000) in association with evidence for a small number of burned animal bones (ruminants), and burned limestone blocks (Hérisson and Locht, 2014). A large number of lithic artefacts (n=3333) have also been noted to have undergone thermoalteration including Levallois points (Hérisson et al., 2013). Organic residues, predominantly burned wood from a family of conifers within the nearby area, are also present within the N3 context (*ibid*. 569). In total twelve 'zones' have been identified throughout the Therdonne (N3) context.

Extensive analyses of the overall context were undertaken by David Hérrison, first as an initial overview of the N3 layer (Hérisson, 2007), and subsequently as a comparative study with the Early Middle Palaeolithic site of Biache-Saint Vaast (Hérisson, 2012). Following these, formal individual reports were published for the evidence for fire (Hérisson et al., 2013), and lithic artefacts (Locht et al., 2010b; Hérisson and Locht, 2014). These latter articles emphasise the nature technological diversity exemplified before the Late Middle Palaeolithic. Interestingly, the variety of strategies are noted as a response before noting the range of systems as a response to "...*la panoplie de besoins des Préhistoriques*." (Hérisson and Locht, 2014: 55); however, these needs are not elaborated on further.

All artefacts are currently stored at the *Centre de Recherches Archéologiques*, in the Amiens branch of INRAP.

7.3.2. Geological and Chronostratigraphic Background

In total fourteen horizons were documented (see Figure 7.9). Most artefacts within the N3 and upper N4 contexts originate from a homogeneous grey-black sand (unit GHS) with many small organo-ferric nodules documented. Locht et al. (2010b) note that artefacts derived from these contexts are non-patinated in nature, with little chemical alteration documented. This horizon is marked by wind-powered (eolian) reshuffled sands, is affected by humic pedogenesis, and features leaching of the overlying brown soils towards the lateral edges of unit SABH. As a result, many of the artefacts will be feature some degree of staining, however as this is localised it would be problematic to examine and interpret the relationship between stained or unstained artefacts. Overall this unit changes to a greyish-brown horizon of compact clay, with its base characterised by a series of small scattered pebbles. Through these descriptions, the occupational unit can be defined as a low energy environment with only minor disturbance.

Above the GHS unit are homogeneous glaucontic marine sedimentary sands (SV) with post-sedimentary alterations resulting from periglacial processes within the SLBL-SAR units. The proceeding SLBL unit above is characterised by a series of brown sandy loams to brown-grey finely non-bedded limestones; this context features significantly more cryoturbation and material originating from the N2 occupational layer(s).

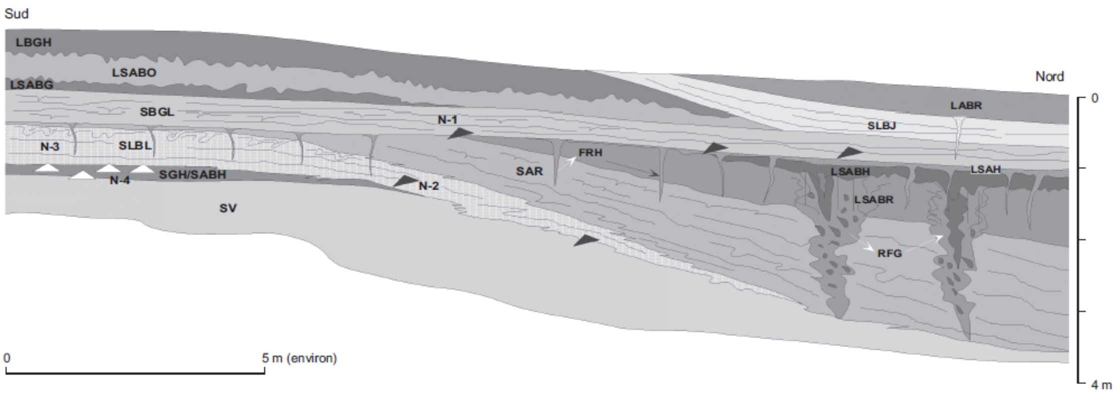


Figure 7.9. Morphostratigraphy of the Therdonne site (modified from Locht et al. 2010b)

Legend: LABR: Red-brown loam clay; SLBJ: Yellow-brown loamy sand; LBGH: Slightly greyish-brown humus; LSABO: Orange-brown sandy-clay loam; LSABG: Grayish-brown sandy-clay loam; SBGL: Silty grey-brown sand; LSAH: Greyish-brown sandy-clay loam with yellow stains, homogeneous, humus; LSABR-LSABH: Sandy-clay loam brown/red-brown; FRH: Humiferous filling; RFG: Heterogeneous large cracks; SAR: Clay-loam sands (brown to red-brown); SLBL: Finely bedded loamy sands (brown to brown-grey); SGH: Homogeneous grey-black sand; SABH: Sand in a compact greyish-brown clay horizon; SV: Glauconitic homogeneous green sand

White triangle: in-situ artefacts; Black triangle: redeposited artefacts

Locht et al. (2010b) note through regional sequences (Antoine, 1994, 2002) and correlated global paleoclimate records (Martinson et al., 1987; Petit et al., 1999) the N3 occupation level can be attributed to the terminal stages of MOIS 7a and beginning of MOIS 6 (c. 190,000-170,000 BP). This correlates with Thermoluminesence dating undertaken, which ages the Therdonne N3 layer to 178 ± 11 ka BP (Locht et al., 2010b). Therdonne (N3), given its stratigraphy and dating, therefore provides a fine-scale resolution for understanding Neanderthal technological and social behaviour within a credible chronological framework.

For a more in-depth description of the pedosedimetary sequence see Locht et al. (2010b).

7.3.3. Artefact Analysis

7.3.3.1. Treatment and Selection of the Collection(s)

All material studied was analysed at the *Centre de Recherches Archéologiques*, in the Picardy branch of INRAP during July 2015. All artefacts were present in conjunction with a FileMaker Pro Database file of all artefacts excavated, allowing an investigation into all known artefacts designated as stemming from a Laminar and Levallois technological blade strategy. As none of the artefacts analysed featured refits, all complete artefacts could be analysed through the geometric morphometric framework adopted.

7.3.3.2. Technological Overview

The sample analysed consists of sixteen artefacts and features evidence for both technological blade strategies (see Tables 7.7 and 7.8). Interesting the majority of material analysed are cores, representing 56.25% of all artefacts analysed. The number of cores over-represents the number of blades recovered in both blade strategies, and given the extent of the area excavated, and the extensive sieving undertaken through excavations (Locht. Pers. Comm.), it can be concluded that the blades or cores were taken or moved from their original area.

Confidence	Laminar core	Levallois core	Laminar product	Levallois product
A (definite)	2 (66.67%)	6 (100.00%)	4 (66.67%)	0 (0.00%)
B (probable)	1 (33.33%)	0 (0.00%)	1 (16.67%)	1 (100.00%)
C (possible)	0 (0.00%)	0 (0.00%)	1 (16.67%)	0 (0.00%)

Table 7.7. Confidence categories for the artefacts studied

7.3.3.3. Taphonomic History

Given the observed low energy environment (Hérisson and Locht, 2014) it was known that artefacts originating from the homogeneous grey-black sands had been subject to minimal disturbance. This is supported and reflected through primary analysis of the artefact's taphonomic history (Table 7.9).

Examination highlights that all artefacts have been subject to minimal mechanical damage, with no evidence for edge rolling, and only one example identified as featuring slight edge damage. The lack of scratching recorded may also support this finding. Only one artefact (TH G100 53) was recorded to feature staining, resulting from the localised leaching of the above brown soils. No other chemical alterations or evidence for patination was recorded.

Artefact	n	Percentage
Laminar blade (unretouched)	4	25.00%
Laminar blade (retouched)	0	0.00%
Laminar blade fragment (unretouched)	1	6.25%
Laminar blade fragment (retouched)	0	0.00%
Laminar crested blade (unretouched)	1	6.25%
Laminar crested blade (retouched)	0	0.00%
Laminar crested blade fragment (unretouched)	0	0.00%
Laminar crested blade fragment (retouched)	0	0.00%
Laminar blade core	3	18.75%
Levallois blade (unretouched)	1	6.25%
Levallois blade (retouched)	0	0.00%
Levallois blade fragment (unretouched)	0	0.00%
Levallois blade fragment (retouched)	0	0.00%
Levallois *éclat débordant* (unretouched)	0	0.00%
Levallois *éclat débordant* (retouched)	0	0.00%
Levallois *éclat débordant* fragment (unretouched)	0	0.00%
Levallois *éclat débordant* fragment (retouched)	0	0.00%
Levallois recurrent blade core	6	37.50%
Total:	16	100.00%

Table 7.8. Technological overview of the artefacts studied

Therdonne (N3): artefact condition (n=16)									
	Levallois (7)		Laminar (9)			Levallois (7)		Laminar (9)	
Whole/broken:					Degree of patination:				
Whole	6	85.71%	8	88.89%	Unpatinated	7	100.00%	9	100.00%
Broken	1	14.29%	1	11.11%	Lightly patinated	0	0.00%	0	0.00%
					Moderately patinated	0	0.00%	0	0.00%
					Heavily patinated	0	0.00%	0	0.00%
Degree of edge damage:					Degree of burning:				
No edge damage	7	100.00%	8	88.89%	Unburned	7	100.00%	9	100.00%
Lightly damaged	0	0.00%	1	11.11%	Lightly burned	0	0.00%	0	0.00%
Moderately damaged	0	0.00%	0	0.00%	Moderately burned	0	0.00%	0	0.00%
Heavily damaged	0	0.00%	0	0.00%	Heavily burned	0	0.00%	0	0.00%
Degree of rolling:					Portion/break:				
Unrolled	7	100.00%	9	100.00%	Complete	6	85.71%	8	88.89%
Lightly rolled	0	0.00%	0	0.00%	Proximal fragment	0	0.00%	1	11.11%
Moderately rolled	0	0.00%	0	0.00%	Medial fragment	0	0.00%	0	0.00%
Heavily rolled	0	0.00%	0	0.00%	Distal fragment	0	0.00%	0	0.00%
					Siret	0	0.00%	0	0.00%
					Other	1	14.29%	0	0.00%
Observations: Localised discolouring; one core break.									

Table 7.9. Detailed taphonomic characteristics of material analysed at Therdonne (N3)

Despite the extensive evidence documented throughout the N3 context no examples analysed feature characteristics of burning.

As noted above, as sieving was known to take place it can be assumed that the artefacts analysed are representative of the total amount of evidence for technological blade strategies within the 125m^2 area, excavated in 1999.

7.3.3.4. Raw Material

All artefacts throughout the assemblage are produced on three different types of raw material. These are all local in nature less than one kilometre away, adjacent to the River Thérain, as noted by Locht et al. (2010b). These are in order of abundance: 1) Campanian flints with cortex, 2) green Thanetian flint, and 3) Thanetian pebbles. All artefacts examined within this analysis are Campanian flint, with no examples of green Thanetian flint or pebbles recorded.

All examples of technological blade cores retain a small volume of cortex with less than 25% cortex coverage documented; only one core (Laminar) features a complete absence of cortex (Table 7.10). The cortex retained is unrolled, thin with minimal abrasion, and slight stained. This is true too for blades recorded, with only two examples featuring a low percentage of cortex coverage (1-24%). All others examples retain no cortex.

7.3.3.5. Technology: Extended Analysis

Within the Therdonne (N3) context, both Levallois and Laminar technological blade strategies are attested with evidence for six Levallois and three Laminar blade cores identified.

From the six Levallois blade cores noted, five (83.33%) adopt a recurrent unidirectional exploitation strategy with one further example exemplifying a recurrent bidirectional technique (Table 7.10). In their preparation, most cores feature a centripetal flaking strategy, with one example unidirectional in exploitation also featuring a unidirectional preparation strategy. The platforms are typically concave in nature, with minimal reworking needed, and in their exploitation core edges are abraded, with ridges delineated for exploitation. In their exploitation, two-to-four elongated scars are documented on avergage. The majority of removals are feathered, through end-types analysis on the core, with only one example demonstrating a series of hinged end-types towards the platform. In their exploitation, Levallois cores retain a small amount of cortex around its circumference, with extensive flaking and modification of the raw material noted throughout the material examined. One Levallois core break is noted, a medial break along the width of the core. No signs of mechanical damage are present, and as such appears to result from the knapping sequence.

Therdonne (N3): technological core observations (n=9)							
Core strategy:			Number of scars/core:				
Laminar	3	33.33%	Laminar: Min: 12, Max: 24, Mean: 16.67 (CV: 38.57)				
Levallois	6	66.67%	Levallois: Min: 8, Max: 22, Mean: 13.83 (CV: 35.24)				
			Number of elongated (L/W = 1.75>) scars/core:				
			Laminar: Min: 3, Max: 7, Mean: 5 (CV: 40.00)				
			Levallois: Min: 2, Max: 4, Mean: 2.83 (CV: 34.70)				
Levallois strategy:			Laminar core shape:				
Recurrent unidirectional	5	83.33%	Orthogonal/prismatic			1	66.67%
Recurrent bidirectional	1	16.67%	Semi-orthogonal/semi-prismatic			2	33.33%
			Pyramidal			0	0.00%
Laminar strategy:			Laminar platform preparation strategy:				
Semi-tournant/semi-rotating	3	100.00%	Single Lineal			1	33.33%
Tournant/rotating	0	0.00%	Multiple Lineal			2	66.66%
Facial	0	0.00%	Bidirectional			0	0.00%
Frontal	0	0.00%	3-way centripetal			0	0.00%
Multiple (combination)	0	0.00%	Centripetal			0	0.00%
			Lateral (left/right)			0	0.00%
			Perpendicular (left/right)			0	0.00%
Laminar core volume utilised:			Distal end-types:	Levallois (6)		Laminar (3)	
1-25%	0	0.00%	Feathered	6	100.00%	3	100.00%
26-50%	3	100.00%	Stepped	0	0.00%	0	0.00%
51-75%	0	0.00%	Hinged	1	16.67%	2	66.67%
76-100%	0	0.00%	Reverse Hinged	0	0.00%	0	0.00%
			Overshot	0	0.00%	0	0.00%
Levallois core preparation strategy:			Number of platforms:				
Unidirectional	1	16.67%	1	5	83.33%	0	0.00%
Bidirectional	0	0.00%	2	1	16.67%	3	100.00%
Convergent Unidirectional	0	0.00%	Cortex percentage:				
Centripetal	5	83.33%	Absent	0	0.00%	1	33.33%
Unidirectional left	0	0.00%	1-25%	6	100.00%	2	66.67%
Unidirectional right	0	0.00%	26-50%	0	0.00%	0	0.00%
Bidirectional lateral	0	0.00%	51-75%	0	0.00%	0	0.00%
Unidirectional distal	0	0.00%	76-100%	0	0.00%	0	0.00%

Table 7.10. Technological observations from Therdonne (N3) (core attributes)

In their morphology, all Levallois recurrent blade cores feature a high flattening index and are relatively standardised in their dimensions; low coefficient of variation (CV) values are documented throughout (see Table 7.11). Interestingly, given the presence of pronounced arrises, and an adequate core morphology exemplified, it appears that further elongated removals could have been exploited.

One thing worth emphasising is the presence of elongated flakes through Levallois recurrent convergent (point) cores. In a number of the recurrent convergent cores, preparatory flakes and the scars produced possess characteristics similarly to that of Levallois blades. This is discussed in more detail in Chapter 11.

In contrast to the evidence for Levallois technological blade cores, only one artefact resembling a Levallois blade was documented (see Table 7.12). The blade exemplifies characteristics of hard-hammer percussion with well-defined bulbar scar characteristics, features central-converging arrises, and is non-cortical in nature. It features many technological features akin of Levallois blades, including a plano-convex cross-section and a wide facetted butt. Given the high number of elongated and non-elongated scars, and the flake scar pattern, the blade can be characterised as a 'second order blade' *sensu* Böeda (1988a). As the artefact cannot be refitted, and the complex scar morphology, it cannot be ruled out at this point that the artefact is fortuitously elongated and not a technological blade. More information about the blade can be observed in Table 7.12.

In addition to the evidence for Levallois technological blade strategies, three Laminar blade cores are represented within the Therdonne (N3) context.

Weight (g)	Min.	Max.	Mean	S.D.	Med.	CV
Levallois	32.42	89.27	53.05	19.79	49.48	37.31
Laminar	40.51	185.4	103.77	74.18	85.40	71.48
Length (mm)	Min.	Max.	Mean	S.D.	Med.	CV
Levallois	53.65	84.86	69.78	13.63	68.80	19.53
Laminar	73.21	105.12	88.02	16.08	85.73	18.27
Width (mm)	Min.	Max.	Mean	S.D.	Med.	CV
Levallois	55.32	62.16	59.33	3.06	59.90	5.15
Laminar	47.92	73.06	61.71	12.75	64.16	20.66
Elongation index (L/W)	Min.	Max.	Mean	S.D.	Med.	CV
Levallois	0.97	1.37	1.17	0.19	1.11	15.87
Laminar	1.34	1.53	1.43	0.10	1.44	6.68
Thickness (mm)	Min.	Max.	Mean	S.D.	Med.	CV
Levallois	14.08	27.52	19.71	4.34	19.17	22.02
Laminar	38.99	49.88	45.53	5.77	47.73	12.67
Core flattening index (Thickness/Width)	Min.	Max.	Mean	S.D.	Med.	CV
Levallois	0.23	0.32	0.28	0.04	0.28	14.19
Laminar	0.47	0.55	0.52	0.04	0.53	8.11

Table 7.11. Metric data for complete cores analysed (n=9)

The first example is often illustrated in archaeological literature highlighting the existence of blade strategies within the Early Middle Palaeolithic (Koehler, 2011b, Locht et al., 2016), a heavily-discoloured semi-orthogonal bidirectional *semi-tournant* Laminar core (TH G100 53). This core features well-prepared platforms with multiple lineal removals, and is intensively flaked, with twenty-four scars larger than 10mm noted. Of these, seven scars are representative of previous blade removals in its final sequence.

Therdonne (N3): technological analysis (n=6)									
Percussion strategy:	Levallois (1)		Laminar (5)		Bulbar scar features:	Levallois (1)		Laminar (5)	
Hard	1	100.00%	5	100.00%	Well defined	1	100.00%	4	80.00%
Soft	0	0.00%	0	0.00%	Diffused	0	0.00%	1	20.00%
Mixed/Indeterminable	0	0.00%	0	0.00%	Absent/missing	0	0.00%	0	0.00%
Absent	0	0.00%	0	0.00%	Removed	0	0.00%	0	0.00%
Cortex percentage:					Number of dorsal scars:				
Absent	1	100.00%	3	60.00%	Absent	0	0.00%	0	0.00%
1-24%	0	0.00%	2	40.00%	1-2	0	0.00%	0	0.00%
25-49%	0	0.00%	0	0.00%	3-4	0	0.00%	4	80.00%
50-74%	0	0.00%	0	0.00%	5-6	0	0.00%	1	20.00%
75-99%	0	0.00%	0	0.00%	7+	1	100.00%	0	0.00%
Complete	0	0.00%	0	0.00%					
Number of elongated scars:					Number of ridges/arrises:				
Absent	0	0.00%	0	0.00%	Absent	0	0.00%	0	0.00%
1-2	0	0.00%	3	60.00%	1	1	100.00%	3	60.00%
3-4	1	100.00%	2	40.00%	2	0	0.00%	2	40.00%
5-6	0	0.00%	0	0.00%	3	0	0.00%	0	0.00%
7+	0	0.00%	0	0.00%	4	0	0.00%	0	0.00%
					5+	0	0.00%	0	0.00%
Dorsal ridge/arise shape:					Flake scar pattern:				
Singular	0	0.00%	3	60.00%	Unidirectional	0	0.00%	3	60.00%
Parallel	0	0.00%	1	20.00%	Centripetal	0	0.00%	1	20.00%
Irregular	0	0.00%	0	0.00%	3-way centripetal	1	100.00%	0	0.00%
Regular converging	0	0.00%	0	0.00%	Bidirectional	0	0.00%	0	0.00%
Regular diverging	0	0.00%	0	0.00%	Lateral left	0	0.00%	0	0.00%
Y-shape	0	0.00%	0	0.00%	Lateral right	0	0.00%	0	0.00%
Inverted Y-shape	0	0.00%	1	20.00%	Convergent unidirectional	0	0.00%	0	0.00%
Offset left/right	0	0.00%	0	0.00%	Convergent bidirectional	0	0.00%	0	0.00%
Partial	0	0.00%	0	0.00%	Convergent and perpendicular	0	0.00%	0	0.00%
Central converging	1	100.00%	0	0.00%	Double perpendicular	0	0.00%	0	0.00%
Absent	0	0.00%	0	0.00%	Straight and perpendicular	0	0.00%	1	20.00%
					Cortical	0	0.00%	0	0.00%
					Indeterminable	0	0.00%	0	0.00%
Distal end-type:					Butt type:				
Feathered	0	0.00%	2	40.00%	Plain/flat	0	0.00%	2	40.00%
Stepped	0	0.00%	2	40.00%	Dihedral	0	0.00%	0	0.00%
Hinged	0	0.00%	0	0.00%	Cortical	0	0.00%	0	0.00%
Overshot	1	100.00%	0	0.00%	Natural (but non-cortical)	0	0.00%	0	0.00%
Present but indeterminable	0	0.00%	0	0.00%	Marginal	0	0.00%	1	20.00%
Missing	0	0.00%	1	20.00%	Mixed	0	0.00%	2	40.00%
					Facetted	1	100.00%	0	0.00%
					Missing (proximal missing)	0	0.00%	0	0.00%
					Trimmed	0	0.00%	0	0.00%
					Chapeau de Gendarme	0	0.00%	0	0.00%
					Damaged/unidentifiable	0	0.00%	0	0.00%

Table 7.12. Technological observations from Therdonne (N3) (blade attributes)

No cortex is retained on the core's circumference or platform, further emphasising the degree of time and energy invested. A series of blades are then exploited around 50-60% of the core's circumference before being obstructed by a flat irregular face on one of the perimeter's faces. These removals are largely successful, with a high number of feathered distal end-types documented.

A second Laminar core (TH C100 109) is semi-orthogonal, converging to pyramidal in shape, and similarly to TH G100 53 is bidirectional in exploitation with two unworked concave platforms noted. On this example, fewer scars are present, with fourteen scars noted, five of which are suggestive of blade removals around the core's circumference. Again, most end-types are feathered in nature with only a small amount of hinged end-types documented, further exemplifying familiarity with the raw material. In the overall exploitation of blades, a *semi-tournant* technique is adopted, with a flat irregular surface, similarly to TH G100 53, hindering the full exploitation of the core's circumference. A small percentage of cortex (c. 10%) is also retained. See Table 7.10 for more information on TH C100 109.

The final example (TH U89 34) is also semi-orthogonal and further exemplifies the bidirectional exploitation of blades through a *semi-tournant* technique. This core, much smaller in shape, retains the most cortex of all three blade cores with roughly 20-25% cortex coverage documented on the core's circumference and on one core platform. This core is also less worked than the previous two examples, with twelve scars documented, four elongated from previous blade removals. This core, however, does feature the continuous exploitation of elongated around half of the core's circumference similarly to the other two blade cores.

Like the evidence for Levallois technological blade cores, all dimensions are fairly standardised, despite the low number of cores excavated with low CV values documented (Table 7.11). Furthermore, like Levallois blade cores documented, the presence of ridges, and adequate core morphologies demonstrate that further exploitations were possible.

In total, six end-products were documented: five Laminar blades (four complete and one proximal blade portion) and a crested blade. Most end-products (80.00%) feature clear use of a hard-hammer exploitation technique, with well-defined bulbar scar features, and are exploited to varying success with two examples of both feathered and stepped end-types, in addition to evidence for the proximal fragment. In their profile, the artefacts documented are twisted or straight, with triangular or trapezoidal cross-sections (Figure 7.10). Three artefacts retain no cortex, with two blades retaining less than 25% cortex.

Weight (g)	Min.	Max.	Mean	S.D.	Med.	CV
Complete Laminar blade	6.20	11.40	8.30	2.56	7.80	30.83
Complete Levallois blade*	20.20	20.20	20.20	0.00	20.20	0.00
Broken Laminar blade*	9.20	9.20	9.20	0.00	9.20	0.00
Broken Levallois blade	-	-	-	-	-	-
Length (mm)	Min.	Max.	Mean	S.D.	Med.	CV
Complete Laminar blade	39.89	67.12	54.51	11.19	55.51	20.53
Complete Levallois blade*	73.40	73.40	73.40	0.00	73.40	0.00
Broken Laminar blade*	53.23	53.23	53.23	0.00	53.23	0.00
Broken Levallois blade	-	-	-	-	-	-
Width (mm)	Min.	Max.	Mean	S.D.	Med.	CV
Complete Laminar blade	16.04	28.32	23.32	5.67	24.46	24.31
Complete Levallois blade*	38.24	38.24	38.24	0.00	38.24	0.00
Broken Laminar blade*	24.77	24.77	24.77	0.00	24.77	0.00
Broken Levallois blade	-	-	-	-	-	-
Elongation Index (L/W)	Min.	Max.	Mean	S.D.	Med.	CV
Complete Laminar blade	2.01	2.60	2.37	0.26	2.43	10.89
Complete Levallois blade*	1.92	1.92	1.92	0.00	1.92	0.00
Broken Laminar blade*	2.15	2.15	2.15	0.00	2.15	0.00
Broken Levallois blade	-	-	-	-	-	-
Thickness (mm)	Min.	Max.	Mean	S.D.	Med.	CV
Complete Laminar blade	5.28	8.42	6.51	1.52	6.18	0.00
Complete Levallois blade*	7.80	7.80	7.80	0.00	7.80	0.00
Broken Laminar blade*	8.06	8.06	8.06	0.00	8.06	0.00
Broken Levallois blade	-	-	-	-	-	-
Working edge/edge circum. (mm)	Min.	Max.	Mean	S.D.	Med.	CV
Complete Laminar blade	107.98	172.73	144.75	27.18	149.14	18.78
Complete Levallois blade*	203.78	203.78	203.78	0.00	203.78	0.00
Broken Laminar blade*	152.12	152.12	152.12	0.00	152.12	0.00
Broken Levallois blade	-	-	-	-	-	-
Cutting edge per weight (mm/g)	Min.	Max.	Mean	S.D.	Med.	CV
Complete Laminar blade	13.49	23.31	18.15	4.04	17.90	22.26
Complete Levallois blade*	10.09	10.09	10.09	0.00	10.09	0.00
Broken Laminar blade*	16.53	16.53	16.53	0.00	16.53	0.00
Broken Levallois blade	-	-	-	-	-	-
Flattening index (mT/mW)	Min.	Max.	Mean	S.D.	Med.	CV
Complete Laminar blade	0.37	0.65	0.49	0.12	0.47	25.19
Complete Levallois blade*	0.38	0.38	0.38	0.00	0.38	0.00

Table 7.13. Metric data for complete and broken Laminar and Levallois blades analysed (n=6); asterisk: individual example

Interestingly, despite the use of a largely bidirectional technique, none of the blades exemplify a bidirectional flake scar pattern, with three unidirectional, one centripetal, and one straight and perpendicular flake scar pattern observed. These blades may, therefore, represent blades earlier on in this or other blade sequences. In their preparation, no facetting is documented in contrast to the potential Levallois blade, with mixed and plain/flat butt-types present.

With respect to their shape and form, all Laminar blades feature a variety of cross-section morphologies (Figure 7.10), a similar flattening index to the experimental Laminar material and a mean higher elongation index in comparison to the sole Levallois example (Table 7.13).

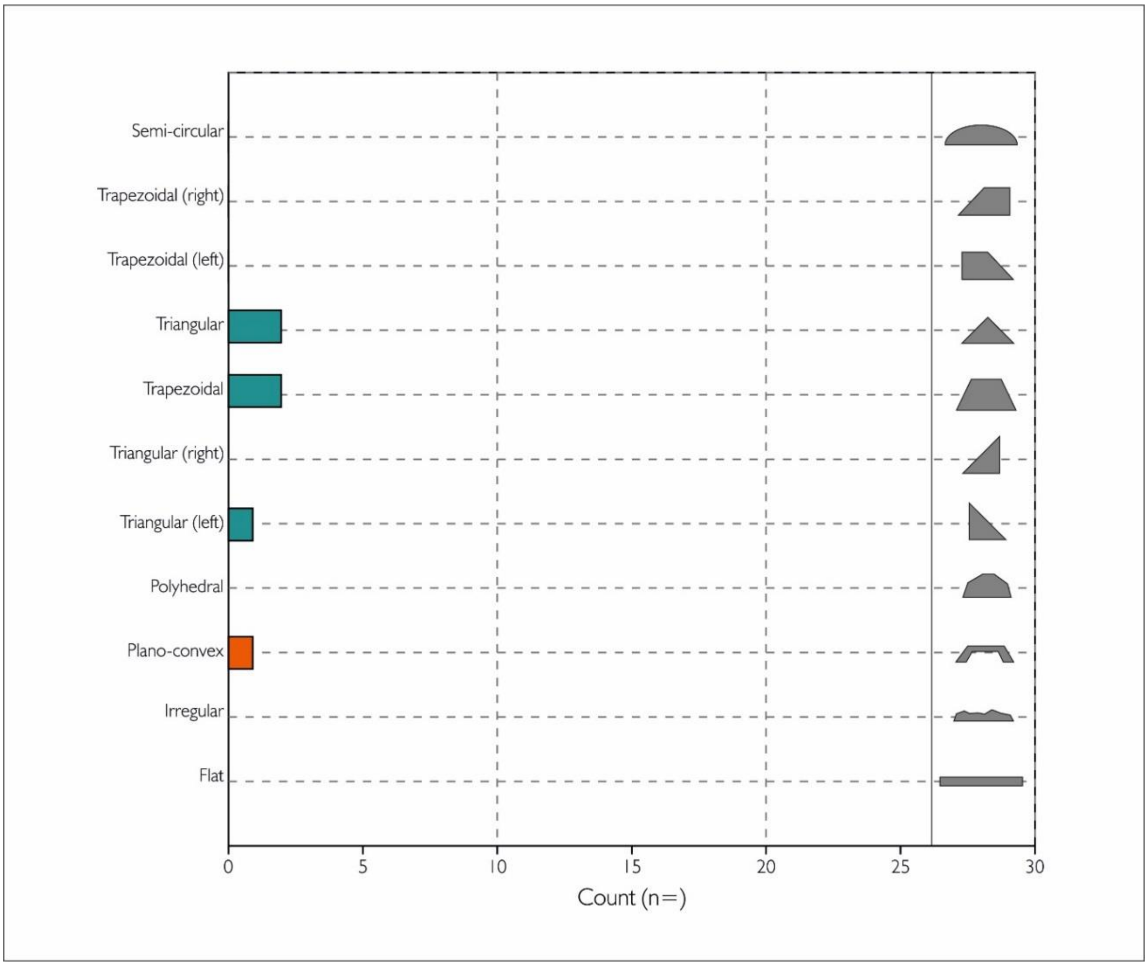


Figure 7.10. A bar-chart of the different cross-sections documented throughout Therdonne (N3) (Dark Cyan: Laminar; Orangered: Levallois)

In addition to the five Laminar blades, a further artefact was recorded suggestive of core preparation. Characteristics typical of a *lame à crête partielle* were recorded on one example, with irregular knapping and scars averaging between 10-15mm documented on one face of the dorsal profile. Cortex is also present, featured on the proximal left section of the blank. However, given the irregularity of the cross-section, the lack of scar coverage on the blank, and the absence of other crested blades, it is possible that this may be a damaged blade.

No evidence for retouch was documented. Furthermore, no refits for the material was recorded.

For examples of technological blade cores and blades see Figure 7.11, Figure 7.12 and Figure 7.13.

Figure 7.11. Examples from Therdonne (N3): three *semi-tournant* Laminar blade cores

Figure 7.12. Examples from Therdonne (N3): two recurrent unidirectional Levallois cores. Top: A recurrent unidirectional (point) core producing elongated flakes.
Bottom: A Levallois bidirectional blade core

Figure 7.13. Examples from Therdonne (N3). Top: Levallois 'second order' *sensu* Böeda (1988a) blade; Bottom right: Laminar technological blade; Bottom left: possible *lame à crête partielle.*

7.3.4. Hominin Behaviour at Therdonne (N3)

The archaeological evidence for hominin activity towards the end of the Early Middle Palaeolithic at Therdonne (N3) is extensive and plentiful, with a variety of differing behaviours documented. In addition to the lithic evidence, evidence for the use of fire with hearths, burned animal bones, and organic residue evidence is well documented, suggesting a longer occupation in contrast to Saint-Valery-sur-Somme. The archaeological evidence for technological blade strategies highlights a variety of behaviours and the degree of proceduralisation in their manufacturing, similarly to MOIS 5 examples. Evidence for both technological blade strategies is attested, despite the lack of evidence for blade products. This lack of association for both strategies strongly suggests their use off-site, and given the lack of Laminar cortical blades or *microdébitage* associated with these cores, it is credible to note that cores were prepared off-site, perhaps nearer to the raw material source on the edge of the River Thérain. Whereas a highly proceduralised method of Laminar production can be attested, the Levallois blade cores appear more fortuitous in contrast to other Early Middle Palaeolithic examples (see Chapter 8), and may represent a change in the approach and use of Levallois blades. This is discussed further in Chapter 10. Irrespective, the rich evidence for blade production documented at Therdonne (N3) provides a high-resolution of Neanderthal behaviour, and a corpus of evidence for cross-examining examples in both parts of the Middle Palaeolthic.

7.4. Fresnoy-au-Val (Série 1)

7.4.1. Introduction and Overview of Investigations

The Late Middle Palaeolithic site of Fresnoy-au-Val result from rescue excavations undertaken by INRAP during construction in 2002 of the Autoroute 29 (A29) motorway, between Amiens to the north-east and Neufchâtel-en-Bray to the north-west (Figure 7.14). The site itself is situated within the Somme Valley ten kilometres to the south-west of Amiens, where the River Selle and River Avre meet the River Somme, and one kilometre south-west of the contemporary MOIS 5 site of Revelles (Sellier, 2002; Guerlin, 2002). Other contemporary blade-bearing sites including Bettencourt-Saint-Ouen (discussed below), and Villiers-Bretonneux (Depaepe et al. 1997) are also within a forty-kilometre Euclidean radius.

Over five months in 2002, an area totalling 1120m^2 was excavated through manual and mechanical excavations. Two occupational layers were uncovered: Fresnoy-au-Val Série 2/N2 attributed through Luminescence dating of burned flint to MOIS 5c (106.8 ± 7.5 Ka BP), and Série 1/N1, dating through chronostratigraphic and pedosedimentary evidence to MOIS 5a (Locht, 2005).

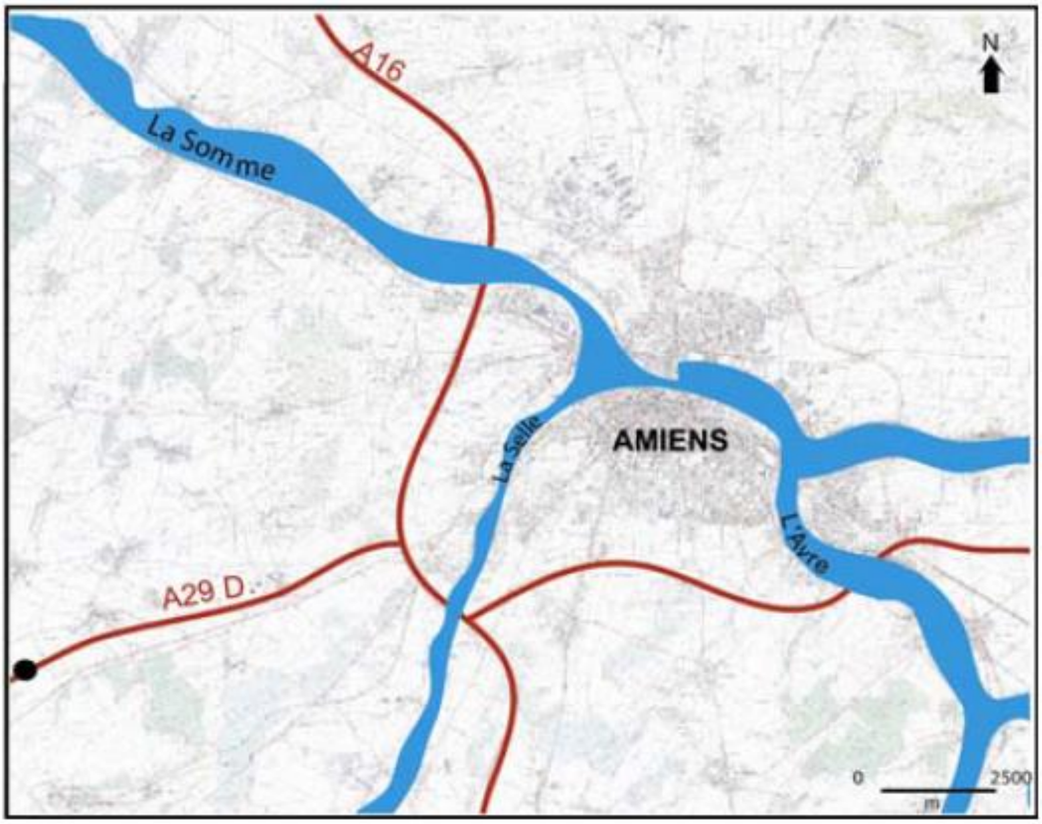


Figure 7.14. The site of Fresnoy-au-Val (black circle) in relation to the main Autoroutes and the three main rivers within the Amiens region (Locht, 2008)

5564 artefacts were recorded in total, with 1280 artefacts recovered from the Série 2 context, and 4284 contexts recovered from Série 1 (Goval and Locht, 2009). Série 2 featured core volume management strategies oriented towards the production of Levallois and pseudo-Levallois points, migrating platform core strategies, and Levallois preferential flaking (Locht, 2008). Evidence for irregular elongated flakes is demonstrated within Série 2, however there is no evidence for stereotyped products or, Levallois recurrent and Laminar blade cores. Unipolar convergent (point) cores are also present, with features typical of Laminar cores (circumference exploitation) however these products appear fortuitous and are largely non-stereotyped in nature. Série 1, in contrast, features considerably more evidence for all Levallois recurrent flaking strategies (flake/elongated/point), and considerable wealth of evidence for Laminar technological blade strategies. Unlike contexts like Bettencourt-Saint-Ouen and Le Rissori, both documented within this thesis, no multi-temporal evidence for blade-bearing contexts is documented.

Following the 2002 excavations, the site's report was reviewed first in 2006 (Locht, 2006) before formal publication two years later (Locht, 2008). Extensive lithic analyses from Locht et al. (2008), and (Goval, 2008) were also developed and published a year later (Goval and Locht, 2009). Discussions on Fresnoy-au-Val (Série 1) have focused on its proximity to other neighbouring MOIS 5a contexts (Locht, 2005; Goval and Locht, 2009), the existence of its blade and point components (Goval, 2008; Goval and Locht, 2009), and its inclusion in discussions of strict contemporaneity as an example supporting the Fluvial Deposition Hypothesis (Locht et al., 2010a) and the Northwest Technocomplex (Locht et al. 2010a).

All artefacts are currently stored at the *Centre de Recherches Archéologiques*, in the Amiens branch of INRAP.

7.4.2. Geological and Chronostratigraphic Background

The occupational layers are positioned on a north-east facing slope of a small valley, opposite a chalk slope (Antoine, 1993). Excavations and analyses (Antoine and Deschodt in Locht, 2008) highlighted the existence of twenty-one stratigraphic units within the Fresnoy-au-Val sequence (Figure 7.15). Only units three to seven are noted here given their direct pertinence to the Fresnoy-au-Val Série 1/Série 2 evidence. Full microstratigraphic details of the complete Fresnoy-au-Val sequence are documented in Antoine and Deschodt in Locht (2008).

Série 1 is situated in unit 4, a dark gray-brown silt (10 YR 4/3 to 3/3), compact and lamellar in structure, and features scattered gravels and concretions of iron-manganese. At its base, unit 4 is marked by flint pebbles, cryoclastic in nature. This unit has been attributed to the *Saint-Sauflieu 1 Grey Forest Soil layer*, a characteristic of the Odderade interstadial (MOIS 5a). Characterised by boreal forests dominated by pine and birch, other archaeological levels included within this same pedosedimentary unit include Séclin (Tuffreau et al., 1994), Mauquenchy (Locht et al., 2001, 2013b), Sains-en-Amienois (Tuffreau, 2001), and Bettencourt-Saint-Ouen (Locht, 2002).

The above layer (unit 5) is a light-grey to brown homogenous layer with scattered flints, representing a colluvial humiferous layer fed by the underlying horizons. This corresponds to other isohumic soils noted (Antoine, 1989; Munaut 1998; Tuffreau, 2001; Locht et al., 2001) and marks the end of MOIS 5a. The three above isohumic soils (units 5/6/7) all demonstrate dramatic climatic instability with their soils representing a dryer loessic, colder and more continental climate (Locht et al., 2010a).

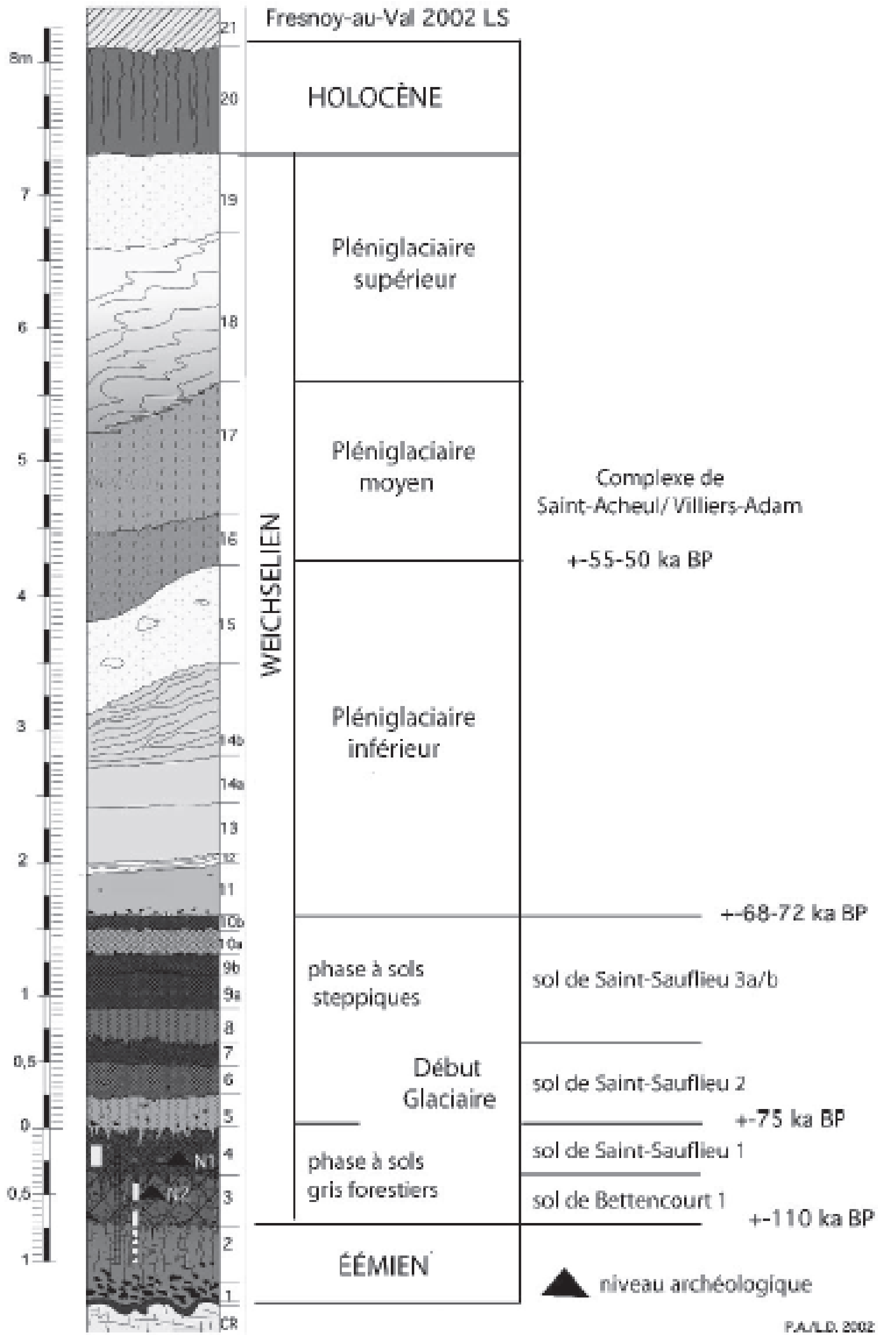


Figure 7.15. The pedosedimentary sequence for Fresnoy-au-Val (Goval and Locht, 2009)

The underlying layer (unit 4) is a greyish brown silt (10 YR 5/4 - 4/4), characterised by black spots, resulting from bioturbation, scattered gravels, and abundant concretions of iron-manganese. It is this layer which contains the evidence for Série 2 and corresponds to the Bettencourt Soil, a constructed soil, created from gradual colluvial deposition under forest cover (Antoine, 2002). Locht et al. (2010a: 330) notes that on a slope context, the Bettencourt soil acts as a record for climatic improvement, corresponding to the Brörup interstadial.

These two contexts are assumed to result from a low energy environment, resulting from slow colluvial build-up under forest cover, and as such are believed to not disrupt the archaeological levels (Antoine, 2002; Locht, 2008). However, given its position within a slope context, and an inclination of fourteen-to-seventeen degrees calculated (Locht, 2008), some displacement may occur. Due to the decarbonisation of the sediment, no zooarchaeological or osteological remains were recovered.

7.4.3. Artefact Analysis

7.4.3.1. Treatment and Selection of the Collection(s)

All material studied was archived at the *Centre de Recherches Archéologiques* in INRAP, Amiens, and studied in conjunction with other contexts discussed previously and subsequently. All artefacts were present and tabulated as a FileMaker Pro Database, allowing a thorough investigation of all necessary artefacts. Due to time constraints, one-hundred of the one-hundred and sixteen Laminar artefacts in the total dataset was analysed, in addition to several artefacts which demonstrate the existence of Levallois recurrent elongated strategies. As the latter were not catalogued as such an examination of all Levallois material was essential. Artefacts which were glued were not subject to geometric morphometric analyses. Sixty-one *éclats débordants* were observed, and as these could derive from several different Levallois core-types it would be problematic to assume that they are of a Levallois blade strategy. Given the amount of time necessary to examine such, these were excluded from analyses.

7.4.3.2. Technological Overview

The dataset consists of one-hundred and twenty artefacts (see Table 7.14), originating from a largely Laminar technological blade strategy (83.33%). Of these artefacts, ninety-five out of hundred were confidently classified as stemming from a Laminar technological blade strategy, with a further five probable examples of blade *débitage* (Table 7.15). Cores are extensively worked, are initiated through cresting/semi-cresting and mainly feature a *semi-tournant* core volume management system. Examples also exist within the assemblage where Laminar technological blade behaviours have been tested on smaller elongated nodules to limited success. Levallois *débitage* was more difficult to identify, and while there are examples which demonstrate examples of elongated Levallois products, almost half of artefacts (40.00%) were not confidently attributed to demonstrating the stereotyping of elongated material. In their totality, both strategies feature minimal reworking with only three examples of blades retouched, all discontinuous and fortuitous in nature.

Artefact	n	Percentage
Laminar blade (unretouched)	51	42.50%
Laminar blade (retouched)	2	1.67%
Laminar blade fragment (unretouched)	25	20.83%
Laminar blade fragment (retouched)	0	0.00%
Laminar crested blade (unretouched)	7	5.83%
Laminar crested blade (retouched)	0	0.00%
Laminar crested blade fragment (unretouched)	0	0.00%
Laminar crested blade fragment (retouched)	0	0.00%
Laminar blade core	15	12.50%
Levallois blade (unretouched)	13	10.83%
Levallois blade (retouched)	1	0.83%
Levallois blade fragment (unretouched)	1	0.83%
Levallois blade fragment (retouched)	0	0.00%
Levallois *éclat débordant* (unretouched)	0	0.00%
Levallois *éclat débordant* (retouched)	0	0.00%
Levallois *éclat débordant* fragment (unretouched)	0	0.00%
Levallois *éclat débordant* fragment (retouched)	0	0.00%
Levallois recurrent blade core	5	4.17%
Total:	120	100.00%

Table 7.14. Technological overview of the artefacts studied

Confidence	Laminar core	Levallois core	Laminar product	Levallois product
A (definite)	13 (92.86%)	3 (60.00%)	82 (96.47%)	9 (60.00%)
B (probable)	2 (7.14%)	2 (40.00%)	3 (3.53%)	6 (40.00%)
C (possible)	0 (0.00%)	0 (0.00%)	0 (0.00%)	0 (0.00%)

Table 7.15. Confidence categories for the artefacts studied

Various refits were recorded allowing a full investigation of the different operational sequences documented on-site.

7.4.3.3. Taphonomic History

Given the stratigraphic positioning of the Série 1 context in the Saint-Sauflieu 1 Grey Forest Soil layer, it was assumed that artefacts would feature minimal mechanical damage, or movement. This is supported and reflected through the taphonomic history of the artefacts analysed (Table 7.16).

Fresnoy-au-Val (Série 1): artefact condition (n=120)									
	Levallois (20)		Laminar (100)			Levallois (20)		Laminar (100)	
Whole/broken:					Degree of patination:				
Whole	19	95.00%	75	75.00%	Unpatinated	19	95.00%	97	97.00%
Broken	1	5.00%	25	25.00%	Lightly patinated	1	5.00%	3	3.00%
					Moderately patinated	0	0.00%	0	0.00%
					Heavily patinated	0	0.00%	0	0.00%
Degree of edge damage:					Degree of burning:				
No edge damage	19	95.00%	99	99.99%	Unburned	20	100.00%	100	100.00%
Lightly damaged	1	5.00%	1	1.00%	Lightly burned	0	0.00%	0	0.00%
Moderately damaged	0	0.00%	0	0.00%	Moderately burned	0	0.00%	0	0.00%
Heavily damaged	0	0.00%	0	0.00%	Heavily burned	0	0.00%	0	0.00%
Degree of rolling:					Portion/break:				
Unrolled	19	95.00%	99	99.00%	Complete	19	95.00%	75	75.00%
Lightly rolled	1	5.00%	1	1.00%	Proximal fragment	1	5.00%	12	12.00%
Moderately rolled	0	0.00%	0	0.00%	Medial fragment	0	0.00%	5	5.00%
Heavily rolled	0	0.00%	0	0.00%	Distal fragment	0	0.00%	8	8.00%
					Siret	0	0.00%	0	0.00%
Observations: Predominant use of one type of flint; no other surface damage evident.									

Table 7.16. Detailed taphonomic characteristics of material analysed at Fresnoy-au-Val (Série 1).

Both Levallois and Laminar technological blade strategies feature minimal evidence for mechanical damage, with only two examples, one in each strategy, to feature slight edge damage and rolling. Furthermore, no other surface damage (e.g. scratching) could be observed on any examples. Minimal evidence for staining or patination is observed, with only five artefacts featuring light patination.

No examples of either technological blade strategy were observed to feature characteristics typical of burning.

7.4.3.4. Raw Material

All material used is local in origin with accessible and available high-quality flint nearby within the Picard Plateau. Throughout the two contexts, Fabre (1999) notes that a variety of flints were observed, all Coniacian, Santonian, and Turonian in nature. Of those confidently identified (n=30), just under half (43.33%) are Santonian D in type, with 36.66% of all material Coniacian B/C in nature. Others were identified as being exogenous.

The majority of technological blade cores (85.00%, n=17) retain less than 50% cortex (see Table 7.17). The cortex is typically fresh with little weathering, thin, and features minimal evidence for rolling and/or abrasion. This too is true for the small number which retain cortex among the end-products (see more below).

Throughout the blade assemblage, a variety of different raw material morphologies were exploited with thin elongated nodules, pebbles and much larger blocks exploited (Goval and Locht, 2009). Despite this, the majority of cores recorded are of similar shape and retain some degree of standardisation (see more below).

7.3.3.5. Technology: Extended Analysis

Within Fresnoy-au-Val (Série 1) the production of stereotyped elongated products is primarily through a Laminar core volume management strategy, as noted previously (Goval and Locht, 2009).

In their initiation platforms are minimally prepared, with sixteen platforms (of the total twenty-two platforms) featuring single lineal flaking strategies, with large flat unmodified platforms created; six platforms demonstrate multiple lineal flaking strategy. Evidence of cresting and semi-cresting is exemplified throughout with seven examples documented. Of these, six feature regular knapping longitudinally down the ridge of the blade, with scars ranging in size between fifteen to twenty-five millimetres, and three examples featuring scar-width averages exceeding twenty-five millimetres (Table 7.19). While the majority of crested blades feature regular consistent flaking, three examples feature knapping down only one face of the blade (*lame á demi-crête*), with a further two examples featuring less than 50% of the ridge knapped (*lame á crête partielle*), suggesting a more fortuitous approach to cresting was also adopted. At the present time, it is unknown whether these more fortuitous examples represent core initiation or rejuvenation crested blades. No examples of crested blades feature retouch, echoing the overall blade component of the assemblage.

Fresnoy-au-Val (Série 1): technological core observations (n=20)							
Core strategy:			Number of scars/core:				
Laminar	15	75.00%	Laminar: Min: 6, Max: 18, Mean: 11.20 (CV: 34.94)				
Levallois	5	25.00%	Levallois: Min: 8, Max: 19, Mean: 13.93 (CV: 26.43)				
			Number of elongated (L/W = 1.75>) scars/core:				
			Laminar: Min: 2, Max: 6, Mean: 4.06 (CV: 27.04)				
			Levallois: Min: 2, Max: 8, Mean: 3.50 (CV: 64.52)				
Levallois strategy:			Laminar core shape:				
Recurrent unidirectional	1	20.00%	Orthogonal/prismatic			1	6.67%
Recurrent bidirectional	4	80.00%	Semi-orthogonal/semi-prismatic			12	80.00%
			Pyramidal			2	13.33%
Laminar strategy:			Laminar platform preparation strategy:				
Semi-tournant/semi-rotating	14	93.33%	Single Lineal			16	72.73%
Tournant/rotating	0	0.00%	Multiple Lineal			6	27.27%
Facial	1	6.67%	Bidirectional			0	0.00%
Frontal	0	0.00%	3-way centripetal			0	0.00%
Multiple (combination)	0	0.00%	Centripetal			0	0.00%
			Lateral (left/right)			0	0.00%
			Perpendicular (left/right)			0	0.00%
Laminar core volume utilised:			Distal end-types:	Levallois (5)		Laminar (15)	
1-25%	0	0.00%	Feathered	5	100.00%	15	62.50%
26-50%	15	100.00%	Stepped	1	20.00%	5	20.83%
51-75%	0	0.00%	Hinged	0	0.00%	4	16.67%
76-100%	0	0.00%	Reverse Hinged	0	0.00%	0	0.00%
			Overshot	0	0.00%	0	0.00%
Levallois core preparation strategy:			Number of platforms:				
Unidirectional	0	0.00%	1	1	20.00%	6	40.00%
Bidirectional	2	40.00%	2	4	80.00%	9	60.00%
Convergent unidirectional	0	0.00%	Cortex percentage:				
Centripetal	3	60.00%	Absent	1	20.00%	2	13.33%
Unidirectional left	0	0.00%	1-25%	3	60.00%	11	73.33%
Unidirectional right	0	0.00%	26-50%	1	20.00%	2	13.33%
Bidirectional lateral	0	0.00%	51-75%	0	0.00%	0	0.00%
Unidirectional distal	0	0.00%	76-100%	0	0.00%	0	0.00%

Table 7.17. Technological observations from Fresnoy-au-Val (Série 1) (core attributes)

The raw material is then knapped through both unidirectional and bidirectional exploitation, with three-fifths of all Laminar cores featuring bidirectional exploitation through opposed platforms (see Table 7.18). Of the fifteen Laminar blade cores, fourteen feature a *semi-tournant* exploitation strategy, typically opposed to a flat unmodified surface; these various aspects create a semi-orthogonal/semi-prismatic core morphology. In the exploitation of blades, the average core retains four scars typical of blade removals, with most successful in nature. All cores exemplify feathered end-type scars, however five examples feature stepped end-types, and four exemplifying hinged end-types.

The blades produced feature characteristics of hard-hammer percussion, with over half (55.13%) of examples exhibiting well-defined and pronounced bulbar scar features (Table

7.20). The number of dorsal scars (and number of elongated scars), in addition to the number of ridges highlight that the blades are relatively standardised, and as just under three-quarters (73.08%) of Laminar blades retain no context, the blades produced are relatively 'deep' into the operational sequence. With most blades featuring a unidirectional flake scar pattern (58.97%), contrasting the negative scars on most blade cores it can be suggested that the cores either start off unidirectional, and a bidirectional system is then adopted, or unidirectional cores are more intensively exploited.

Weight (g)	Min.	Max.	Mean	S.D.	Med.	CV
Levallois	114.29	287.75	223.33	70.78	256.65	31.69
Laminar	64.43	423.83	200.64	125.34	144.40	62.47
Length (mm)	Min.	Max.	Mean	S.D.	Med.	CV
Levallois	75.34	119.72	91.87	17.56	86.90	19.11
Laminar	70.48	154.58	104.02	27.62	100.77	26.55
Width (mm)	Min.	Max.	Mean	S.D.	Med.	CV
Levallois	68.83	99.83	85.23	10.90	87.03	12.79
Laminar	35.37	97.84	63.64	18.41	61.73	28.94
Elongation index (L/W)	Min.	Max.	Mean	S.D.	Med.	CV
Levallois	0.76	1.54	1.09	0.29	1.00	25.99
Laminar	0.77	2.68	1.71	0.47	1.63	27.45
Thickness (mm)	Min.	Max.	Mean	S.D.	Med.	CV
Levallois	23.90	45.80	37.06	8.90	40.67	24.01
Laminar	25.92	63.20	43.94	11.43	44.28	26.01
Core flattening index (thickness/width)	Min.	Max.	Mean	S.D.	Med.	CV
Levallois	0.31	0.63	0.44	0.12	0.43	27.25
Laminar	0.53	1.34	0.73	0.22	0.68	30.33

Table 7.18. Metric data for complete cores analysed (n=20)

Fresnoy-au-Val (Série 1) technological data: crested blades (7)		
Crested blade scar percentage:		
<50% (*lame à crête partielle*)	2	28.57%
>50% (*lame à crête*)	5	71.43%
Crested blade scar regularity:		
Regular	6	85.71%
Irregular	1	14.29%
Number of crested sides knapped:		
One (*lame à demi-crête*)	3	42.86%
Two (*lame à crête*)	4	57.14%
Average width of scars:		
> 25 mm	3	42.86%
25-20 mm	2	28.57%
20-15 mm	2	28.57%
15-10 mm	0	0.00%
< 10 mm	0	0.00%
Presence of retouch:		
Yes	0	0.00%
No	7	100.00%
Retouch information: No retouch or modification following crested blade production		

Table 7.19. Technological observations from Fresnoy-au-Val (Série 1) (crested blade attributes)

Interestingly, extensive preparation before exploitation is demonstrated by the presence of facetting on many of the Laminar blades analysed (n=17). The blades produced are also of relative standardisation, with low CV values (Table 7.21) and are most commonly triangular in cross-section (Figure 7.16). Despite this, many blades feature hinging (20.51%) or missing distal end-types (19.23%).

Fresnoy-au-Val (Série 1): technological blade analysis (n=93)									
Percussion strategy:	Levallois (15)		Laminar (78)		Bulbar scar features:	Levallois (15)		Laminar (78)	
Hard	15	100.00%	60	76.92%	Well defined	10	66.67%	36	46.15%
Soft	0	0.00%	0	0.00%	Diffused	5	33.33%	20	25.64%
Mixed/Indeterminable	0	0.00%	18	23.08%	Absent/missing	0	0.00%	15	19.23%
Absent	0	0.00%	0	0.00%	Removed		0.00%	7	8.97%
Cortex percentage:					Number of dorsal scars:				
Absent	14	93.33%	57	73.08%	Absent	0	0.00%	0	0.00%
1-24%	1	6.67%	17	21.79%	1-2	2	13.33%	12	15.38%
25-49%	0	0.00%	4	5.13%	3-4	5	33.33%	53	67.95%
50-74%	0	0.00%	0	0.00%	5-6	4	26.67%	11	14.10%
75-99%	0	0.00%	0	0.00%	7+	4	26.67%	2	2.56%
Complete	0	0.00%	0	0.00%					
Number of elongated scars:					Number of ridges/arrises:				
Absent	0	0.00%	0	0.00%	Absent	0	0.00%	41	52.56%
1-2	8	53.33%	35	44.87%	1	13	86.67%	36	46.15%
3-4	7	46.67%	42	53.85%	2	2	13.33%	1	1.28%
5-6	0	0.00%	1	1.28%	3	0	0.00%	0	0.00%
7+	0	0.00%	0	0.00%	4	0	0.00%	0	0.00%
					5+	0	0.00%	0	0.00%
Dorsal ridge/arise shape:					Flake scar pattern:				
Singular	3	20.00%	16	20.51%	Unidirectional	6	40.00%	46	58.97%
Parallel	0	0.00%	11	14.10%	Centripetal	0	0.00%	1	1.28%
Irregular	0	0.00%	5	6.41%	3-way centripetal	0	0.00%	2	2.56%
Regular converging	1	6.67%	3	3.85%	Bidirectional	6	40.00%	18	23.08%
Regular diverging	0	0.00%	4	5.13%	Lateral left	0	0.00%	0	0.00%
Y-shape	4	26.67%	23	29.49%	Lateral right	0	0.00%	0	0.00%
Inverted Y-shape	2	13.33%	8	10.26%	Convergent unidirectional	1	6.67%	1	1.28%
Offset left/right	3	20.00%	1	1.28%	Convergent bidirectional	1	6.67%	2	2.56%
Partial	2	13.33%	4	5.13%	Convergent and perpendicular	0	0.00%	0	0.00%
Central converging	0	0.00%	3	3.85%	Double perpendicular	0	0.00%	1	1.28%
Absent	0	0.00%	0	0.00%	Straight and perpendicular	0	0.00%	7	8.97%
					Cortical	0	0.00%	0	0.00%
					Indeterminable	1	6.67%	0	0.00%
Distal end-type:					Butt type:				
Feathered	11	73.33%	34	43.59%	Plain/flat	2	13.33%	13	16.67%
Stepped	0	0.00%	8	10.26%	Dihedral	0	0.00%	1	1.28%
Hinged	2	13.33%	16	20.51%	Cortical	0	0.00%	1	1.28%
Overshot	1	6.67%	5	6.41%	Natural (but non-cortical)	0	0.00%	0	0.00%
Present but indeterminable	0	0.00%	0	0.00%	Marginal	3	20.00%	14	17.95%
Missing	1	6.67%	15	19.23%	Mixed	1	6.67%	16	20.51%
					Facetted	9	60.00%	17	21.79%
					Missing (proximal missing)	0	0.00%	14	17.95%
					Trimmed	0	0.00%	1	1.28%
					Chapeau de Gendarme	0	0.00%	0	0.00%
					Damaged/unidentifiable	0	0.00%	1	1.28%

Table 7.20. Technological observations from Fresnoy-au-Val (Série 1) (blade attributes)

Only two examples feature modification following detachment. These are fortuitous, discontinuous, and are not heavily worked with low coverage (see Table 7.22).

There is also a large amount of evidence for the adoption of Levallois unidirectional and bidirectional elongated recurrent and convergent (point) techniques. From these, five Levallois cores exemplify dorsal scar patterns typical of recurrent elongated products, however in their nature these are rather informal and fortuitous in comparison, with other examples within the Middle Palaeolithic.

Weight (g)	Min.	Max.	Mean	S.D.	Med.	CV
Complete Laminar blade	2.34	154.98	25.83	27.80	15.65	107.62
Complete Levallois blade	17.20	76.43	43.96	18.97	41.81	41.15
Broken Laminar blade	2.10	59.30	11.41	13.40	7.00	117.49
Broken Levallois blade*	30.20	30.20	30.20	0.00	30.20	0.00
Length (mm)	Min.	Max.	Mean	S.D.	Med.	CV
Complete Laminar blade	37.7	147.93	79.37	26.54	72.51	33.44
Complete Levallois blade	67.68	109.95	89.04	13.28	88.41	14.91
Broken Laminar blade	31.11	106.63	55.06	19.06	51.48	34.61
Broken Levallois blade*	81.78	81.78	81.78	0.00	81.78	0.00
Width (mm)	Min.	Max.	Mean	S.D.	Med.	CV
Complete Laminar blade	10.68	64.62	31.28	10.47	30.30	33.40
Complete Levallois blade	40.51	67.39	49.60	7.95	49.38	16.03
Broken Laminar blade	15.62	49.77	27.07	9.71	26.65	35.87
Broken Levallois blade*	44.65	44.65	44.65	0.00	44.64	0.00
Elongation Index (L/W)	Min.	Max.	Mean	S.D.	Med.	CV
Complete Laminar blade	1.76	4.19	2.62	0.63	2.43	24.09
Complete Levallois blade	1.76	2.29	1.97	0.18	1.89	9.01
Broken Laminar blade	1.44	2.87	2.06	0.31	2.06	15.17
Broken Levallois blade*	1.83	1.83	1.83	0.00	1.83	0.00
Thickness (mm)	Min.	Max.	Mean	S.D.	Med.	CV
Complete Laminar blade	2.95	21.85	7.87	3.29	7.24	41.83
Complete Levallois blade	5.10	12.96	8.98	2.10	8.57	23.41
Broken Laminar blade	4.18	16.53	9.03	3.37	7.92	37.37
Broken Levallois blade*	13.49	13.49	13.49	0.00	13.49	0.00
Working edge/edge circum. (mm)	Min.	Max.	Mean	S.D.	Med.	CV
Complete Laminar blade	88.39	387.41	204.01	64.57	193.40	31.65
Complete Levallois blade	190.42	316.49	253.08	40.35	255.02	15.95
Broken Laminar blade	93.41	285.00	151.99	50.98	148.68	33.54
Broken Levallois blade*	236.59	236.59	236.59	0.00	236.59	236.59
Cutting edge per weight (mm/g)	Min.	Max.	Mean	S.D.	Med.	CV
Complete Laminar blade	2.50	39.84	13.56	8.38	11.71	61.80
Complete Levallois blade	3.65	12.29	6.57	2.29	6.42	34.81
Broken Laminar blade	4.81	47.59	23.61	13.15	21.31	55.67
Broken Levallois blade*	7.83	7.83	7.83	0.00	7.83	0.00
Flattening index (mT/mW)	Min.	Max.	Mean	S.D.	Med.	CV
Complete Laminar blade	0.26	1.00	0.47	0.15	0.45	32.52
Complete Levallois blade	0.21	0.48	0.32	0.07	0.34	20.13

Table 7.21. Metric data for complete and broken Laminar and Levallois blades analysed (n=93); asterisk: individual example

Cores are prepared through a variety of centripetal and bidirectional preparation strategies, and feature a low amount preparation with cortex recorded on the flaking surface, and the core's convexities. Platform preparation is also minimal, however facetting is documented on two cores.

Following core preparation, a recurrent bidirectional strategy is undertaken with four cores exemplifying the use of two platforms. The exploitation surface typically features three elongated removals on average, and are all successful in nature, as documented by the amount of feathered end-types. Only one core is documented as featuring other distal end-types.

Fifteen Levallois blades are also documented within the Série 1 context, thirteen unretouched blades, one retouched blade, and one Levallois blade fragment. The majority (93.33%) retain no cortex, feature an increased number of scars (both elongated and non-elongated) in comparison to Laminar technological blades, and are more irregular in general observation. While the blades are varied in cross-section (Figure 7.16), blades feature characteristics typical of Levallois production, including a high percentage of facetting, with 60% of all Levallois blades featuring preparation.

Fresnoy-au-Val (Série 1): retouch analysis (n=93)									
Presence of retouch:	Levallois (15)		Laminar (78)		Location of retouch:	Levallois (15)		Laminar (78)	
Yes	1	6.67%	2	2.56%	Proximal left	0	0.00%	0	0.00%
No	14	93.33%	76	97.44%	Proximal right	0	0.00%	0	0.00%
					Medial left	0	0.00%	0	0.00%
					Medial right	0	0.00%	0	0.00%
					Distal left	1	50.00%	1	50.00%
					Distal right	1	50.00%	1	50.00%
					Complete/continuous	0	0.00%	0	0.00%
Position of retouch:					Retouch coverage (%):				
Direct	1	100.00%	1	50.00%	No retouch	14	93.33%	76	97.44%
Inverse	0	0.00%	1	50.00%	1-25%	1	6.67%	2	2.56%
Alternate	0	0.00%	0	0.00%	26-50%	0	0.00%	0	0.00%
Bifacial	0	0.00%	0	0.00%	51-75%	0	0.00%	0	0.00%
Crossed	0	0.00%	0	0.00%	76-99%	0	0.00%	0	0.00%
Proximal (i.e. burin)	0	0.00%	0	0.00%	Complete retouch	0	0.00%	0	0.00%
Presence of burination:					Distribution of retouch:				
Yes	0	0.00%	0	0.00%	Continuous	1	100.00%	2	100.00%
No	15	100.00%	78	100.00%	Discontinuous	0	0.00%	0	0.00%
					Partial	0	0.00%	0	0.00%
Form of retouched edge:					Morphology of retouch:				
Rectilinear	0	0.00%	2	100.00%	Scaled	1	100.00%	1	50.00%
Concave	1	100.00%	0	0.00%	Stepped	0	0.00%	1	50.00%
Convex	0	0.00%	0	0.00%	Sub-parallel	0	0.00%	0	0.00%
Single removal (notch/burin)	0	0.00%	0	0.00%	Parallel	0	0.00%	0	0.00%
Denticulate	0	0.00%	0	0.00%	Notch/Denticulate	0	0.00%	0	0.00%
Multiple	0	0.00%	0	0.00%	Burin	0	0.00%	0	0.00%

Table 7.22. Technological observations from Fresnoy-au-Val (Série 1) (retouch attributes)

Both bidirectional and unidirectional flake scar patterns are documented throughout the Levallois blades analysed, similarly to the evidence for Laminar blade production.

Only one Levallois blade features retouch. Like the two Laminar blades, the morphology is discontinuous and is of low coverage, covering 5-10% of the edge circumference. Given the fragmentary evidence for retouch, and the nature of retouch observed, it is likely that these three examples result from mechanical damage or use, and not retouch.

See Figure 7.17 for examples of technological blade material at Fresnoy-au-Val (Série 1).

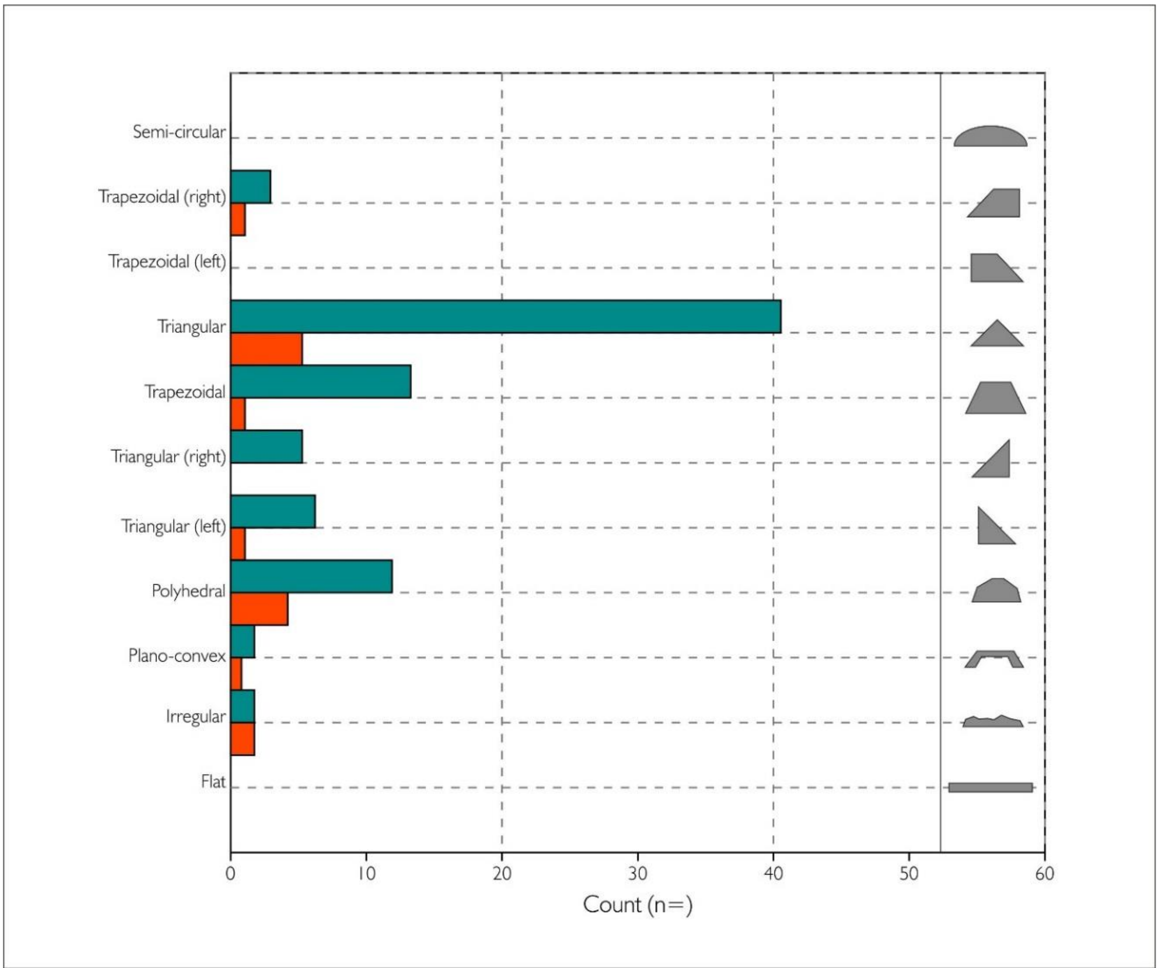


Figure 7.16. A bar-chart of the different cross-sections documented throughout Fresnoy-au-Val (Série 1) (Dark Cyan: Laminar; Orangered: Levallois)

Figure 7.17. Examples from (Série 1): Top left: Laminar facial core; Top right: *semi-tournant* Laminar core; Bottom left: Cortical Laminar blade; Middle left: Levallois blade; Middle right: proximal Laminar fragment; Bottom right: Laminar blade

7.4.3.6. Refit Analysis

One-hundred and fifty different refit sequences were identified within the Série 1 context, courtesy of analyses undertaken by Locht (2008), Goval (2008) and Goval and Locht (2009). These are largely Laminar in nature with only one Levallois blade core refit noted. Throughout, raw material is heavily modified, sometimes with the use of multiple crests prior the exploitation of a series of blades. Nodules exemplify the plasticity of the Laminar technique, with raw material demonstrating the production of more than one core within a single nodule. More details for each refit documented are noted below.

Remontage 15: Remontage 15 is composed of fifteen artefacts in total made from Santonian D flint. This is comprised of one *semi-tournant* core, a series of flakes with varying cortical coverage (two complete cortical flakes, five cortical flakes featuring less than 50% coverage, and five cortical flakes featuring greater than 50% flakes), one uncortical flake and a blade.

Remontage 36: Comprised of twenty-seven artefacts in total and produced from Santonian D flint. Made up of two *semi-tournant* cores, two complete Laminar blades, one medial Laminar blade fragment, three uncortical flakes, eleven flakes featuring <50% cortex, six flakes featuring >50% cortex, and two complete cortical flakes.

Remontage 44 (see Figure 7.18): Composed of twelve artefacts on Santonian D flint and made up of two separate refits (i and ii), with a *semi-tournant* Laminar core, two crested blades (one *lame á crête* and one *demi-lame á crête*), four complete Laminar blades and three flakes featuring <50% cortex, and two flakes featuring >50% cortex. Negative scars indicate that blades are obtained following the removal of cortical products.

Remontage 45: Comprised of thirty-two artefacts, with fifteen blades produced. Of these, there is one *lame á demi-crête*, nine Laminar blades, two proximal blade fragments, 1 medial blade fragment, and two distal blade fragments. Eleven flakes (<50% cortex), and six flakes (>50% cortex) are also recorded. No core is in association with this refit.

Remontage 69: A series of two blades made on an unknown type of flint.

Remontage 72: Comprised of three artefacts produced on Santonian D flint: one *semi-tournant* core, one complete blade and one distal blade fragment.

Remontage 74: Comprised of three artefacts produced on Santonian D flint: one *semi-tournant* core and two complete blades.

Remontage 81: Comprised of two artefacts produced on Santonian D flint: one *semi-tournant* core, and a platform flake removal.

Remontage 127: Originally noted as a bidirectional core, however a delineated surface is observed, with the creation of a striking surface and flaking surface. Features one Levallois blade, one *éclat débordant*, and a non-cortical flake. Made on an unknown type of flint.

Remontage 150: Composed of three artefacts, one *semi-tournant* Laminar core and two complete blades. Made on an unknown type of flint.

7.4.4. Hominin Behaviour at Fresnoy-au-Val (Série 1)

The assemblage from Fresnoy-au-Val (Série 1) exemplifies the plasticity of Neanderthal technological behaviour towards the beginning of the Late Middle Palaeolithic. The context boasts both extended and non-extended flaking strategies, with elaborate and fortuitous blade production methods on a variety of core morphologies. This contrasts previous examples of blade technology documented previously in this chapter, in both the density of Laminar technological blade strategies, and in their proceduralisation. However, many similarities are also apparent. Like Therdonne, the presence of both Levallois and Laminar flaking strategies using high-quality local flint is observed, within one layer of a multi-temporal context. A series of shared technological behaviours are also apparent including an emphasis on convergent points, a proceduralised Laminar sequence and a more fortuitous approach to Levallois blade production. Furthermore, both emphasise a more fortuitous and non-invasive approach to transforming material following detachment, possibly for immediate use, similar to Saint-Valery-sur-Somme. These commonalities and differences are discussed further in Chapters 10 and 11.

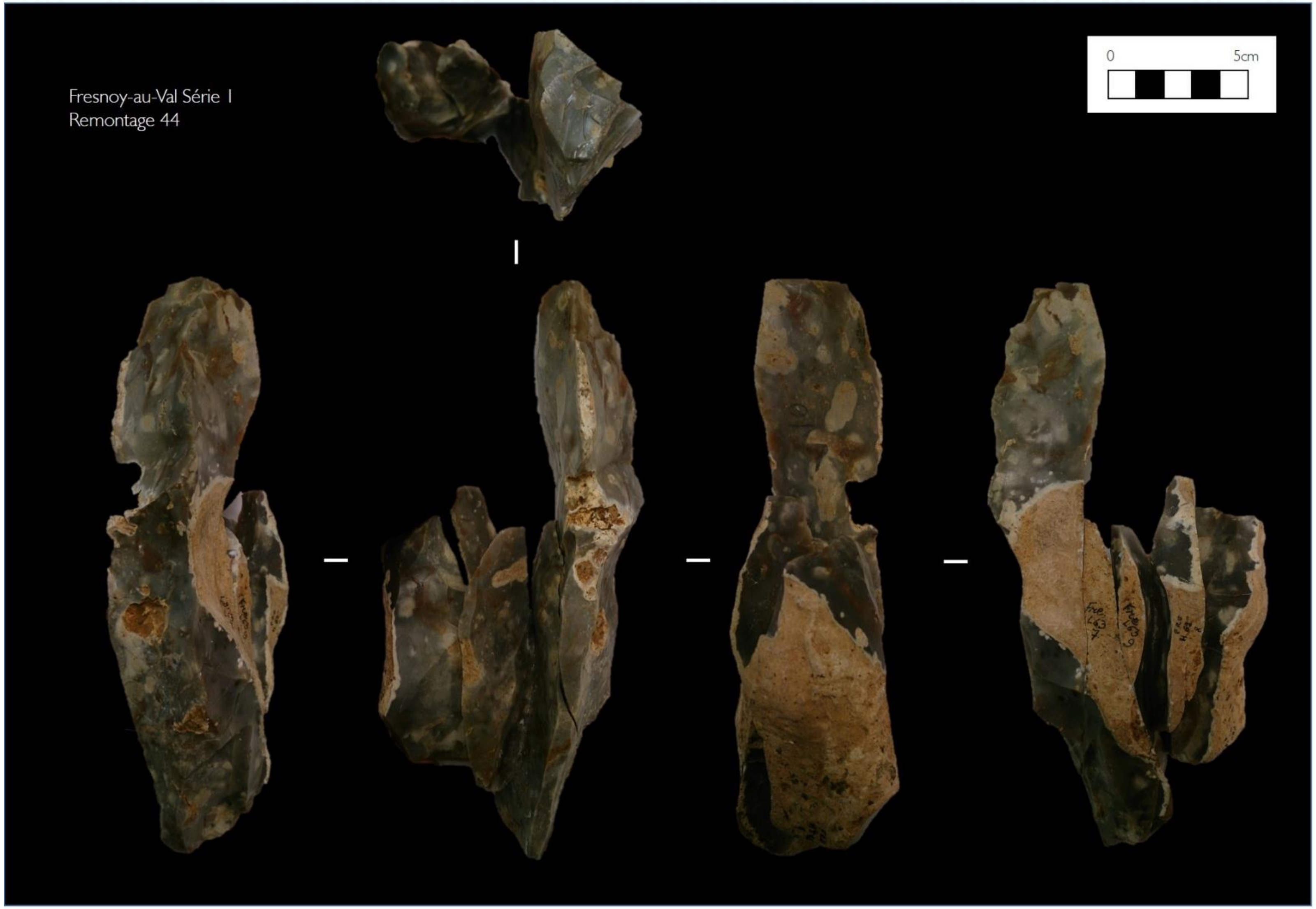


Figure 7.18. Refit 'Remontage 44 (ii)' from Fresnoy-au-Val (Série 1) (for details see text)

7.5. Bettencourt-Saint-Ouen (N2B)

7.5.1. Introduction and Overview of Investigations

The Middle Palaeolithic occupational layers of Bettencourt-Saint-Ouen are located three kilometres from the Nièvre tributary of the Somme river, north-west of Amiens in northern France. Discovered on the middle of a north-east facing loamy slope, the context is situated within a dry asymmetric valley parallel to the major Somme Valley system, known locally as Le Fond des Éronvalles (Locht, 2002). Le Fond des Éronvalles is typical of the Somme basin in terms of morphology, with a contrasting steep chalky slope (exposed E-N-E) and silty gentle slopes exposed to the east (*ibid.* 13). Locht (2002) notes that this region would have been a desirable locality for Neanderthal populations given its geographical positioning within the landscape, close to a source of water at the base of the Somme Valley and the high-quality local raw material present nearby (discussed below).

With a known and well-developed pedosedimentary sequence, geomorphological surveys were undertaken in July 1994 through Pierre Antoine and the CNRS, as part of archaeological operations prior the construction of the Autoroute 16 (A16) between Amiens and Boulogne. Following further assessments in December 1994, five months of excavations were untaken from February to July 1995 under the direction of Jean-Luc Locht. The deposit was partitioned into three ('secteurs' 1/2/3) following fossil erosion/karstic depression cutting the humiferous layer. The third sector is characterised by a karstic depression which preserved a larger accumulation of deposit than any other region of the site. In total, 866m^2 of area was excavated and five occupational layers were identified: N3B, N3A, N2B, N2A and N1, all of which are present within the karstic depression. Of these, N3B, N2B and N1 are the three main occupational layers identified with lithic counts of 1298, 6466, and 438 artefacts respectively. In addition, two main stratigraphic profiles were also undertaken (L1 and L2) which highlighted a complex, but well-developed, stratigraphic sequence (see below).

Here the Bettencourt-Saint-Ouen N2B context is discussed, given the abundance of archaeological material excavated, and the substantial amount of evidence for the adoption of a Laminar technological blade strategy, with some suggestion for Levallois elongated products, all within a robust temporal framework. It must be noted that all other levels also feature evidence for the production of Laminar technological blades, but to a significantly lesser degree.

Archaeological material within the N2B context was recorded in all secteurs excavated, with zone three demonstrating the most abundant evidence for human activity, zone two featuring a smaller (but still substantial) amount of archaeological evidence, and zone one featuring the least (Figure 7.19). In all three secteurs, Laminar technological blades to varying quantities were also excavated (Table 7.23). In secteur 1 (N2B1), fifteen blades and two *semi-tournant* blade cores were recorded, alongside evidence for Levallois unidirectional convergent (point), Levallois recurrent unidirectional/bidirectional (elongated and non-elongated), and migrating platform strategies. Secteur 2 (N2B2) featured greater evidence for the production of Laminar technological blade strategies, with two-hundred and eight blades (including thirteen crested blades) uncovered, in addition to a number of Laminar cores, points and Levallois flaking strategies (preferential/recurrent), a small amount of which are elongated in nature. The final zone secteur 3 (N2B3) features the greatest number of artefacts (n=4523). Despite this, secteur 3 comprises of a lower number of blades in comparison to N2B2 (n=170), with emphasis on the production of point cores and points through a convergent unidirectional technique (Locht, 2002). Towards the end of the sequence, as viewed within the N1 context, there is a distinct lack of blade technologies within the archaeological record, with sequences oriented towards the production of flake-based technologies.

Artefact	N3B	N2B1	N2B2	N2B3	N1
Levallois flake	50	18	34	66	13
Flake	356	145	305	1273	114
Blade (Laminar)	66	14	195	165	10
Crested blade	67	1	13	5	1
Point	1	4	7	117	4
Éclat débordant	32	3	8	20	3
Core count	33	20	65	88	18
Other	746	381	730	2789	275
Total	1351	586	1357	4523	438

Table 7.23. Assemblage composition of the three main occupational layers in the Bettencourt-Saint-Ouen complex (green: context studied)

Other material including faunal remains have been discovered within the N2B context with eighty-six bone and teeth fragments recorded. All remains are representative of two species, small in quantity: *equidae* and *bovinae*.

As noted in Chapter 4, functional trace-wear analyses were undertaken on material within each zone of the N2B context, to varying degrees of success. These, however, highlighted the use of Levallois flakes and Laminar technological blade strategies in association of woodwork and butchery-related activities. Analyses of lithics through refitting were also undertaken (Locht, 2002) and highlighted that rare admixture between the three zones occurred, with both the spatial data for the faunal remains and lithics supporting ideas that the context represented a processing and butchery event.

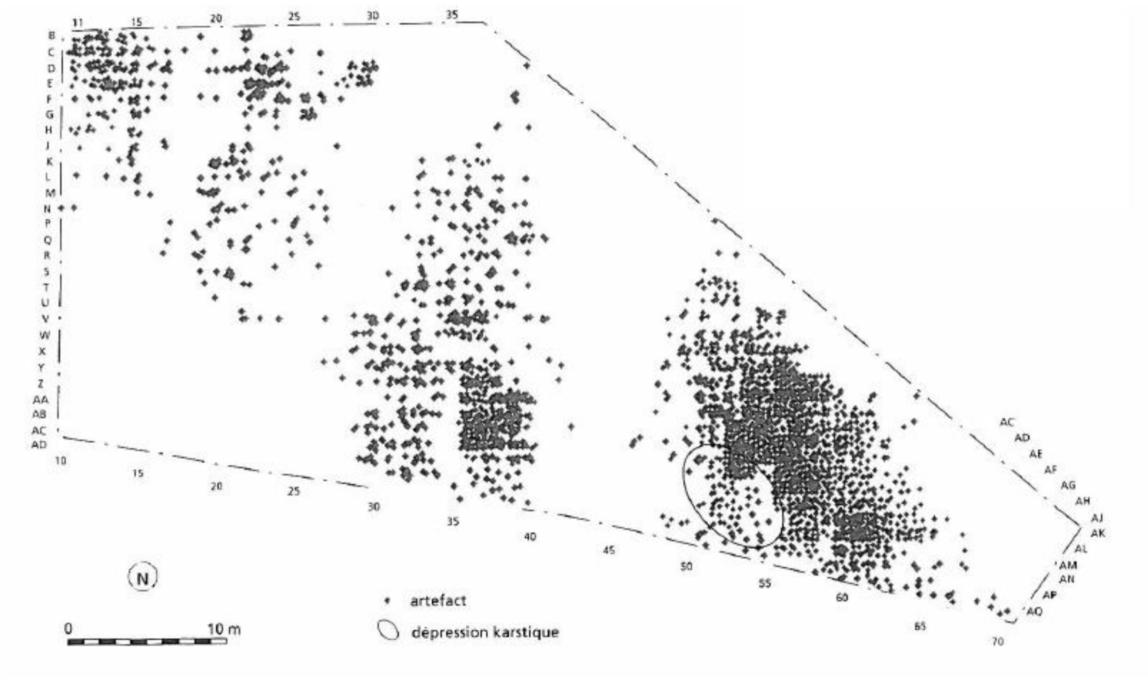


Figure 7.19. Localisation of artefacts within the Bettencourt-Saint-Ouen (N2B) context; white spaces represent the recent cuts, from fossil erosion through the humiferous layer (Locht, 2002). Zones/secteurs 1-3 correspond to concentrations from left to right

When faunal, stratigraphic, sedimentological and limited palynological data (see Locht, 2002) are assessed in conjunction, it was determined that the context dates towards the end of MOIS 5. Thermoluminescence (TL) and Infra-Red Stimulated Luminescence (IRSL) conducted by Manfred Frenchen, Anette Engelmann, and others further demonstrated this periodisation, with sediments dating the N2B sequence to the beginning of MOIS 5a, dating between c.75,000-85,000 BP, and the N1 layer dating to the end of MOIS 5a (Engelmann et al., 1999; Locht, 2002).

Following the publication of the Bettencourt-Saint-Ouen complex (Locht, 2002), studies have focused on the use of point-based technologies in association with discussions on mobility (e.g. Goval, 2008), the contemporaneity of Bettencourt-Saint-Ouen with other nearby MOIS 5a contexts (e.g. Locht et al., 2010a; Locht et al., 2016), and adaptive faculties within the Neanderthal toolkit (e.g. Locht et al., 2016).

7.5.2. Geological and Chronostratigraphic Background

Through the construction of the L1 and L2 profiles, a total of sixteen units were identified by Pierre Antoine (Figure 7.20). The occupational layer in question (N2B) is situated within the first few centimetres of unit 7, a non-calcareous humiferous-clay compact silt, black-brown to black (10 YR 3/2 - 2/2), with a *lâche* (loose) prismatic structure (Antoine in Locht, 2002). Illuviation (the deposition of minerals (salts) and other materials (colloids) within a soil horizon) has also been noted through strong root porosity (*ibid*. 27). The N2B context is separated from the N3A/N3B occupational layer through two units: 1) a bioturbed small light-grey silty horizon, non-calcareous in nature with orange oxidation stains (unit 8), and a light greyish-brown non-calcareous compact layer, featuring numerous concretions of ferromanganese (unit 9).

The N2B layer corresponds to the Grey Forest Soil phase, and specifically the beginning of Saint-Sauflieu 1. Given the evidence for erosion within the bioturbed layer above, the environmental instability of MOIS 5b can be hypothesised as being responsible, with the forest soil (with colluvium) layer, comparable to Fresnoy-au-Val Série 1, with a pedostratigraphic positioning of MOIS 5a. This was confirmed with TL/IRSL dating, as noted above.

All artefacts are known to not be disrupted or subject to high-energy taphonomic forces, given the slow gradual colluvial and eolian deposition (Locht, 2002).

7.5.3. Artefact Analysis

7.5.3.1. Treatment and Selection of the Collection(s)

All material examined was stored at the *Centre de Recherches Archéologiques*, at INRAP, and studied in conjunction with other contexts discussed previously. All artefacts were present and tabulated as a FileMaker Pro Database, allowing a thorough investigation of all necessary artefacts. As Levallois recurrent elongated strategies were not categorised as such, it was essential to review all Levallois material.

As all artefacts are located in secteurs, only divided by taphonomic processes, all artefacts are examined in conjunction, and treated as one unit. Furthermore, given the multitude of Levallois core flaking strategies present, *éclats débordants* were not known to be sourced from an exclusively Levallois blade strategy, and were excluded from analyses.

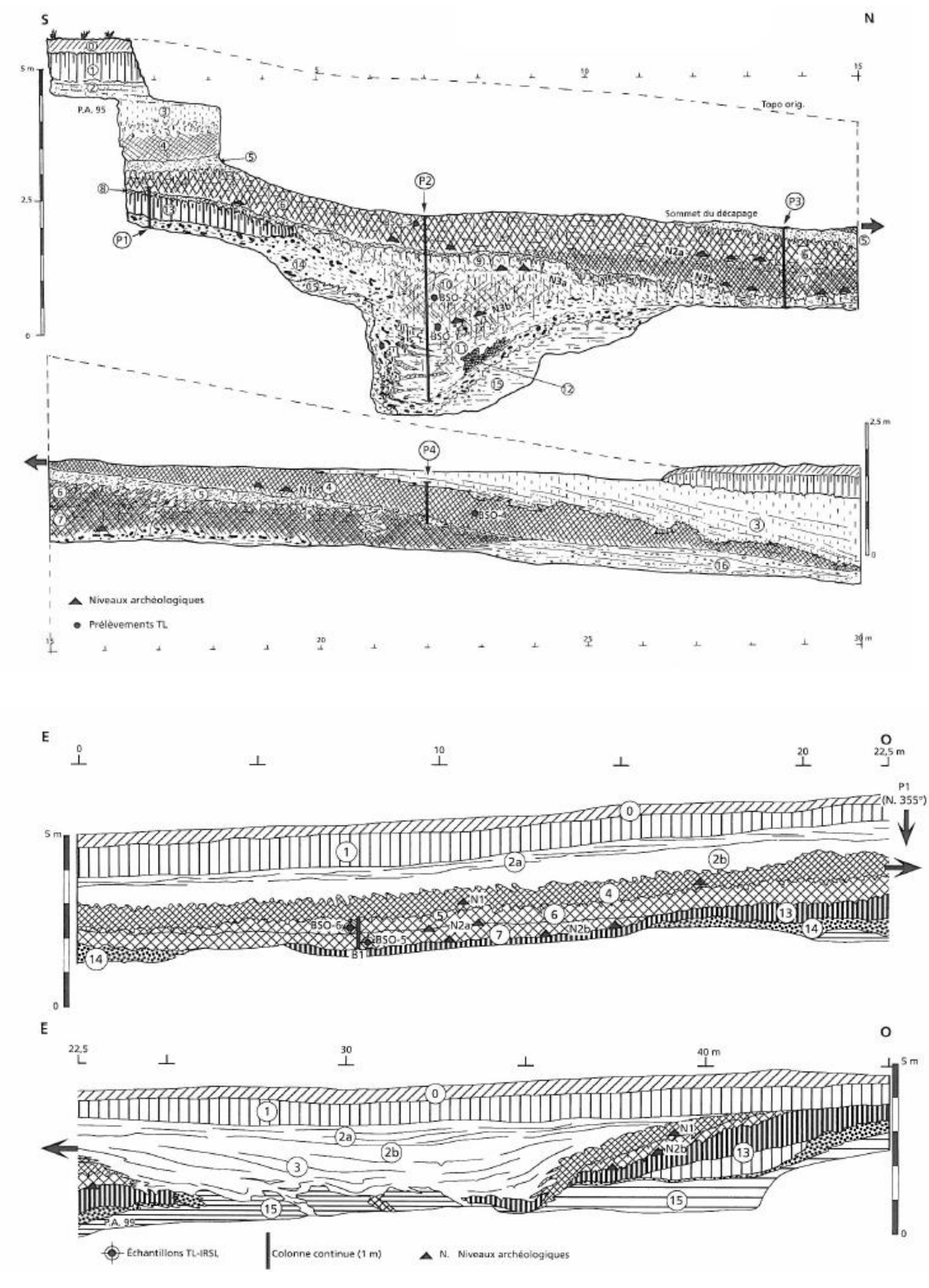


Figure 7.20. The stratigraphic profiles from the L1 (top) and L2 (bottom) sections created within the Bettencourt-Saint-Ouen region. Numbers correspond to stratigraphic units (see Locht, 2002 for other units not described within the text)

7.5.3.2. Technological Overview

One-hundred and forty-eight artefacts (Table 7.24) were analysed in total. A thorough analysis of all Levallois artefacts within the N2B context revealed the presence of eleven artefacts, which can be suggested to stem from Levallois recurrent elongated strategies. No Levallois cores were recorded, however Levallois products appear to resemble products of a Levallois blade strategy, and given their relative standardisation, products were recorded to some degree of confidence (Table 7.25).

Artefact	n	Percentage
Laminar blade (unretouched)	81	54.73%
Laminar blade (retouched)	6	4.05%
Laminar blade fragment (unretouched)	20	13.51%
Laminar blade fragment (retouched)	0	0.00%
Laminar crested blade (unretouched)	10	6.76%
Laminar crested blade (retouched)	2	1.35%
Laminar crested blade fragment (unretouched)	0	0.00%
Laminar crested blade fragment (retouched)	0	0.00%
Laminar blade core	18	12.16%
Levallois blade (unretouched)	11	7.44%
Levallois blade (retouched)	0	0.00%
Levallois blade fragment (unretouched)	0	0.00%
Levallois blade fragment (retouched)	0	0.00%
Levallois *éclat débordant* (unretouched)	0	0.00%
Levallois *éclat débordant* (retouched)	0	0.00%
Levallois *éclat débordant* fragment (unretouched)	0	0.00%
Levallois *éclat débordant* fragment (retouched)	0	0.00%
Levallois recurrent blade core	0	0.00%
Total:	148	100.00%

Table 7.24. Technological overview of the artefacts studied

Confidence	Laminar core	Levallois core	Laminar product	Levallois product
A (definite)	16 (88.89%)	0 (0.00%)	112 (94.12%)	4 (36.36%)
B (probable)	2 (11.11%)	0 (0.00%)	7 (5.88%)	7 (63.63%)
C (possible)	0 (0.00%)	0 (0.00%)	0 (0.00%)	0 (0.00%)

Table 7.25. Confidence categories for the artefacts studied

Systems of Laminar production are initiated through cresting/semi-cresting and exploited through a predominantly *semi-tournant* system. Like Fresnoy-au-Val, a low retouch percentage is observed. However, several examples demonstrate more invasive retouch, and varied including end-scraper forms. Examples of burination are also documented.

Several refits were also recorded allowing a thorough investigation of the different sequences undertaken throughout the Bettencourt-Saint-Ouen (N2B) context.

7.5.3.3. Taphonomic History

Through the pedosedimentary observations from the L1 and L2 profiles (Antoine in Locht, 2002) it was assumed, given slow gradual colluvial and eolian deposition within the Saint-Sauflieu 1 Grey Forest Soil that the artefacts would feature minimal mechanical damage, movement and patination, similarly to Fresnoy-au-Val. This is also demonstrated through a recording of the artefact's taphonomic histories (Table 7.26).

Bettencourt-Saint-Ouen (N2B): artefact condition (n=148)									
	Levallois (11)		Laminar (137)			Levallois (11)		Laminar (137)	
Whole/broken:					Degree of patination:				
Whole	11	100.00%	117	85.40%	Unpatinated	11	100.00%	136	99.27%
Broken	0	0.00%	20	14.60%	Lightly patinated	0	0.00%	1	0.73%
					Moderately patinated	0	0.00%	0	0.00%
					Heavily patinated	0	0.00%	0	0.00%
Degree of edge damage:					Degree of burning:				
No edge damage	11	100.00%	131	95.62%	Unburned	11	100.00%	137	100.00%
Lightly damaged	0	0.00%	6	4.38%	Lightly burned	0	0.00%	0	0.00%
Moderately damaged	0	0.00%	0	0.00%	Moderately burned	0	0.00%	0	0.00%
Heavily damaged	0	0.00%	0	0.00%	Heavily burned	0	0.00%	0	0.00%
Degree of rolling:					Portion/break:				
Unrolled	11	100.00%	135	98.54%	Complete	11	100.00%	117	85.40%
Lightly rolled	0	0.00%	2	1.46%	Proximal fragment	0	0.00%	9	6.57%
Moderately rolled	0	0.00%	0	0.00%	Medial fragment	0	0.00%	5	3.65%
Heavily rolled	0	0.00%	0	0.00%	Distal fragment	0	0.00%	6	4.38%
					Siret	0	0.00%	0	0.00%
Observations: No scratching recorded; little staining.									

Table 7.26. Detailed taphonomic characteristics of material analysed at Bettencourt-Saint-Ouen (N2B)

Both Levallois and Laminar technological blade strategies feature comparable taphonomic histories, with similar degrees of patination, scratching and rolling recorded. Only one example, a Laminar blade fragment, was observed as featuring possible evidence for patination. In almost all examples no patination was recorded. No evidence for edge damage, rolling, or other mechanical disturbances (scratching, abrasion etc.) has been noted on Levallois artefacts, with only a small percentage of Laminar artefacts featuring examples of light edge or ridge damage, and light rolling.

No examples of either strategy feature evidence characteristic of burning.

As the context was known to feature sieving/micro-sieving it can be assumed that the total amount of technological blade strategies excavated are representative of the 866m^2 of area excavated in 1995.

7.5.3.4. Raw Material

All artefacts throughout the assemblage were produced on local high-quality from the Turonian and Coniacian formations similarly to Fresnoy-au-Val. Specifically, material is produced from Upper Turonian/Lower Coniacian and Upper/Middle Coniacian raw material. These are discussed in detail below.

Upper Turonian/Lower Coniacian flint is present throughout the assemblage, and features a uniform black matrix with rare occurrences of white anomalous structures, resulting from incomplete silicification. Cortex can be varied, and can be fresh or rolled in nature. Upper/Middle Coniacian flint noted by Locht (2002) as the most commonly utilised material, and most abundant within the residual gravels on the slope (occupational layers). This comprises the majority of blades too. It is light-grey in colour with many instances of incomplete silicification and frost fracturing. Most broken blades appear to be of Upper/Middle Coniacian flint and may, in part, explain their quantity. Locht (2002) notes the presence of one artefact, a convex scraper of Campanian origin, non-local in nature, sourced over ten kilometres away to the north-east of the context. All other material is local in origin.

The raw material is of varying dimensions and sizes, with Laminar cores ranging in weight between 30.37g - 310.24g (see next section), with both extremes retaining cortex of varying degrees. Cortex appears fresh in nature with very few examples of staining or rolling. This is also true for blades produced. No artefacts recorded retain greater than 50% cortex coverage.

7.5.3.5. Technology: Extended Analysis

Within the Bettencourt-Saint-Ouen (N2B) occupational layer(s), a strong Laminar blade component is attested, with possible evidence for the existence of a Levallois technological blade system.

In the initiation of Laminar blade production, platforms are created through single lineal and multiple lineal flake removals (see Table 7.27) with cortex retained on several examples. In two examples a centripetal (3-way and centripetal *sensu stricto*) method of platform creation is undertaken.

Bettencourt-Saint-Ouen (N2B): technological core observations (n=18)							
Core strategy:			Number of scars/core:				
Laminar	18	100.00%	Laminar: Min: 7, Max: 24, Mean: 13.00 (CV: 34.70)				
Levallois	0	0.00%	Levallois: N/A				
			Number of elongated (L/W = 1.75>) scars/core:				
			Laminar: Min: 3, Max: 10, Mean: 4.94 (CV: 37.02)				
			Levallois: N/A				
Levallois strategy:			Laminar core shape:				
Recurrent unidirectional	0	0.00%	Orthogonal/prismatic			3	16.67%
Recurrent bidirectional	0	0.00%	Semi-orthogonal/semi-prismatic			14	77.78%
			Pyramidal			1	5.56%
Laminar strategy:			Laminar platform preparation strategy:				
Semi-tournant/semi-rotating	10	55.56%	Single Lineal			12	44.44%
Tournant/rotating	3	16.67%	Multiple Lineal			13	48.15%
Facial	5	27.78%	Bidirectional			0	0.00%
Frontal	0	0.00%	3-way centripetal			1	3.70%
Multiple (combination)	0	0.00%	Centripetal			1	3.70%
			Lateral (left/right)			0	0.00%
			Perpendicular (left/right)			0	0.00%
Laminar core volume utilised:			Distal end-types:	Levallois (0)		Laminar (18)	
1-25%	1	5.56%	Feathered	0	0.00%	18	46.15%
26-50%	8	44.44%	Stepped	0	0.00%	6	15.38%
51-75%	6	33.33%	Hinged	0	0.00%	14	35.90%
76-100%	3	16.67%	Reverse Hinged	0	0.00%	1	2.56%
			Overshot	0	0.00%	0	0.00%
Levallois core preparation strategy:			Number of platforms:				
Unidirectional	0	0.00%	1	0	0.00%	9	50.00%
Bidirectional	0	0.00%	2	0	0.00%	9	50.00%
Convergent unidirectional	0	0.00%	Cortex percentage:				
Centripetal	0	0.00%	Absent	0	0.00%	3	16.67%
Unidirectional left	0	0.00%	1-25%	0	0.00%	6	33.33%
Unidirectional right	0	0.00%	26-50%	0	0.00%	9	50.00%
Bidirectional lateral	0	0.00%	51-75%	0	0.00%	0	0.00%
Unidirectional distal	0	0.00%	76-100%	0	0.00%	0	0.00%

Table 7.27. Technological observations from Bettencourt-Saint-Ouen (N2B) (core attributes)

Cresting and semi-cresting is then undertaken with numerous examples documented (Table 7.28). In the twelve crested blades documented, one face is typically knapped with only two examples (16.67%) featuring the knapping of two faces (*lame à crête a deux versants*). Crested blades also feature an equal number of regular and irregular flaking scars, with scars typically 15-20mm in width. Almost two-thirds of all crested blades analysed are *lame à crête partielle* in nature, with 50% of the dorsal scar ridge transformed, suggesting a more fortuitous and expedient method of initiating blade production. Following their detachment, two crested blades feature further modification/retouch (see below).

In their reduction, a *semi-tournant* blade production system is most common (55.56%). These typically feature an unmodified, often cortical, face with half of all blade cores analysed featuring less than 50% of the core volume utilised. The extensive use of a *semi-tournant* technique results in cores which are typically semi-orthogonal in nature, with only one example of a pyramidal (unidirectional convergent) system of blade production noted. Evidence for a number of other core volume management strategies are also apparent, including the presence of facial (n=5) and *tournant* (n=3) blade production systems.

Bettencourt-Saint-Ouen (N2B) technological data: crested blades (12)		
Crested blade scar percentage:		
<50% (*lame à crête partielle*)	8	66.67%
>50% (*lame à crête*)	4	33.33%
Crested blade scar regularity:		
Regular	6	50.00%
Irregular	6	50.00%
Number of crested sides knapped:		
One (*lame à demi-crête*)	10	83.33%
Two (*lame à crête*)	2	16.67%
Average width of scars:		
> 25 mm	1	8.33%
25-20 mm	1	8.33%
20-15 mm	6	50.00%
15-10 mm	4	33.33%
< 10 mm	0	0.00%
Presence of retouch:		
Yes	2	16.67%
No	10	83.33%
Retouch information		
- 1 x direct notch (proximal right)		
- 1 x direct rectilinear parallel retouch (medial left)		

Table 7.28. Technological observations from Bettencourt-Saint-Ouen (N2B) (crested blade attributes)

In their exploitation, all cores (n=18) feature feathered distal end-types, with a large proportion of cores (77.78%) also documenting hinging. Cores feature an equal number of bidirectional and unidirectional scar removals, with nine single and opposed platform cores. The cores produced vary considerably in their weight, elongation, thickness and dimensions, with relatively high CV values and standard deviations (Table 7.29).

With respect to the Laminar blades produced, most examples feature characteristics typical of hard hammer percussion with well-defined and pronounced percussion bulbs in over three-fifths (63.55%) of all blades analysed (Table 7.31). The blades also feature little if any cortex with 67.29% of all examples retaining no cortex on the dorsal surface or platform, and feature a variety of differing butts with a predominantly plain and mixed butt-type evident. A number of blades (n=12) also feature facetted platforms, exemplifying evidence for platform preparation prior to exploitation.

Weight (g)	Min.	Max.	Mean	S.D.	Med.	CV
Levallois	-	-	-	-	-	-
Laminar	30.37	310.24	106.98	96.08	67.20	89.80
Length (mm)	Min.	Max.	Mean	S.D.	Med.	CV
Levallois	-	-	-	-	-	-
Laminar	58.50	192.22	89.91	36.03	75.86	40.07
Width (mm)	Min.	Max.	Mean	S.D.	Med.	CV
Levallois	-	-	-	-	-	-
Laminar	29.03	126.00	55.02	24.58	43.37	44.68
Elongation index (L/W)	Min.	Max.	Mean	S.D.	Med.	CV
Levallois	-	-	-	-	-	-
Laminar	0.86	2.59	1.70	0.39	1.75	22.79
Thickness (mm)	Min.	Max.	Mean	S.D.	Med.	CV
Levallois	-	-	-	-	-	-
Laminar	19.87	64.92	34.90	13.37	30.53	38.30
Core flattening index (Thickness/Width)	Min.	Max.	Mean	S.D.	Med.	CV
Levallois	-	-	-	-	-	-
Laminar	0.26	1.30	0.68	0.24	0.62	34.58

Table 7.29. Metric data for complete cores analysed (n=18)

The blades produced are commonly triangular in cross-section (Figure 7.21) and vary considerably in their dimension and weight, marrying up to the different morphologies of raw material exploited. Despite this, the blades are standardised in their elongation index, with a low CV value (Table 7.30). Laminar blades also feature a flattening index comparable to the experimental dataset, and other contexts studied (see Chapter 10 for more information).

Of the sample analysed, six Laminar blades document retouch. The blades (Table 7.32) typically feature direct retouch on the distal portion of the blade, and are often of little coverage. In its form, retouch is focussed on the production of notches and denticulated edges with two examples of scraper-edge retouch documented, and one further example of burination. A further two crested blades also document retouch. One blade exemplifies a notch on the proximal right portion of the crested blade, and a further crested blade exemplifying direct rectilinear parallel retouch on its medial left portion.

Eleven unretouched Levallois products were also identified as originating from a Levallois blade strategy. Despite the absence of Levallois blade cores, these products feature a number of technological characteristics akin to Levallois blades including wide facetted platforms, elongated stereotyped morphologies, longitudinal arrises, and a flattening index comparable to other examples of Levallois blades documented throughout. At present, their technological origin cannot be determined, and as such,their involvement in further analyses needs to be cautiously examined alongside other data. No examples of Levallois material documented herein features retouch. For technological details on the Levallois 'blades' see Table 7.31.

Examples of blade *débitage* can be seen in Figure 7.22, 7.23, and 7.24.

Weight (g)	Min.	Max.	Mean	S.D.	Med.	CV
Complete Laminar blade	1.25	165.44	20.29	23.47	13.20	115.70
Complete Levallois blade	16.29	62.34	36.50	15.21	39.31	41.67
Broken Laminar blade	2.16	16.34	7.18	4.81	5.30	66.93
Broken Levallois blade	-	-	-	-	-	-
Length (mm)	Min.	Max.	Mean	S.D.	Med.	CV
Complete Laminar blade	31.03	141.63	71.47	23.85	65.93	33.38
Complete Levallois blade	70.40	101.71	83.34	9.89	80.93	11.86
Broken Laminar blade	19.79	125.75	54.44	22.69	51.38	41.68
Broken Levallois blade	-	-	-	-	-	-
Width (mm)	Min.	Max.	Mean	S.D.	Med.	CV
Complete Laminar blade	9.46	56.09	30.28	10.57	28.42	34.90
Complete Levallois blade	36.49	59.03	48.50	5.56	48.88	11.47
Broken Laminar blade	17.03	56.63	28.51	9.69	25.80	33.99
Broken Levallois blade	-	-	-	-	-	-
Elongation Index (L/W)	Min.	Max.	Mean	S.D.	Med.	CV
Complete Laminar blade	1.78	4.19	2.55	0.59	2.38	23.08
Complete Levallois blade	1.78	2.01	1.85	0.11	1.82	5.76
Broken Laminar blade	0.62	2.87	1.95	0.54	2.09	27.69
Broken Levallois blade	-	-	-	-	-	-
Thickness (mm)	Min.	Max.	Mean	S.D.	Med.	CV
Complete Laminar blade	2.33	17.01	7.25	2.89	6.77	39.90
Complete Levallois blade	4.87	12.73	9.79	2.86	11.22	29.20
Broken Laminar blade	3.43	16.62	8.96	3.29	8.57	36.74
Broken Levallois blade	-	-	-	-	-	-
Working edge/edge circum. (mm)	Min.	Max.	Mean	S.D.	Med.	CV
Complete Laminar blade	91.41	328.48	186.27	59.04	174.42	31.69
Complete Levallois blade	193.78	286.49	237.93	29.99	234.99	12.60
Broken Laminar blade	89.33	325.60	150.20	55.51	132.39	36.96
Broken Levallois blade	-	-	-	-	-	-
Cutting edge per weight (mm/g)	Min.	Max.	Mean	S.D.	Med.	CV
Complete Laminar blade	1.06	80.56	18.22	16.15	13.19	88.68
Complete Levallois blade	4.24	13.24	7.53	2.91	6.48	38.60
Broken Laminar blade	10.34	50.61	25.53	13.42	23.45	52.58
Broken Levallois blade	-	-	-	-	-	-
Flattening index (mT/mW)	Min.	Max.	Mean	S.D.	Med.	CV
Complete Laminar blade	0.25	0.93	0.46	0.14	0.43	29.45
Complete Levallois blade	0.22	0.51	0.36	0.09	0.37	25.43

Table 7.30. Metric data for complete and broken Levallois and Laminar blades analysed (n=118)

Bettencourt-Saint-Ouen (N2B): technological analysis (n=118)									
Percussion strategy:	Levallois (11)		Laminar (107)		Bulbar scar features:	Levallois (11)		Laminar (107)	
Hard	11	100.00%	96	89.72%	Well defined	10	90.91%	68	63.55%
Soft	0	0.00%	0	0.00%	Diffused	1	9.09%	28	26.17%
Mixed/Indeterminable	0	0.00%	0	0.00%	Absent/missing	0	0.00%	11	10.28%
Absent	0	0.00%	11	10.28%	Removed	0	0.00%	0	0.00%
Cortex percentage:					Number of dorsal scars:				
Absent	9	81.82%	72	67.29%	Absent	0	0.00%	0	0.00%
1-24%	2	18.18%	27	25.23%	1-2	0	0.00%	17	15.89%
25-49%	0	0.00%	8	7.48%	3-4	7	63.64%	63	58.88%
50-74%	0	0.00%	0	0.00%	5-6	4	36.36%	22	20.56%
75-99%	0	0.00%	0	0.00%	7+	0	0.00%	5	4.67%
Complete	0	0.00%	0	0.00%					
Number of elongated scars:					Number of ridges/arrises:				
Absent	0	0.00%	0	0.00%	Absent	0	0.00%	0	0.00%
1-2	2	18.18%	58	54.21%	1	2	18.18%	65	60.75%
3-4	9	81.82%	46	42.99%	2	9	81.82%	40	37.38%
5-6	0	0.00%	3	2.80%	3	0	0.00%	1	0.93%
7+	0	0.00%	0	0.00%	4	0	0.00%	1	0.93%
					5+	0	0.00%	0	0.00%
Dorsal ridge/arise shape:					Flake scar pattern:				
Singular	0	0.00%	43	40.19%	Unidirectional	1	9.09%	44	41.12%
Parallel	4	36.36%	16	14.95%	Centripetal	0	0.00%	0	0.00%
Irregular	0	0.00%	7	6.54%	3-way centripetal	0	0.00%	2	1.87%
Regular converging	1	9.09%	6	5.61%	Bidirectional	6	54.55%	29	27.10%
Regular diverging	0	0.00%	2	1.87%	Lateral left	0	0.00%	0	0.00%
Y-shape	5	45.45%	19	17.76%	Lateral right	0	0.00%	0	0.00%
Inverted Y-shape	0	0.00%	9	8.41%	Convergent unidirectional	0	0.00%	14	13.08%
Offset left/right	1	9.09%	3	2.80%	Convergent bidirectional	3	27.27%	6	5.61%
Partial	0	0.00%	0	0.00%	Convergent and perpendicular	0	0.00%	4	3.74%
Central converging	0	0.00%	2	1.87%	Double perpendicular	0	0.00%	0	0.00%
Absent	0	0.00%	0	0.00%	Straight and perpendicular	1	9.09%	8	7.48%
					Cortical	0	0.00%	0	0.00%
					Indeterminable	0	0.00%	0	0.00%
Distal end-type:					Butt type:				
Feathered	8	72.73%	54	50.47%	Plain/flat	6	54.55%	25	23.36%
Stepped	2	18.18%	14	13.08%	Dihedral	0	0.00%	8	7.48%
Hinged	1	9.09%	22	20.56%	Cortical	0	0.00%	7	6.54%
Overshot	0	0.00%	2	1.87%	Natural (but non-cortical)	0	0.00%	0	0.00%
Present but indeterminable	0	0.00%	1	0.93%	Marginal	0	0.00%	11	10.28%
Missing	0	0.00%	14	13.08%	Mixed	3	27.27%	29	27.10%
					Facetted	2	18.18%	12	11.21%
					Missing (proximal missing)	0	0.00%	11	10.28%
					Trimmed	0	0.00%	4	3.74%
					Chapeau de Gendarme	0	0.00%	0	0.00%
					Damaged/unidentifiable	0	0.00%	0	0.00%

Table 7.31. Technological observations from Bettencourt-Saint-Ouen (N2B) (blade attributes)

Bettencourt-Saint-Ouen (N2B): retouch analysis (n=118)									
Presence of retouch:	Levallois (11)		Laminar (107)		Location of retouch:	Levallois (11)		Laminar (107)	
Yes	0	0.00%	6	5.61%	Proximal left	0	0.00%	1	12.50%
No	11	100.00%	101	94.39%	Proximal right	0	0.00%	1	12.50%
					Medial left	0	0.00%	0	0.00%
					Medial right	0	0.00%	0	0.00%
					Distal left	0	0.00%	4	50.00%
					Distal right	0	0.00%	2	25.00%
					Complete/continuous	0	0.00%	0	0.00%
Position of retouch:					Retouch coverage (%):				
Direct (from dorsal)	0	0.00%	4	66.67%	No retouch	11	0.00%	10	94.39%
Inverse (from ventral)	0	0.00%	1	16.67%	1-25%	0	0.00%	1	4.67%
Alternate	0	0.00%	0	0.00%	26-50%	0	0.00%	5	0.93%
Bifacial	0	0.00%	0	0.00%	51-75%	0	0.00%	1	0.00%
Crossed	0	0.00%	0	0.00%	76-99%	0	0.00%	0	0.00%
Proximal (i.e. burin)	0	0.00%	1	16.67%	Complete retouch	0	0.00%	0	0.00%
								0	
Presence of burination:					Distribution of retouch:				
Yes	0	0.00%	1	0.93%	Continuous	0	0.00%	5	83.33%
No	11	100.00%	106	99.07%	Discontinuous	0	0.00%	0	0.00%
					Partial	0	0.00%	1	16.67%
Form of retouched edge:					Morphology of retouch:				
Rectilinear	0	0.00%	0	0.00%	Scaled	0	0.00%	2	28.57%
Concave	0	0.00%	1	16.67%	Stepped	0	0.00%	0	0.00%
Convex	0	0.00%	0	0.00%	Sub-parallel	0	0.00%	0	0.00%
Single removal (notch/burin)	0	0.00%	3	50.00%	Parallel	0	0.00%	0	0.00%
Denticulate	0	0.00%	2	33.33%	Notch/Denticulate	0	0.00%	4	57.14%
Multiple	0	0.00%	0	0.00%	Burin	0	0.00%	1	14.29%

Table 7.32. Technological observations from Bettencourt-Saint-Ouen (N2B) (retouch attributes)

7.5.3.6. Refit Analysis

In total, there are forty-two different instances or refits featuring a blade component. Eighteen refit sequences are described in detail below.

Refit analyses highlight the on-site production of blades within *chaînes opératoires* explicitly oriented towards the production of blades, sometimes in association with the production of points through unidirectional convergent schemes to varying degrees of opportunism. Rejuvenation techniques including semi-cresting are also highlighted, in addition to uncommon retouch behaviours e.g. burination. Natural ridges of elongated material are also used, exemplifying the plasticity of *chaînes opératoires* oriented towards Laminar blade production.

Remontage 115: Remontage 115 is comprised of six artefacts: one core (Laminar unidirectional pyramidal core from a facial strategy), one complete unretouched blade retaining no cortex, and three flakes - two cortical flakes and one preparation flake.

Remontage 16 (Figure 7.25): Remontage 16 is comprised of twenty-nine artefacts. The raw material is oriented towards the production of both points (n=4) and blades (n=4) from a unidirectional convergent scheme. Two cores are retained: a unidirectional parallel Laminar (facial) scheme, and a unidirectional convergent scheme, both oriented towards the production of elongated stereotyped material. Throughout, a succession of blades are produced after each point removal. Locht (2002) notes this to be of a Levallois operational scheme, given the production of points from two predetermined scars, however the *chaîne opératoire* is geared towards the production of both points and blades from a core volume management strategy that is Laminar in nature.

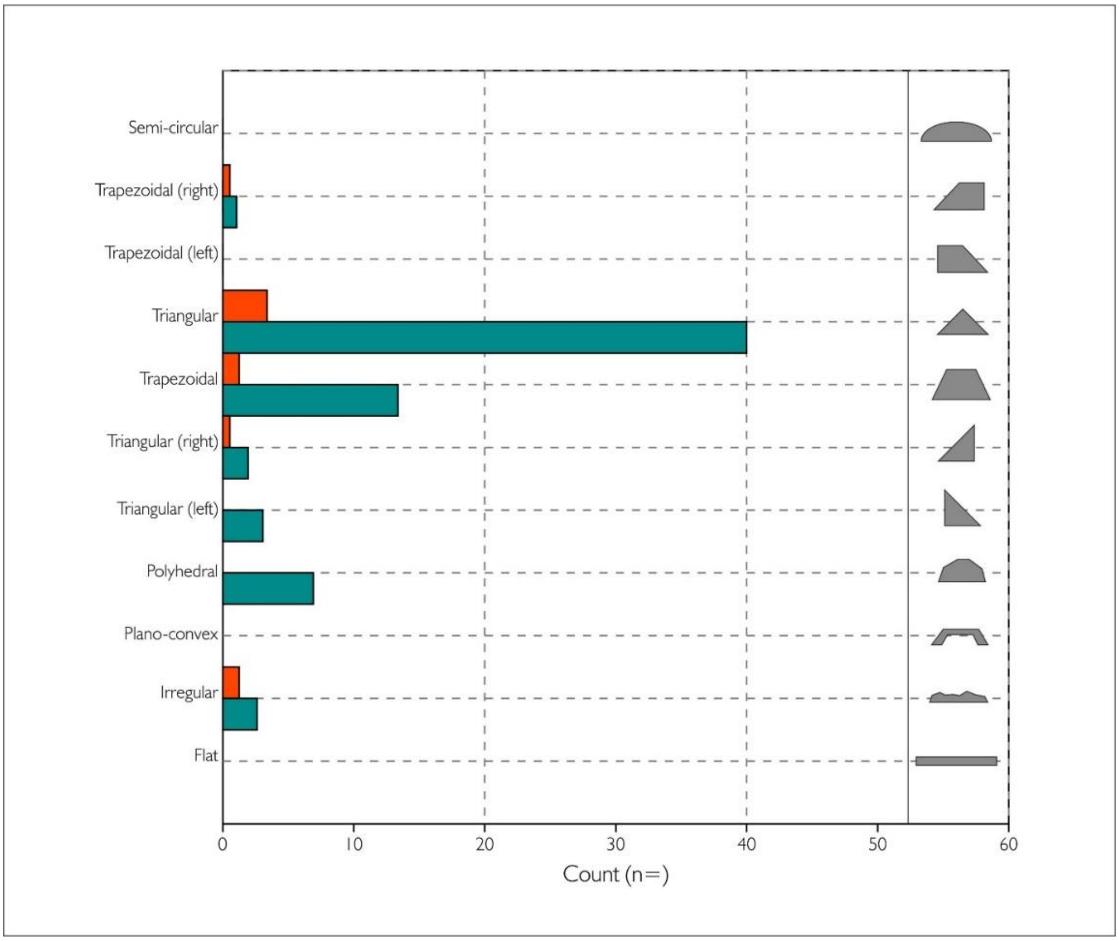


Figure 7.21. A bar-chart of the different cross-sections documented throughout Bettencourt-Saint-Ouen (N2B) (Dark Cyan: Laminar; Orangered: Levallois)

Remontage 51: Remontage 51 is comprised of two artefacts: a whole unretouched complete Laminar blade and a Laminar distal fragment. Both feature a bidirectional flake scar pattern, and represent successive blade removals (of differing success) around an absent core.

Figure 7.22. Examples from Bettencourt-Saint-Ouen (N2B). Top: *semi-tournant* blade core; Centre right: *tournant* blade core; Centre left: *semi-tournant* blade core; Bottom: *semi-tournant* blade core

Figure 7.23. Examples from Bettencourt-Saint-Ouen (N2B): Top left, Middle left, Middle right: unretouched Laminar blades; Top right, Bottom left, Bottom right: crested blades

Figure 7.24. Examples from Bettencourt-Saint-Ouen (N2B): retouched Laminar blades (retouch noted by arrows)

Remontage 35: Remontage 35 consists of three artefacts: a *tournant* bidirectional Laminar blade core, and two blades, one which features a burin removal.

Remontage 34: Remontage 34 is comprised of three artefacts: a *semi-tournant* bidirectional Laminar blade core, one complete blade and one proximal blade fragment (both unretouched).

Remontage 78: Remontage 78 is comprised of two artefacts: a complete blade (unretouched) refitted on the dorsal surface of a larger flake (rejuvenation flake?).

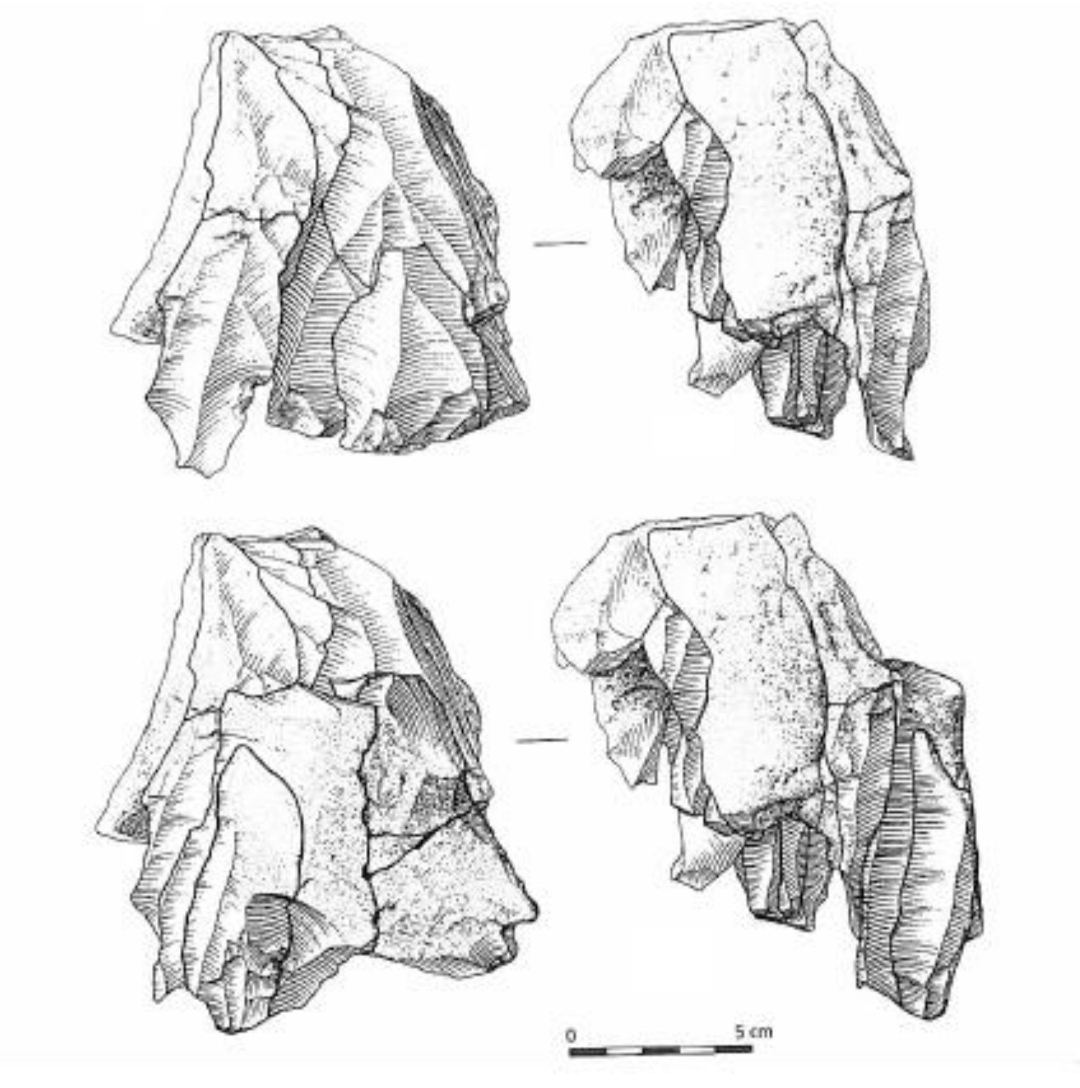


Figure 7.25. Remontage 16 from Bettencourt-Saint-Ouen (N2B) exemplifying the different stages of reduction and different components of the nodule, including the production of both blades and points. Modified from Locht (2002)

Remontage 136: Remontage 136 is made up of two artefacts: a complete Laminar blade resting on a *lame à demi-crête* - the semi-cresting here is potentially adopted in this instance as a rejuvenation technique.

Remontage 37: Remontage 37 is comprised of five artefacts: a *tournant* unidirectional blade core, two blades (unretouched) and two flakes (rejuvenation chunks?).

Remontage 47: Remontage 47 is comprised of two artefacts: a complete (unretouched) Laminar blade and a cortical flake.

Remontage 31: Remontage 31 comprises of eight artefacts - four flakes (all retaining some cortex), two blades (unretouched), a core tablet and a bidirectional *semi-tournant* core.

Remontage 113: Remontage 113 consists of thirty-six artefacts. The elongated nodule is first reduced through the production of cortical blades and flakes; the natural convexities and natural ridges are then exploited to ensure continuous exploitation. Backed blades are also produced to continue the production of blades and points. Throughout this sequence, six blade products are produced, all complete and unretouched in structure. A bidirectional scheme is utilised throughout.

Remontage 29: Remontage 29 comprises of four artefacts: one complete unretouched blade, two flakes, and a possible Laminar unidirectional (facial?) core.

Remontage 36: Remontage 36 is comprised of ten artefacts: four flakes, five unretouched blades and a *semi-tournant* Laminar core. The core features little preparation prior to exploitation.

Remontage 7: Remontage 7 is an irregular shaped nodule reduced almost to its entirety, and is comprised of eighteen artefacts. Following initial decortification and the production of cortical flakes three blades are produced. A second surface, opposite to the exploitation surface is then created. Following the production of several flakes, one further blade is produced before the initial platform is then exploited to produce three blades and points. Locht (2002) notes that the nodule is reduced to 8.25% of its original size (1090g).

Remontage 143: Remontage 143 comprised of two artefacts: a complete unretouched blade and a non-cortical flake.

Remontage 52: Remontage 52 comprises of two artefacts: a Laminar blade medial fragment, and a complete unretouched blade, superimposable on the dorsal surface.

Remontage 28: Remontage 28 comprises of eleven artefacts: a series of flakes (retaining varying degrees of cortex) and two blades in conjunction with a unidirectional convergent core.

For further illustrations of refits discussed see Figure 7.27.

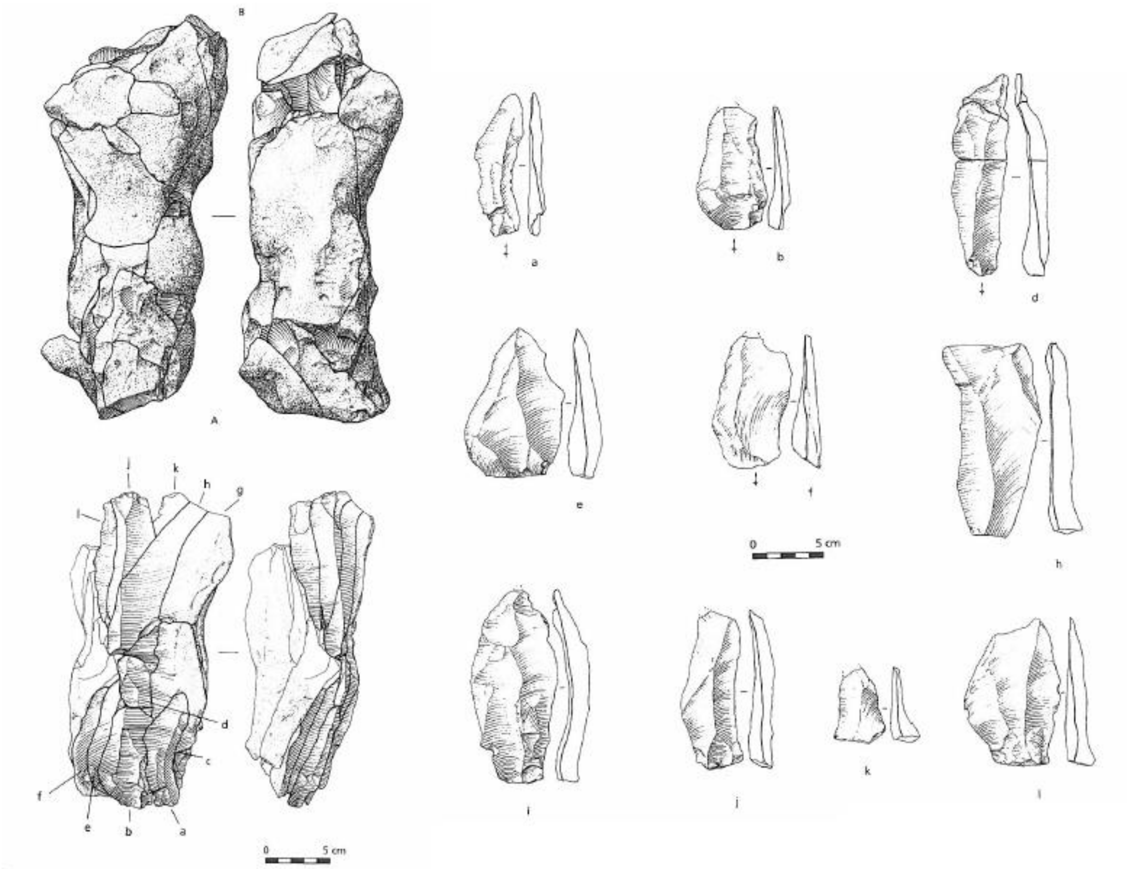


Figure 7.26. Left: Remontage 113 from Bettencourt-Saint-Ouen N2B exemplifying the sequence from full cortical nodule to exploitation (see Figure 7.25 for the exhausted core). Right: products (excluding 'g') from Remontage 113: a) Laminar blade, b) flake, c) naturally-backed Laminar blade (right), d) Laminar blade, e) point (unidirectional convergent flake), f) naturally-backed Laminar blade (left), h-j) Laminar blades, k) possible point, l) flake (modified from Locht, 2002)

7.5.4. Hominin Behaviour at Bettencourt-Saint-Ouen (N2B)

The extensive evidence for hominin activity at Bettencourt-Saint-Ouen (N2B) highlights a multitude of different technological and social behaviours towards the beginning of the Late Middle Palaeolithic. In its very nature, the sites document the continuous return to the site, and the continuous use of Laminar technology albeit to varying concentrations. The context also highlights the use of the landscape's advantages, specifically its location and use of high-quality local raw material, for butchery-related activities, as supported through the faunal and use-wear analyses.

The context boasts the flexibility of the Laminar technique. Whether this be in the method with which blades are produced (discretely or from point based technology), the varying levels of proceduralisation, the varying raw material morphologies used, or the technological behaviours undertaken (e.g. the multiple uses of cresting, the existence of platform and core rejuvenation and the presence of burin technologies), the Laminar concept is demonstrated in full. The techniques observed are not always lineal and systematic, but sometimes responsive and reactive, with behaviours including semi-cresting and rejuvenation demonstrating the Neanderthal's technological competency in the response of issues, and the malleability of blade techniques

Many parallels with Fresnoy-au-Val (Série 1) in almost all aspects of the Laminar technique are exemplified, lending to the notion of a technocomplex. This also holds true for the Levallois component of both assemblages, despite differences in their blade composition. Despite the recording of different Levallois flaking techniques, Laminar is clearly preferred and elongated Levallois products appear to be fortuitous in both examples noted within this chapter. For extensive inter-context analyses see Chapter 10.

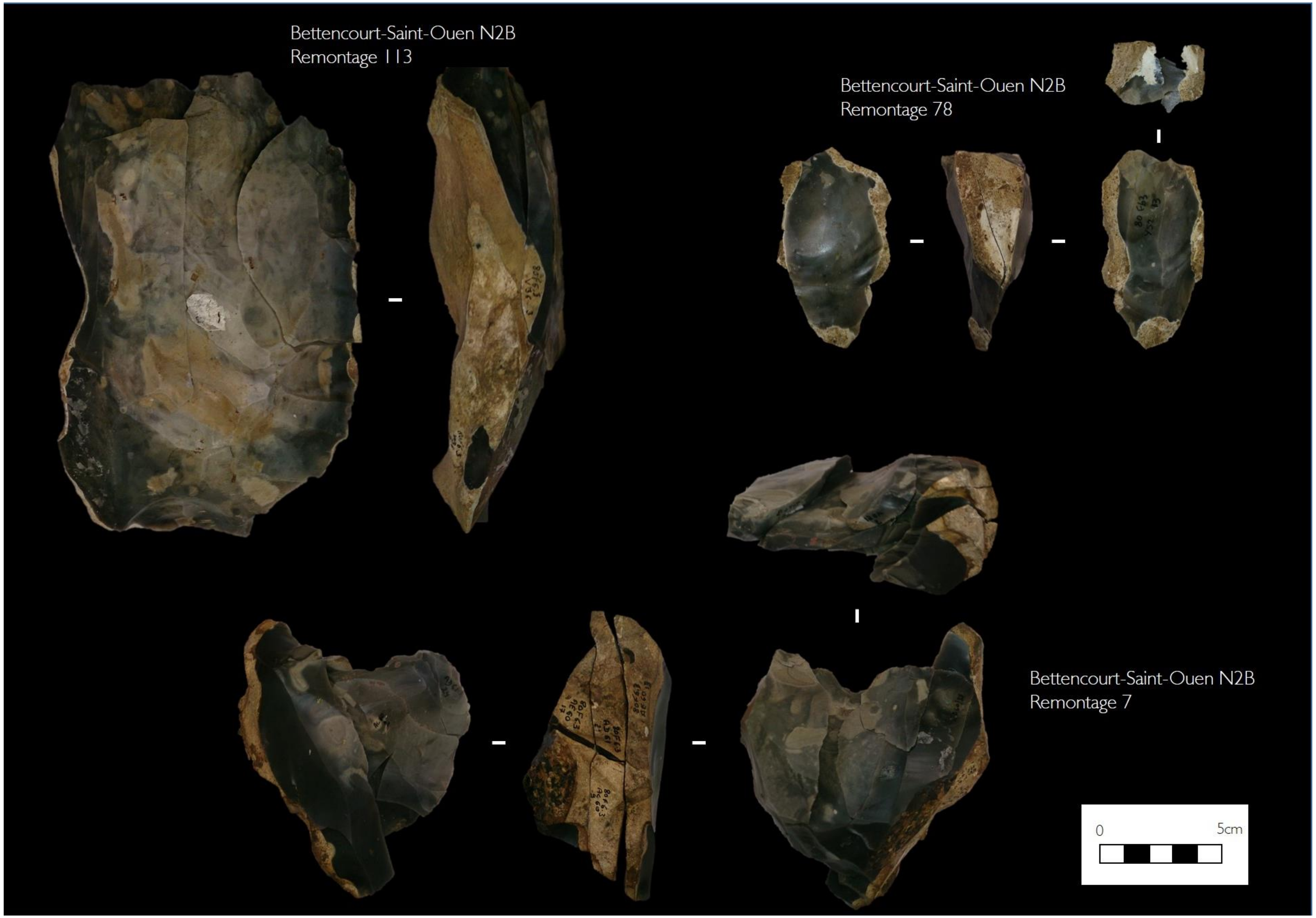


Figure 7.27. Refits from Bettencourt-Saint-Ouen (N2B) (for descriptions see text)

Chapter Eight
Technological Blade Strategies in Belgium: Selected Contexts

8.1. Introduction

In contrast to the previous chapter, both Belgium and UK feature significantly less evidence for Laminar and Levallois technological blade strategies within the Middle Palaeolithic, particularly so for the Late Middle Palaeolithic. In this section five occupational layers are discussed in detail. First, the archaeological material within the MOIS 8 context of Mesvin (IV) will be outlined, before documenting the evidence for blade technologies within the occupational layers of Le Rissori (IV/IIIA/IIIB). These two examples are a stark contrast to previous Early Middle Palaeolithic contexts discussed, with considerably more data for the presence of Levallois technological blade strategies, and significantly less evidence for Laminar blade products, more suggestive of the wider context. This section then concludes with the archaeological evidence for blade technology at Rocourt, where extensive *chaînes opératoires* exemplify a range of Laminar behaviours akin to that of Bettencourt-Saint-Ouen and Fresnoy-au-Val, both discussed in the previous chapter.

Like the previous chapter, a detailed taphonomic and technological analysis is outlined, with more extensive morphometric analyses discussed in Chapter 10.

8.2. Mesvin (IV)

8.2.1. Introduction and Overview of Investigations

The archaeological material of Mesvin (IV) is located among fluvatile sediments nearby the River Trouille within the Haine basin, 5km south of the town of Mons (Figure 8.1). On the edge of what is classified as the 'Mesvin terrace' (see below), the material at Mesvin (IV) was first investigated (following initial surface prospection) from 1977/1978 to 1984 resulting in part from a larger research program aimed at understanding the Palaeolithic occupation of the Haine river-terraces (Cahen et al., 1984).

A variety of evidence was excavated including faunal, floral and lithic material, providing a controlled chronostratigraphic and palaeoenviromnetal framework for the Haine Basin and contemporaneous contexts within the fluvatile terrace (Cahen et al., 1984, Cahen and Michel, 1986). Faunal research undertaken (Van Neer, 1981, 1985, 1986; Van Asperen, 2008) highlighted the presence of mammoth (*mammuthus primigenius*), woolly rhinoceros (*coelodonta antiquitatis*), bison (*bison sp.*), megaceros (*megaceros giganteus*), reindeer (*rangifer tarandus*), arctic fox (*alopex lagopus*), wild boar (*sus scrofa*) and horse (*equus sp.*), with horse being the most abundant. The variety of cool-adapted species in addition to comparative morphometric analyses of the *equus* remains with other remains around north-west Europe (Van Asperen, 2008) suggests the Mesvin IV landscape to have been a steppe-like environment of early Saalian date (c. MOIS 8), with the presence of wild boar also suggestive of localised patches of sheltered woodland nearby the River Trouille (Cahen et al., 1984; Van Neer, 1986). While poor in quality, palynological analysis (Roche, 1981; Cahen et al., 1984) further supported the zooarchaeological and morphometric evidence, highlighting the presence of a steppe-like vegetation with grasses dominating the palynological samples (90%), in addition to small amounts of *betulaceae*, specifically *spetula* (8%) and *alnus* (2%). Support for an early Saalian date was confirmed through Uranium-Thorium dating undertaken by the United States Geological Survey. Through analyses of *mammuthus* and *equus* in both the Upper and Basal gravels (see below for a geological explanation), a date of between c.300,000 and c.250,000 BP was concluded (Cahen et al., 1984). See Table 8.1 for a breakdown of dates obtained.

In total, over seven thousand lithic artefacts were excavated (n = 7438), documenting evidence for various core volume management strategies aimed at the production of flake, blade and point products. Evidence also highlights the presence of discoidal production in conjunction with a variety of other core volume strategies including unprepared, Levallois and both types of technological blade production, in addition to unifacially retouched tools and Micoquian asymmetrically bifaced tools (Cahen, 1981; Cahen et al., 1984; Ryssaert, 2004, 2006a, 2006b). Extensive technological analyses by Ryssaert (2006) highlight that all stages of core reduction for most systems are present, of varying expediency. Blade technology through a Laminar technique was noted by Ryssaert (2006), but not discussed in detail. Other previous technological analyses (Ryssaert, 2005) also note the possible use of the bidirectional anvil technique (*sensu* Breuil and Bordes), however due to a lack of usable experimental data and comparable studies, further work is necessary to assess the role the technique may have had within the assemblage. In terms of their function, analyses undertaken (Gysels and Cahen, 1981) document the use of various products with behaviours associated with butchery, hide-working, and wood-working. A blade was investigated from reports (Gysels and Cahen, 1981) and this was concluded as being unutilised; no other blades were known to be examined.

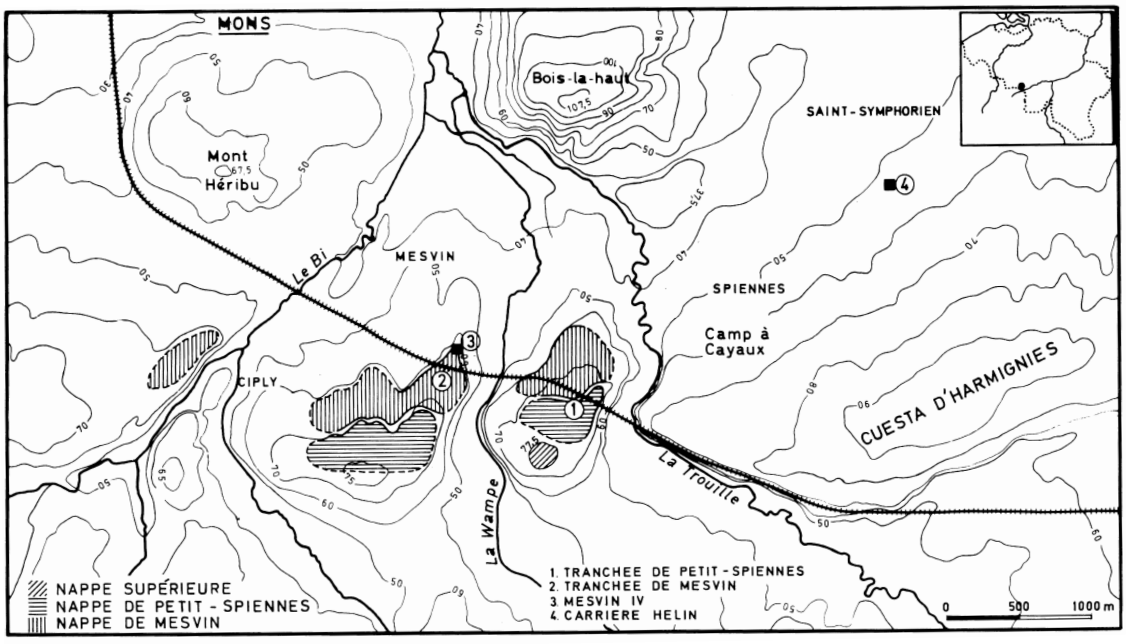


Figure 8.1. Location of Mesvin (IV) within the immediate landscape (Haine Basin), with other notable contexts documented (Cahen et al. 1984)

Context	Sample	Date (kya)
Upper Gravel	Mammuthus bone	298,000 +50,000/-35,000 275,000 +38,000/-29,000
Lower Gravel	Mammuthus bone Equus tooth	201,000 +37,000/-28,000 >123,000

Table 8.1. Uranium-Thorium dates for the Mesvin (IV) gravels (Cahen et al. 1984)

At present, it is unknown whether the archaeological evidence for Mesvin (IV) represents the accumulation of many occupational phases or one distinct occupational event. Ryssaert (2005, 2006a, 2006b) notes, given the presence of many different *façonnage* and reduction strategies, and through secondary movement of the Mesvin (IV) artefacts, that the evidence is time-averaged and represents multiple events, perhaps with differing populations. It cannot however be concluded at this time whether the assemblage reflects a single or multiple occupation events.

8.2.2. Geological and Chronostratigraphic Background

Both lithic and faunal evidence originate from two channels located just below the ground surface (Haesaerts, 1978). Both channels are incised in tertiary Thanetian (Landenian) sands (Figure 8.2). Channel One features the highest concentration of archaeological evidence and is positioned on the edge of the Mesvin terrace (Haesaerts, 1978, 1994). This terrace is situated within the Veldwezelt Formation, a unit within the Romont Group sixty metres in altitude above sea level (Haesaerts, 1978, 1994), and represents one of four units prior to the Last Interglacial palaeosols, ranging from MOIS 12 to MOIS 6 in date (Haesaerts, 1978, 1994; Pirson et al., 2009). It follows two previous units, the Pa d'la l'iau and Petit Spiennes units attributed to the Elsterian Glaciation, dating between 400,000 and 320,000 years ago (Litt et al., 2007). With an underlying cyclic glacial-interglacial pattern, similarities in the unit have been made to the Somme basin (Antoine, 2002), where the bulk of evidence in Chapter 7 originates from (see Di Modica and Pirson, 2016). In nature, Channel One is composed of two gravels: a basal gravel featuring high quantities of frost-fractured flint fragments, and an upper gravel featuring a high composition of chalky granules and smaller flint fragments (Cahen and Haesaerts, 1981; Cahen et al., 1984). In their recovery, most artefacts were located at the bottom of the basal gravel context, parallel to the eroding Palaeocene sand (Cahen et al., 1984; Cahen and Michel, 1986). This incision resulting from hydrographic systems has been hypothesised to correspond to the reworking and displacement of material, from channel one to channel two (Cahen and Haesaerts, 1981; Cahen and Michel, 1986).

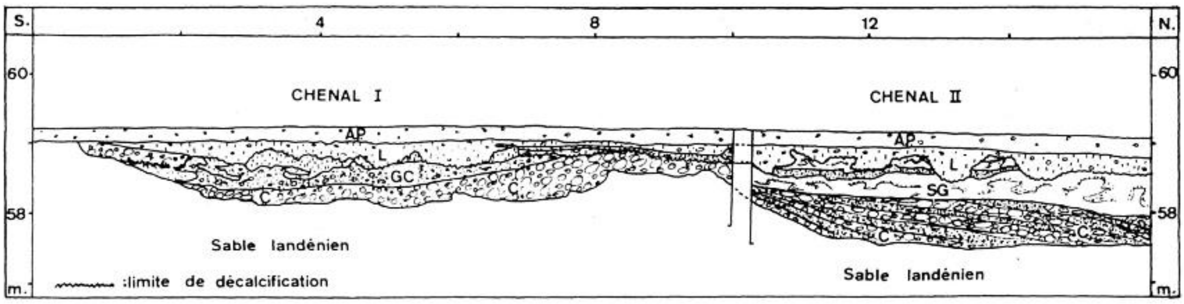


Figure 8.2. Stratigraphy of the two Mesvin (IV) channels (Cahen and Michel, 1986)

Legend: Holocene (AP); Brown silt (L); Chalk granules (GC); Grey sand (SG); Gravel (C)

Due to the underlying taphonomic conditions, primarily the rapid burial of the material within a fluvatile environment, and the presence of a chalky layer above the main fossil bearing context, faunal artefacts were retained. However, given hydraulic selection, acidic alteration, and freeze-thaw cycles many of the smaller bones were not retained (Van Neer, 1986). With regards to the lithic evidence, it was concluded that material was only slightly displaced from its original depositional context (Cahen et al., 1984). Despite this, artefacts are noted as being of varying states of preservation, with a mixture of both fresh and heavily rolled and damaged artefacts, with notable heavy patination (Cahen et al., 1984).

8.2.3. Artefact Analysis

8.2.3.1. Treatment and Selection of the Collection(s)

All material studied was studied in the *Institut Royal des Sciences Naturelles de Belgique* (IRSNB), and examined over several visits throughout the research process. As all artefacts were not catalogued it was necessary to examine all material, to check for blade material. In total, four-thousand two-hundred and forty-nine artefacts (accounting for 57% of the overall assemblage) was examined with only a small fraction pertaining to blade strategies. Historical information, including personal notes and other documentation by Daniel Cahen and others, were also used where relevant. As only one refit was noted (a blade break), all complete unretouched blades were subject to two-dimensional geometric morphometrics and digital measurements.

Given the presence of Levallois elongated recurrent strategies, and the quantity of Levallois blade *débitage, éclats débordants* were considered and examined alongside. However, as a variety of different Levallois strategies were also featured within the assemblage, caution must be needed in their direct association with blade *débitage*.

8.2.3.2. Technological Overview

The sample analysed consists of one-hundred and thirty-three artefacts; ninety-four when excluding *éclats débordants* (Table 8.2). Analyses highlight that material examined is oriented towards the production of elongated material through a Levallois recurrent strategy, on a variety of differing raw materials and morphologies. A large percentage of Levallois blades (complete and incomplete) are retouched, with many instances of continuous invasive retouch noted. Interestingly, a large number of retouched *éclats débordants* were also documented with just under a third of all *éclats débordants* examined featuring transformation.

Artefact	n	Percentage
Laminar blade (unretouched)	6	4.51%
Laminar blade (retouched)	0	0.00%
Laminar blade fragment (unretouched)	0	0.00%
Laminar blade fragment (retouched)	0	0.00%
Laminar crested blade (unretouched)	1	0.75%
Laminar crested blade (retouched)	0	0.00%
Laminar crested blade fragment (unretouched)	0	0.00%
Laminar crested blade fragment (retouched)	0	0.00%
Laminar blade core	4	3.00%
Levallois blade (unretouched)	34	25.57%
Levallois blade (retouched)	22	16.54%
Levallois blade fragment (unretouched)	15	11.28%
Levallois blade fragment (retouched)	7	5.26%
Levallois *éclat débordant* (unretouched)	26	19.55%
Levallois *éclat débordant* (retouched)	8	6.02%
Levallois *éclat débordant* fragment (unretouched)	2	1.50%
Levallois *éclat débordant* fragment (retouched)	2	1.50%
Levallois recurrent blade core	6	4.51%
Total:	133	100.00%

Table 8.2. Technological overview of the artefacts studied

Confidence	Laminar core	Levallois core	Laminar product	Levallois product
A (definite)	3 (75.00%)	6 (100.00%)	2 (28.57%)	93 (80.17%)
B (probable)	1 (25.00%)	0	3 (42.86%)	20 (17.24%)
C (possible)	0	0	2 (28.57%)	3 (2.59%)

Table 8.3. Confidence strategies for the artefacts studied

Evidence for Laminar technological blade systems are present, with four cores documented. These are of varying levels of formality, with evidence for both the direct exploitation of elongated nodules in addition to more formal blade *débitage* systems. While the evidence for Laminar core systems cannot be disputed, there is much less evidence for the presence of Laminar blade products, with seven artefacts recorded (one semi-crested blade and six possible blades). These are of varying levels of confidence in terms of identification (Table 8.3) and caution is again necessary with their incorporation into larger datasets given the abundance of evidence for Levallois blade production and Levallois blade products.

Only one refit was documented, representing a blade break.

8.2.3.3. Taphonomic History

Analyses of the assemblage's taphonomic history (Table 8.4) highlights previous author's views (e.g. Cahen et al., 1984) that the assemblage is indeed of mixed condition, with examples of heavily damaged and rolled artefacts, in addition to relatively fresh unpatinated artefacts.

Both Levallois and Laminar technological blades exhibited edge damage, with just under a quarter of all Levallois blade *débitage* exemplifying edge damage (typically light edge damage), and over a quarter of all Laminar blade *débitage* exemplifying edge damage (also typically light). Both this damage, and evidence of ridge damage documented may represent regionalised areas of high energy, given the known cryoturbation. Both technological strategies also feature evidence for scratching and battering, suggested of cold-climate re-arrangement and high-energy environments. A large number of frost-fractures were also noted (n=33).

Mesvin (IV): artefact condition (n=133)									
	Levallois (122)		Laminar (11)			Levallois (122)		Laminar (11)	
Whole/broken:					Degree of patination:				
Whole	95	77.87%	11	100.00%	Unpatinated	61	50.00%	6	54.55%
Broken	27	22.13%	0	0.00%	Lightly patinated	50	40.98%	4	36.36%
					Moderately patinated	7	5.74%	1	9.09%
					Heavily patinated	4	3.28%	0	0.00%
Degree of edge damage:					Degree of burning:				
No edge damage	93	76.23%	7	63.64%	Unburned	122	100.00%	11	100.00%
Lightly damaged	24	19.67%	4	36.36%	Lightly burned	0	0.00%	0	0.00%
Moderately damaged	5	4.10%	0	0.00%	Moderately burned	0	0.00%	0	0.00%
Heavily damaged	0	0.00%	0	0.00%	Heavily burned	0	0.00%	0	0.00%
Degree of rolling:					Portion/break:				
Unrolled	103	84.42%	10	90.91%	Complete	95	77.86%	11	100.00%
Lightly rolled	15	12.30%	1	9.09%	Proximal fragment	6	4.92%	0	0.00%
Moderately rolled	2	1.64%	0	0.00%	Medial fragment	9	7.38%	0	0.00%
Heavily rolled	2	1.64%	0	0.00%	Distal fragment	6	4.92%	0	0.00%
					Siret	6	4.92%	0	0.00%
Other observations: Some abrasion and some scratching present.									

Table 8.4. Detailed taphonomic characteristics of material analysed at Mesvin (IV)

The continuum of condition is also reflected in the degree of patination and chemical altering observed for all blade *débitage* with half (50.00%) of all Levallois material, and just under half (45.46%) of all Laminar material, featuring some degree of patination or chemical alteration. A handful of examples (n = 4, 3.28%), mostly Levallois in nature, are here categorised as being heavily patinated, suggestive of some degree of fluvial rearrangement. No artefacts were recorded as featuring burning at Mesvin (IV).

It is unknown if systematic sieving was undertaken at Mesvin (IV), so the material represented may or may not be representative of the site's total material.

8.2.3.4. Raw Material

Only two cores from the total amount of examples (n = 10) retain some degree of cortex (Table 8.5). This is positioned in both instances, on the circumference of a Laminar core where exploitation is incomplete. The cortex retained is unstained but worn, possibly from fluvial action, following extraction and deposition. This too is similar for blades recorded, with just over a quarter (n = 22, 28.57%) of all blade *débitage* retaining some degree of cortex. The greater number of all examples (90.90%) also feature cortex that is unstained and relatively worn.

As noted by Cahen et al. (1984), a variety of different local raw materials are utilised. Most examples appear to be largely homogenous in structure, with just under a quarter of examples retaining regions where silification was incomplete. In their morphology, a variety of shapes are utilised, including cylindrical, lenticular and globular examples documented. Despite this, cores are of similar weight and size throughout (see below), following reduction.

8.2.3.5. Technology: Extended Analysis

Within the Mesvin (IV) occupational layer(s), a predominantly Levallois technological blade strategy is attested, with some evidence for Laminar blade *débitage* also noted (Table 8.5).

The four Laminar recorded cores are largely facial in their exploitation strategy. Platforms feature little preparation, with only one core exemplifying multiple lineal flaking prior to blade detachment. In their exploitation, a unidirectional scheme is utilised, with no examples documented for the use of multiple/opposed platform schemes. In two instances, the Laminar production method is direct, with exploitation of elongated cortical nodules and very little core preparation, for more fortuitous exploitation of elongated material. In another instance, a *tournant* scheme is undertaken, however the core appears more informal and globular in shape, with scars exemplifying a lack of stereotyping. This rather informal approach to blade production is supported by the lack of evidence for cresting and semi-cresting, and rejuvenation flakes throughout the assemblage. Only one example of an artefact with characteristics exemplifying semi-cresting was recovered. The artefact (NSU 79 65-70) features no cortex and is unretouched in nature, with a flat/plain platform. In its form, the cresting is rather informal with less than 50% of the dorsal ridge exploited and only one face exploited. Ryssaert (2006b) notes the issue of similarities with crested products and *éclats débordants* from Levallois strategies at Mesvin IV (see Chapter 2 for more information). As the semi-crested blade is fortuitous this notion cannot be discounted.

Mesvin (IV): technological core observations (n=10)							
Core strategy:			Number of scars/core:				
Laminar	4	40.00%	Laminar: Min: 10, Max: 23, Mean: 15.25, (CV: 39.49)				
Levallois	6	60.00%	Levallois: Min: 11, Max: 17, Mean: 13.33, (CV: 20.49)				
			Number of elongated (L/W = 1.75>) scars/core:				
			Laminar: Min: 3, Max: 9, Mean: 5 (CV: 56.57)				
			Levallois: Min: 2, Max: 6, Mean: 3.17 (CV: 50.59)				
Levallois strategy:			Laminar core shape:				
Recurrent unidirectional	1	16.66%	Orthogonal/prismatic			0	0.00%
Recurrent bidirectional	5	83.33%	Semi-orthogonal/semi-prismatic			4	100.00%
			Pyramidal			0	0.00%
Laminar strategy:			Laminar platform preparation strategy:				
Semi-tournant/semi-rotating	0	0.00%	Single Lineal			3	75.00%
Tournant/rotating	1	25.00%	Multiple Lineal			1	25.00%
Facial	3	78.00%	Bidirectional			0	0.00%
Frontal	0	0.00%	3-way centripetal			0	0.00%
Multiple (combination)	0	0.00%	Centripetal			0	0.00%
			Lateral (left/right)			0	0.00%
			Perpendicular (left/right)			0	0.00%
Laminar core volume utilised:			Distal end-types:	Levallois (6)		Laminar (4)	
1-25%	0	0.00%	Feathered	5	83.33%	4	100.00%
26-50%	2	50.00%	Stepped	3	50.00%	1	25.00%
51-75%	2	50.00%	Hinged	0	0.00%	1	25.00%
76-100%	0	0.00%	Reverse Hinged	0	0.00%	0	0.00%
			Overshot	0	0.00%	0	0.00%
Levallois core preparation strategy:			Number of platforms:				
Unidirectional	1	16.67%	1	1	16.66%	4	100.00%
Bidirectional	0	0.00%	2	5	83.33%	0	0.00%
Convergent unidirectional	2	33.33%	Cortex percentage:				
Centripetal	1	16.67%	Absent	6	100.00%	2	50.00%
Unidirectional left	0	0.00%	1-25%	0	0.00%	1	25.00%
Unidirectional right	1	16.67%	26-50%	0	0.00%	1	25.00%
Bidirectional lateral	1	16.67%	51-75%	0	0.00%	0	0.00%
Unidirectional distal	0	0.00%	76-100%	0	0.00%	0	0.00%

Table 8.5. Technological observations from Mesvin (IV) (core attributes)

One Laminar core exemplifies a more formal stereotyped sequence of blade production, with a number of parallel elongated dorsal ridges down one face of the nodule. In this example, the broadest face of the core is exploited, with analyses of documented distal end-types demonstrating that the most recent scars are just three of a number of at least three sequences on the same face of the core. The core retains no cortex, and in its totality, is a stark contrast to the informal Laminar strategies exemplified. No refits are documented, or blades of similar colour or raw material type.

In addition to varying levels of formality, the Laminar cores are also of varying size (Table 8.6) with elongation indices between 0.9 and 2.0 noted.

Weight (g)	Min.	Max.	Mean	S.D.	Med.	CV
Levallois	110.40	204.30	175.30	36.45	188.90	20.80
Laminar	178.70	290.40	248.35	50.41	262.35	20.30
Length (mm)	Min.	Max.	Mean	S.D.	Med.	CV
Levallois	19.20	48.90	36.58	10.81	37.15	29.54
Laminar	77.15	142.70	103.17	29.14	96.44	28.24
Width (mm)	Min.	Max.	Mean	S.D.	Med.	CV
Levallois	57.14	116.20	86.98	24.51	87.15	28.18
Laminar	52.19	85.23	67.24	14.30	65.83	21.27
Elongation index (L/W)	Min.	Max.	Mean	S.D.	Med.	CV
Levallois	0.31	0.68	0.43	0.13	0.40	30.40
Laminar	0.90	2.00	1.58	0.47	1.71	30.00
Thickness (mm)	Min.	Max.	Mean	S.D.	Med.	CV
Levallois	32.10	54.30	42.53	8.52	41.55	20.03
Laminar	35.44	72.10	51.89	15.62	50.00	30.11
Core flattening index (Thickness/Width)	Min.	Max.	Mean	S.D.	Med.	CV
Levallois	0.31	0.66	0.51	0.12	0.52	24.15
Laminar	0.59	0.86	0.76	0.13	0.80	16.66

Table 8.6. Metric data for complete cores analysed (n=10)

The blades produced exemplify the use of hard hammer production, are non-cortical, and feature very few dorsal scars, with five of six recovered featuring 1-2 dorsal scars, and 1-2 elongated scars (Table 8.7). All examples possess one singular ridge, and are from both unidirectional and bidirectional core strategies. In all cases, the butts are dihedral, and are, in most examples (83.33%), feathered in their distal end-type. None of the blades produced feature retouch, contrasting the evidence for Levallois technological blade strategies documented (see below).

Six Levallois blade cores were also recorded. Many of these examples (83.33%) are bidirectional in exploitation, and are of varying core preparation strategy with three unidirectional (two convergent unidirectional), one centripetal, one unidirectional right, and one bidirectional lateral preparation strategy noted. None of the Levallois cores retain any cortex, and all feature some degree of facetting and platform preparation, demonstrating the degree of preparation, and perhaps necessity to produce blades. These form part of a rich Levallois strategy at Mesvin (IV) with evidence for preferential and centripetal recurrent Levallois flaking strategies, in addition to non-elongated and non-stereotyped Levallois recurrent techniques also present (Cahen et al., 1984). Only feathered and stepped distal end-types are observed.

Mesvin (IV): technological analysis (n=83)									
Percussion strategy:	Levallois (77)		Laminar (6)		Bulbar scar features:	Levallois (77)		Laminar (6)	
Hard	59	76.62%	4	66.67%	Well defined	31	40.26%	3	50.00%
Soft	0	0.00%	0	0.00%	Diffused	46	59.74%	3	50.00%
Mixed/Indeterminable	18	23.38%	2	33.33%	Absent/missing	0	0.00%	0	0.00%
Absent	0	0.00%	0	0.00%	Removed	0	0.00%	0	0.00%
Cortex percentage:					Number of dorsal scars:				
Absent	55	71.43%	6	100.00%	Absent	0	0.00%	0	0.00%
1-24%	20	25.97%	0	0.00%	1-2	15	19.48%	5	83.33%
25-49%	2	2.60%	0	0.00%	3-4	44	57.14%	1	16.67%
50-74%	0	0.00%	0	0.00%	5-6	13	16.88%	0	0.00%
75-99%	0	0.00%	0	0.00%	7+	5	6.49%	0	0.00%
Complete	0	0.00%	0	0.00%					
Number of dorsal scars:					Number of ridges/arrises:				
Absent	0	0.00%	0	0.00%	Absent	0	0.00%	0	0.00%
1-2	55	71.43%	5	83.33%	1	56	72.73%	6	100.00%
3-4	21	27.27%	1	16.67%	2	20	25.97%	0	0.00%
5-6	1	1.30%	0	0.00%	3	1	1.30%	0	0.00%
7+	0	0.00%	0	0.00%	4	0	0.00%	0	0.00%
					5+	0	0.00%	0	0.00%
Dorsal ridge/arise shape:					Flake scar pattern:				
Singular	34	44.16%	6	100.00%	Unidirectional	37	48.05%	3	50.00%
Parallel	11	14.29%	0	0.00%	Centripetal	1	1.30%	0	0.00%
Irregular	1	1.30%	0	0.00%	3-way centripetal	5	6.49%	0	0.00%
Regular converging	1	1.30%	0	0.00%	Bidirectional	20	25.97%	2	33.33%
Regular diverging	4	5.19%	0	0.00%	Lateral left	0	0.00%	0	0.00%
Y-shape	11	14.29%	0	0.00%	Lateral right	0	0.00%	0	0.00%
Inverted Y-shape	3	3.90%	0	0.00%	Convergent unidirectional	7	9.09%	0	0.00%
Offset left/right	5	6.49%	0	0.00%	Convergent bidirectional	0	0.00%	0	0.00%
Partial	4	5.19%	0	0.00%	Convergent and perpendicular	2	2.60%	0	0.00%
Central converging	3	3.90%	0	0.00%	Double perpendicular	1	1.30%	0	0.00%
Absent	0	0.00%	0	0.00%	Straight and perpendicular	3	3.90%	0	0.00%
					Cortical	0	0.00%	0	0.00%
					Indeterminable	1	1.30%	1	16.67%
Distal end-type:					Butt type:				
Feathered	49	63.64%	5	83.33%	Plain/flat	21	27.27%	0	0.00%
Stepped	10	12.99%	0	0.00%	Dihedral	0	0.00%	6	100.00%
Hinged	4	5.19%	1	16.67%	Cortical	10	12.99%	0	0.00%
Overshot	1	1.30%	0	0.00%	Natural (but non-cortical)	1	1.30%	0	0.00%
Present but indeterminable	0	0.00%	0	0.00%	Marginal	1	1.30%	0	0.00%
Missing	13	16.88%	0	0.00%	Mixed	11	14.29%	0	0.00%
					Facetted	19	24.68%	0	0.00%
					Missing (proximal missing)	11	14.29%	0	0.00%
					Trimmed	0	0.00%	0	0.00%
					Chapeau de Gendarme	3	3.90%	0	0.00%
					Damaged/unidentifiable	0	0.00%	0	0.00%

Table 8.7. Technological observations from Mesvin (IV) (blade attributes)

Weight (g)	Min.	Max.	Mean	S.D.	Med.	CV
Complete Laminar blade	3.25	23.40	14.50	9.20	13.34	54.55
Complete Levallois blade	5.20	54.60	33.25	14.65	24.30	72.80
Broken Laminar blade	-	-	-	-	-	-
Broken Levallois blade	3.10	32.10	16.58	6.21	23.20	65.30
Length (mm)	Min.	Max.	Mean	S.D.	Med.	CV
Complete Laminar blade	32.19	57.20	43.96	9.03	41.37	20.54
Complete Levallois blade	33.54	126.82	68.28	22.07	60.80	32.32
Broken Laminar blade	-	-	-	-	-	-
Broken Levallois blade	32.04	69.85	47.08	9.46	43.79	20.10
Width (mm)	Min.	Max.	Mean	S.D.	Med.	CV
Complete Laminar blade	9.21	25.30	16.41	6.08	16.24	37.10
Complete Levallois blade	12.52	66.84	30.00	13.48	26.10	44.95
Broken Laminar blade	-	-	-	-	-	-
Broken Levallois blade	13.77	39.54	25.23	7.39	24.44	29.29
Elongation Index (L/W)	Min.	Max.	Mean	S.D.	Med.	CV
Complete Laminar blade	1.79	3.81	2.90	0.78	2.85	26.74
Complete Levallois blade	1.76	3.95	2.39	0.55	2.20	23.01
Broken Laminar blade	-	-	-	-	-	-
Broken Levallois blade	1.14	2.98	1.96	0.48	1.81	24.63
Thickness (mm)	Min.	Max.	Mean	S.D.	Med.	CV
Complete Laminar blade	3.67	8.25	6.10	2.11	6.68	34.64
Complete Levallois blade	2.95	30.18	8.30	4.79	7.28	57.79
Broken Laminar blade	-	-	-	-	-	-
Broken Levallois blade	4.36	16.02	8.61	3.12	8.23	36.27
Working edge/edge circum. (mm)	Min.	Max.	Mean	S.D.	Med.	CV
Complete Laminar blade	79.81	125.46	104.69	21.82	102.64	31.44
Complete Levallois blade	86.01	380.26	165.01	54.71	152.62	33.15
Broken Laminar blade	-	-	-	-	-	-
Broken Levallois blade	89.45	195.84	130.43	29.95	123.22	22.96
Cutting edge per weight (mm/g)	Min.	Max.	Mean	S.D.	Med.	CV
Complete Laminar blade	4.25	15.40	10.90	4.53	11.60	65.40
Complete Levallois blade	2.12	8.70	5.48	2.32	7.10	54.90
Broken Laminar blade	-	-	-	-	-	-
Broken Levallois blade	2.42	8.94	5.62	2.10	4.92	34.50
Flattening index (mT/mW)	Min.	Max.	Mean	S.D.	Med.	CV
Complete Laminar blade	0.20	0.80	0.55	0.27	0.70	49.35
Complete Levallois blade	0.18	1.41	0.41	0.21	0.36	50.26

Table 8.8. Metric data for complete and broken Laminar blades and Levallois analysed (n=83)

The blades produced from Levallois recurrent elongated strategies feature characteristics typical of hard hammer production, despite the majority of examples (59.74%) featuring diffused bulbar scar features. Like Levallois blade cores, products retain little cortex with just over a quarter (28.77%) of examples retaining some cortex. Blades typically feature three-to-four scars but, similarly to Laminar blades, most often feature one-to-two elongated scars. Despite the predominant use of bidirectional recurrent strategies, a unidirectional scar pattern is most common, seen in just under half of all examples (48.05%). A bidirectional technique is then the next common, seen in just over a quarter (25.97%) of all examples. In their preparation, more than a quarter of blades exemplify some form of preparation with nineteen examples of facetting, and three examples of the *chapeau de gendarme* technique.

The blades produced are typically triangular in cross-section (Figure 8.3) and vary in size considerably. Furthermore, Levallois blades feature a mean elongation index lower than Laminar technological blades, and feature a much lower flattening index - this flattening index is comparable to other documented examples in both their archaeological and experimental equivalents.

Mesvin (IV): retouch analysis (n=83)									
Presence of retouch:	Levallois (77)		Laminar (6)		Location of retouch:	Levallois (77)		Laminar (6)	
Yes	28	36.36%	0	0.00%	Proximal left	6	7.79%	0	0.00%
No	49	63.64%	6	100.00%	Proximal right	5	6.49%	0	0.00%
					Medial left	10	12.99%	0	0.00%
					Medial right	9	11.69%	0	0.00%
					Distal left	8	10.39%	0	0.00%
					Distal right	5	6.49%	0	0.00%
					Complete/continuous	7	9.09%	0	0.00%
Position of retouch:					Retouch coverage (%):				
Direct	22	78.57%	0	0.00%	No retouch	49	63.64%	0	0.00%
Inverse	3	10.71%	0	0.00%	1-25%	6	7.79%	0	0.00%
Alternate	1	3.57%	0	0.00%	26-50%	9	11.69%	0	0.00%
Bifacial	2	7.14%	0	0.00%	51-75%	3	3.90%	0	0.00%
Crossed	0	0.00%	0	0.00%	76-99%	3	3.90%	0	0.00%
Proximal (i.e. burin)	0	0.00%	0	0.00%	Complete retouch	7	9.09%	0	0.00%
Presence of burination:					Distribution of retouch:				
Yes	0	0.00%	0	0.00%	Continuous	20	71.43%	0	0.00%
No	77	100.00%	6	100.00%	Discontinuous	1	3.57%	0	0.00%
					Partial	7	25.00%	0	0.00%
Form of retouched edge:					Morphology of retouch:				
Rectilinear	11	39.29%	0	0.00%	Scaled	26	92.86%	0	0.00%
Concave	4	14.29%	0	0.00%	Stepped	0	0.00%	0	0.00%
Convex	11	39.29%	0	0.00%	Sub-parallel	0	0.00%	0	0.00%
Single removal (notch/burin)	1	3.57%	0	0.00%	Parallel	0	0.00%	0	0.00%
Denticulate	1	3.57%	0	0.00%	Notch/Denticulate	2	7.14%	0	0.00%
Multiple	0	0.00%	0	0.00%	Burin	0	0.00%	0	0.00%

Table 8.9. Technological observations from Mesvin (IV) (retouch attributes)

One notable observation is the presence of retouch on twenty-eight examples (36.36%). Retouch is seen on all regions of the blade, with seven examples featuring continuous retouch around the entire edge of the blade. Retouch is typically direct in nature (78.57% of all retouched pieces), with retouch from the dorsal face, and is continuous in nature. Very few instances of notches and denticulates are present, with retouch typically rectilinear or convex in nature, in more of a scraper-like form. Refer to Table 8.9 for more information. A similar pattern of retouch is observed for the *éclats débordants* recorded. Of the thirty-nine *éclats débordants* recorded, eleven feature retouch, with five examples featuring more than 50% retouch coverage, and similarly to Levallois blades are continuous in form. They also feature a similar percentage of facetting, with eight of thirty-nine blades documenting the presence of facetting. Despite the problems and difficulty in determining *éclats débordants* as resulting from a recurrent elongated and stereotyped strategy, similar behaviours are witnessed. In this it can be hypothesised that naturally and worked backed knives, with a similar elongation index to Levallois blades (*éclat débordant* elongation index: 2.57, Levallois blade: 2.39), were of similar use, equifinal in nature.

For examples of blade *débitage* see Figure 8.4.

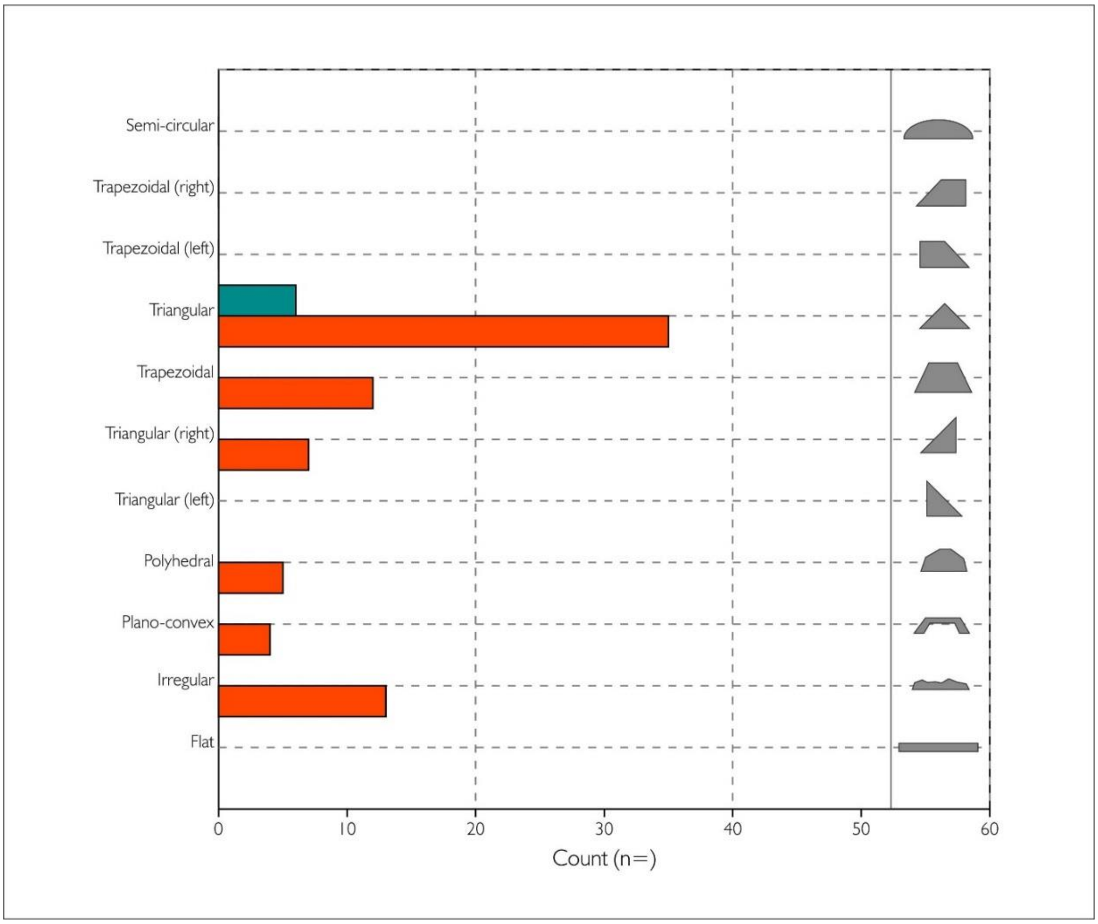


Figure 8.3. A bar-chart of the different cross-sections documented throughout Mesvin (IV) (Dark Cyan: Laminar; Orangered: Levallois)

Figure 8.4. Examples from Mesvin (IV): Laminar blade cores (left) and Levallois blade products (right).

8.2.4. Hominin Behaviour at Mesvin (IV)

The artefacts at Mesvin (IV) demonstrate the concurrency of technological blade strategies within a much larger technological repertoire during the Early Middle Palaeolithic. While it cannot be attested as to whether the assemblage results from multiple occupations or groups/populations, the material highlights the flexibility of the Laminar technique within a variety of raw material morphologies, and the formal production of blades through both a Levallois and Laminar technique. Similarly to other early sites in north-west Europe, there is little evidence for the use of cresting/semi-cresting, and an absence of behaviours associated with the maintenance of blade cores. However, as the more formal example demonstrates, Neanderthals possess the necessary behaviour for a proceduralised Laminar technique, with cores repeatedly exploited for blades, around the core's circumference. It is also interesting to note the absence of Laminar blade *débitage* associated with these cores and a distinct lack of refitting in both examples, and how these tie into behaviours associated with mobility and the transportation of artefacts. However, the extent that a high-energy taphonomic environment plays in their redeposition is unknown. The use of *éclats débordants*, and similarities in retouch with other Levallois blades, further highlights an advantage of Levallois blade technology in comparison to the Laminar technique: the creation of natural and backed knives, along the blade production sequence. The experimental evidence (Chapter 6) already highlights that *éclats débordants* possess a similar working edge angle, and could perform similarly to Levallois blade with the ergonomic advantage of a backed edge. This evidence further supports a body of existing knowledge demonstrating the use of artefacts typically categorised as waste products (see Chapter 2), and similarities between the transformation behaviours of Levallois blades and *éclats débordants*.

8.3. Le Rissori

8.3.1. Introduction and Overview of Investigations

Located 5km north of Mons, the site of Le Rissori is situated near the village of Masnuy-Saint-Jean within the Hainaut province of Belgium (Figure 8.5). Occupying the bottom of the Haine valley, a tributary which drains into the river Schedly, Le Rissori has been explored multiple times from the beginning of the twentieth century, with Palaeolithic material recovered within the region since 1905 (Lefrancq, 1951). The context and deposit now known as Le Rissori was discovered in the summer of 1953 by Louis Letocart of *La Société de Recherche préhistorique en Hainaut*, who identified Palaeolithic material within an earthwork spoil. Following a period of hiatus, investigations were undertaken by André Adam in summer 1961 until 1966 (Adam and Tuffreau, 1973). Later excavations were undertaken in order to understand the intricate chronostratigraphy of the Rissori complex from 1985 to 1992 (Adam, 1991, 2002); this later set of excavations revealed another major occupational level, or set of levels (see next section). All material is now divided among two collections housed at the *Institut Royal des Sciences Naturelles de Belgique* (IRSNB), and the *Société de Recherche préhistorique en Hainaut* (SRPH), in conjunction with the *Service public de Wallonie* (SPW).

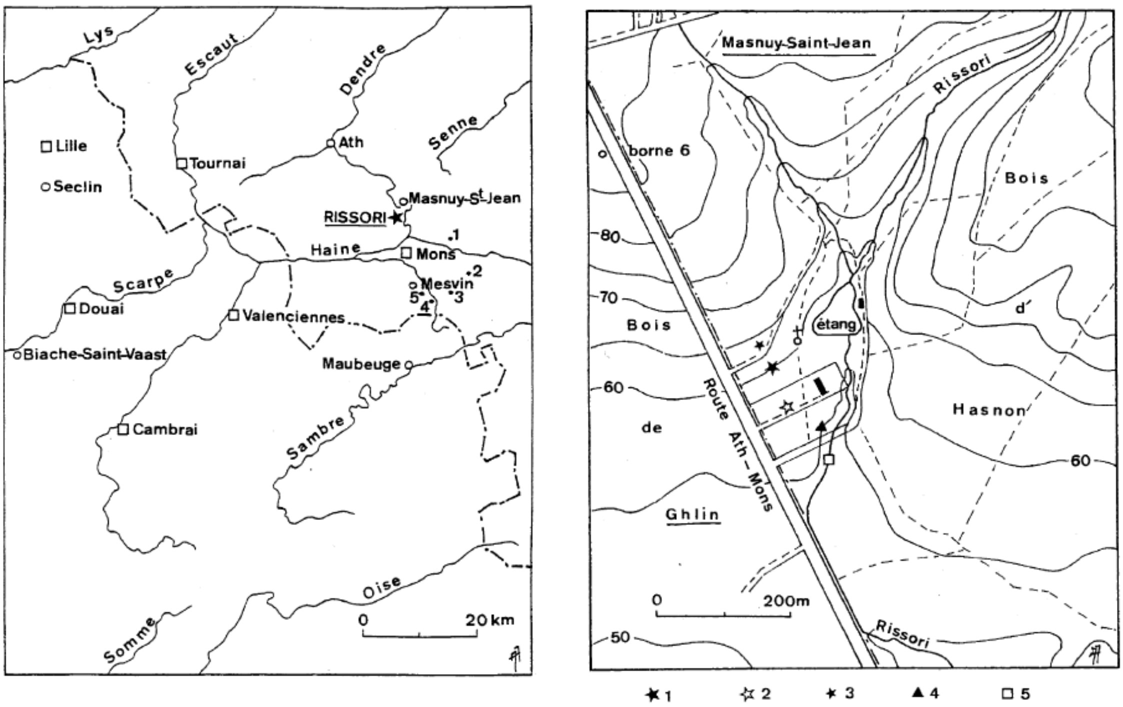


Figure 8.5. Left: geographic location for Le Rissori and nearby sites (1: Bois du Gard, 2: carrière d'Hardenpont, 3: carrière Hélin, 4: Pa d'là l'iau, 5: Mesvin IV). Right: topographic location for Rissori (1: 1985-1992 excavation, 2: 1960-1966 excavation, 3: northern limit of the site, 4: 1980-1986 Mesolithic site test pit, 5: Le Rissori Trench); Modified from Adam (1991)

Literature on Le Rissori has widely highlighted the existence of multiple different blade *débitage* systems within the Le Rissori complex in addition to its other technological components, and/or lack of. Initial analyses following the 1961 excavations (Adam and Tuffreau, 1973) emphasised the Levallois component of the assemblage, particularly the Levallois blades and points, and tools of Upper Palaeolithic type e.g. end-scrapers. These initial excavations and analyses featured a significant lower blade component, with twenty-one examples of Levallois blade products and one-hundred and eighteen products featuring a blade-based index, from a total of eight-hundred and five (ILam: 16.32).

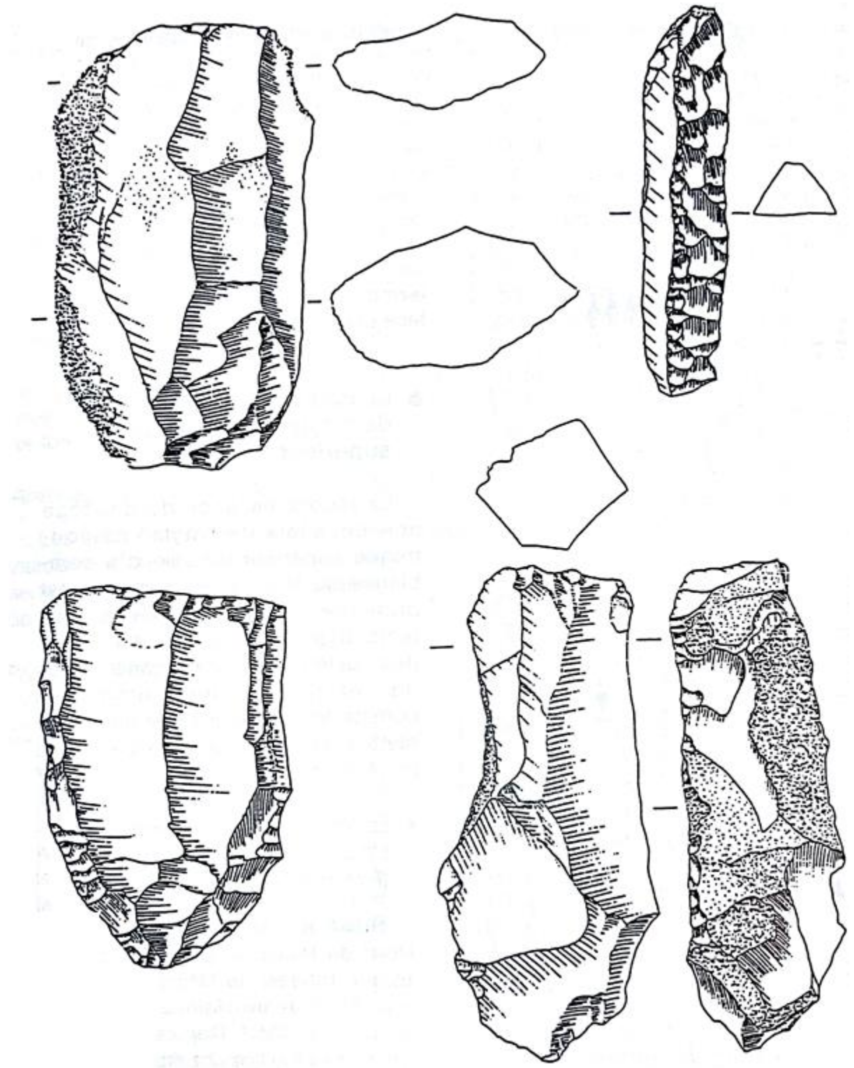


Figure 8.6. Technological blade strategies recorded throughout Le Rissori (not to scale): top left: Laminar blade core (IIIA), top right: *lame â créte* (IIIA), bottom left: unidirectional Levallois blade core (I), bottom right: Laminar blade core (IIIA) (modified from Adam, 1991)

Blade technology was first discussed in detail through technological and typological analyses undertaken by Locht (1986), in which he noted the thick morphologies of some blades, possible examples of crested blades and a high facetting percentage (20%). Locht (1986: 33) also notes the difficulty in determining the exact *chaîne opératoire* with which the blades on-site were produced from, writing: "*Il nous est impossible de déterminer exactement au moyen de quel mode opératoire chaque lame a été obtenue, les produits laminaires ne correspondant* *pas toujours aux négatifs de même type*". With respect to the cores identified, Locht (1986) documents the use of both single and multiple opposed platforms, rectilinear in morphology, with some maintenance on the distal convexities. With respect to the Upper Palaeolithic cores, Locht (1986: 38) notes: "*Certains nucleus, de technique très sure pourraient, dans un sens large, annoncer le paléolithique supérieur*". The Upper Palaeolithic affinities of the blade production at Le Rissori were also noted in the initial excavation report undertaken by André Adam (Adam, 1991, Figure 8.6), and in Révillion's (1993b) examination of different core volume management systems, noting the presence of direct, Levallois, *semi-tournant* and Upper Palaeolithic type systems of blade production on-site.

In the last fifteen years, studies have focused on other components of the assemblage and commonalities and differences between differing layers of the Le Rissori complex. The study of the pseudo-Levallois points, through the working of *éclats débordants* by Adam (2002) represents the last in-depth technological analysis of the Le Rissori contexts. In this, Adam (2002) suggests that the dimensions of the *éclats débordants* were produced through specific rearrangement of the core, tailoring the production of pseudo-Levallois points (an idea discussed more below). More recently, the succession of the different layers (see below) have been questioned. Similarities in the patina throughout the IV, IIIA and IIIB layers (discussed and analysed in detail below) has led to suggestions by Pirson and Di Modica (2011) that reworking and the admixture of layers may have occurred. However, as noted by both Pirson and Di Modica (2011) and Adam (1991, 2002) note, there are distinct differences in the technological component of each assemblage with considerably less evidence for technological blade strategies in Series IV, which Adam (1991) note as marked evolution within the Laminar component of the assemblage. Despite this, the true chronostratigraphic nature of Le Rissori (IIIA/IIIB) remain unclear.

8.3.2. Geological and Chronological Background

Initial investigations during the 1960s (Adam and Tuffreau, 1973) noted that Le Rissori was comprised of three major units not belonging to a fluvatile-loess sequence, as is the case with Mesvin (IV). The stratigraphy was later reclassified through the later excavations from 1985-1992 revealed four major units, composed of gravels and sands or silty sands (lithostratigraphic units) separated by three palaeosol formations. The first upper palaeosol, previously recognised in earlier excavations (Adam and Tuffreau, 1973), is reddish tint in nature and sits on-top of unit two. Given its distinct chronological placement and the complexity of the sequence, it is known to date from the Eemian Interglacial (MOIS 5) (Adam, 2002; Haesaerts, 1984a, 1984b; Haesaerts and Dupuis, 1986). A second palaeosol, ochre-brown in colour (reflecting pedogenesis of a brown soil type, was discovered through the second set of excavations and is preserved above unit three (Haesaerts, 1984a, 1984b; Adam, 2002). A third palaeosol developed in the upper silty sands completes the sequence (Adam, 2002). Each of the lithostratigraphic units throughout these palaeosols termed Le Rissori IV/IIIB/IIIA/I) all feature archaeological material, with Le Rissori (IV/IIIB/IIIA), termed the *séries brunes* (Adam, 2002), given their brown patination and staining, This sedimentary sequence concludes with Turonian chalk and Thanetian sands (Adam, 2002). See Figure 8.7 for an overview of the chronostratigraphic sequence.

With respect to dating, no radiometric dates are available, and dating is concluded through the chronostratigraphic positioning of the lithostratigraphic units. The archaeological material in the Le Rissori IV context is considered contemporary with the lithic material at Mesvin (IV), MOIS 8/7c in date. This is hypothesised as the basal gravel lies at an altitude of 53m which Adam (2002) believes corresponds to the incision of the Mesvin terrace on the southern slope of the Haine basin (Haesaerts, 1984a, 1984b). The Le Rissori (IIIB) material is believed to date from MOIS 7b given the incision date and the presence of palaeosols, with Le Rissori (IIIA) thought to be contemporaneous or postdating MOIS 7a (Adam and Tuffreau, 1973; Adam, 2002).

As noted in the previous section, it is unknown whether the three assemblages are reworked and redeposited. All three assemblages do feature brown patination, reflecting pedogenesis and leaching from the brown soil type from the various palaeosols, and it is plausible that this may represent one distinct artefact layer. Three palaeosols can, however be observed within the stratigraphic record, demonstrating long periods of temporal division. Despite this, the horizons are unclear and distinct divisions are difficult to determine. The chronostratigraphy is further complicated through its slope context (7.1% inclination), suggestive of further possible movement and successive remodelling of phases. The contemporaneity of the different contexts will be considered through an examination of the taphonomic history of all three contexts, and its technological characteristics.

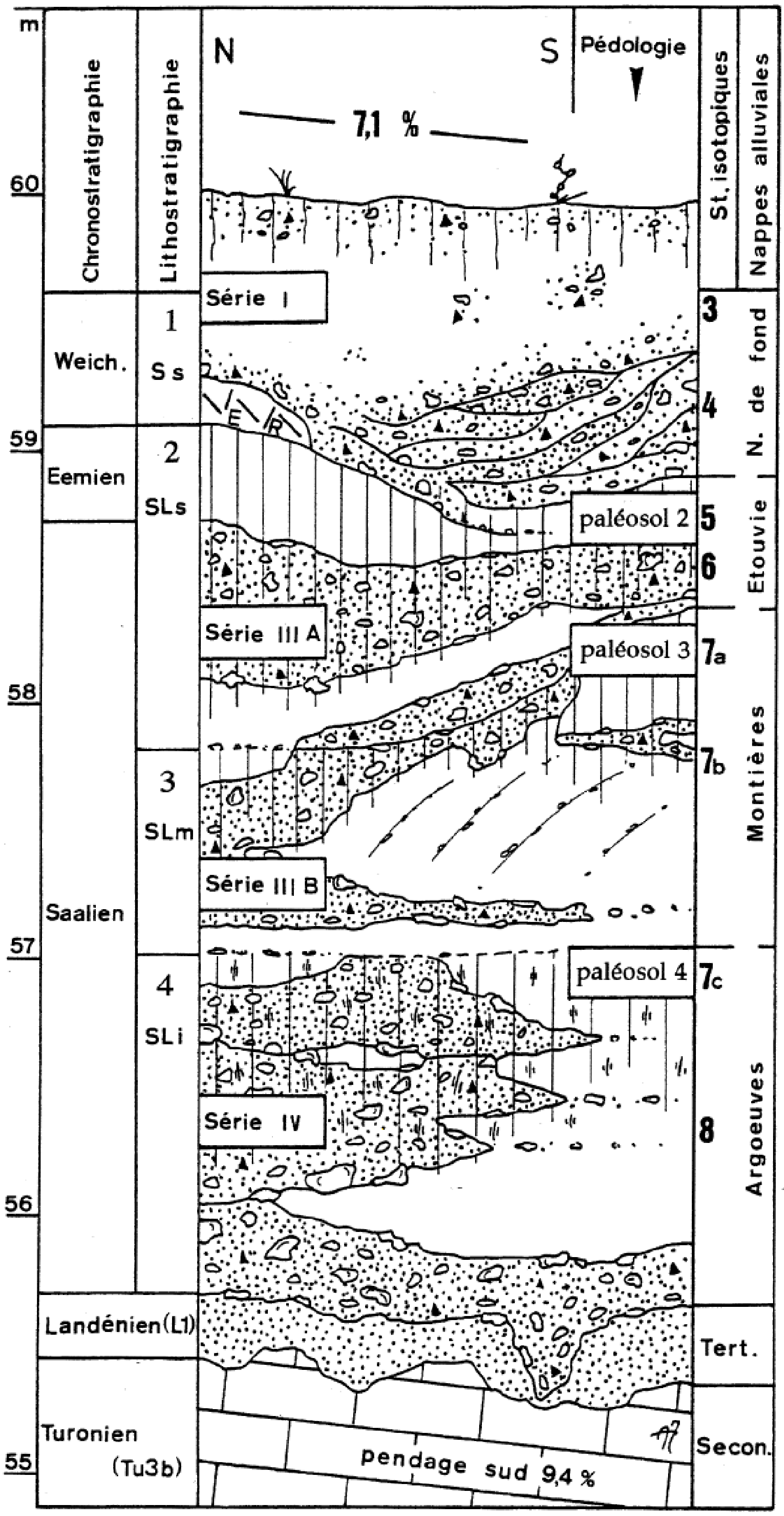


Figure 8.7. The stratigraphic sequence for the Le Rissori complex with palaeosols and lithostratigraphic units labelled (Adam, 2002)

8.3.3. Artefact Analysis

8.3.3.1. Treatment and Selection of the Collections

All material studied within this section was analysed from material archived at the *Institut royal des Sciences naturelles de Belgique* (IRSNB), in over multiple visits throughout the research candidature. The material examined originates from the most recent excavations, and is fragmented in nature with material also archived with the *Société de Recherche préhistorique en Hainaut* (SRPH) in conjunction with the *Service public de Wallonie* (SPW). Material in the IRSNB represents material unstudied in-depth for their blade component, and represents a chance to fully understand the nature of behaviour within the Le Rissori complex. All material had to be investigated as artefacts were not catalogued per artefact type. Historic material (papers and documents by André Adam) were also used where applicable to better understand the context with which the artefacts originated from.

In total, two-hundred and seventeen artefacts were analysed from three different contexts: eighteen artefacts from Le Rissori (IV), ninety artefacts from Le Rissori (IIIB), and one-hundred-and-nine artefacts from Le Rissori (IIIA). These are discussed separately in detail below.

8.3.3.2. Le Rissori (IV)

8.3.3.2.1. Technological Overview

Eighteen artefacts were identified as originating from a technological blade strategy, and specifically a Levallois recurrent elongated strategy. Four examples, representing 22.22% of the sample were confidently identified as originating from a Levallois blade system, given their wide platforms, dorsal scar patterns, and other technological characteristics. A further fourteen examples (77.78%) were identified as 'probable' Levallois blade products, given their technological attributes (Table 8.10). Of the eighteen, the majority are complete Levallois blades with a high retouch presence (Table 8.11). No Levallois recurrent blade cores were recorded among the assemblage, and as no refits are present, it should not be discounted that these artefacts do not originate from a Levallois elongated recurrent blade system.

Confidence	Laminar core	Levallois core	Laminar product	Levallois product
A (definite)	-	-	-	4 (22.22%)
B (probable)	-	-	-	14 (77.78%)
C (possible)	-	-	-	-

Table 8.10. Confidence categories for the artefacts studied

Artefact	n	Percentage
Laminar blade (unretouched)	0	0.00%
Laminar blade (retouched)	0	0.00%
Laminar blade fragment (unretouched)	0	0.00%
Laminar blade fragment (retouched)	0	0.00%
Laminar crested blade (unretouched)	0	0.00%
Laminar crested blade (retouched)	0	0.00%
Laminar crested blade fragment (unretouched)	0	0.00%
Laminar crested blade fragment (retouched)	0	0.00%
Laminar blade core	0	0.00%
Levallois blade (unretouched)	9	50.00%
Levallois blade (retouched)	7	38.89%
Levallois blade fragment (unretouched)	2	11.11%
Levallois blade fragment (retouched)	0	0.00%
Levallois *éclat débordant* (unretouched)	0	0.00%
Levallois *éclat débordant* (retouched)	0	0.00%
Levallois *éclat débordant* fragment (unretouched)	0	0.00%
Levallois *éclat débordant* fragment (retouched)	0	0.00%
Levallois recurrent blade core	0	0.00%
Total:	18	100.00%

Table 8.11. Technological overview of the artefacts studied

8.3.3.2.2. Taphonomic History

Recording of the context's taphonomic history (Table 8.12) highlights many previously known attributes of the lithic material, its context, and the characteristics of the stratigraphic record. A low-moderate energy environment is illustrated throughout the data analysed within Le Rissori (IV), with over half of all blades (61.11% of all artefacts) featuring some degree of (light) edge damage, with only seven examples (38.89% of all artefacts) featuring relatively fresh edges. Six examples also feature scratching on either the dorsal or ventral profiles of blade *débitage*, with evidence for rolling evident also apparent (n = 5, 28.57%). This level of energy may result from a number of mechanical factors including the site's slope formation or cryoturbation.

Le Rissori (IV): artefact condition (n=18)									
	Levallois (18)		Laminar (0)			Levallois (18)		Laminar (0)	
Whole/broken:					Degree of patination:				
Whole	16	88.89%	0	0.00%	Unpatinated	3	16.67%	0	0.00%
Broken	2	11.11%	0	0.00%	Lightly patinated	8	44.44%	0	0.00%
					Moderately patinated	6	33.33%	0	0.00%
					Heavily patinated	1	5.56%	0	0.00%
Degree of edge damage:					Degree of burning:				
No edge damage	7	38.89%	0	0.00%	Unburned	18	100.00%	0	0.00%
Lightly damaged	11	61.11%	0	0.00%	Lightly burned	0	0.00%	0	0.00%
Moderately damaged	0	0.00%	0	0.00%	Moderately burned	0	0.00%	0	0.00%
Heavily damaged	0	0.00%	0	0.00%	Heavily burned	0	0.00%	0	0.00%
Degree of rolling:					Portion/break:				
Unrolled	14	77.78%	0	0.00%	Complete	16	0.00%	0	0.00%
Lightly rolled	4	22.22%	0	0.00%	Proximal fragment	0	0.00%	0	0.00%
Moderately rolled	0	0.00%	0	0.00%	Medial fragment	1	0.00%	0	0.00%
Heavily rolled	0	0.00%	0	0.00%	Distal fragment	1	0.00%	0	0.00%
					Siret	0	0.00%	0	0.00%
Other observations: Some abrasion and some scratching present.									

Table 8.12. Detailed taphonomic characteristics of material analysed at Le Rissori (IV)

Patination is observed throughout the artefacts studied with only three examples of unpatinated blades (16.67%), from leaching of overlying/adjacent palaeosols. Cortex is retained on a small number of examples (see below), and this appears relatively fresh in nature.

No examples of characteristics typically associated with burning were noted.

8.3.3.2.3. Raw Material

The blade *débitage* exemplifies the use of a cryptocrystalline flint featuring a high degree of silicification. It is hypothesised that the raw material is of local origin within the immediate landscape (Adam and Tuffreau, 1973; Adam, 1991).

No technological blade cores were recorded throughout the Le Rissori (IV) collection, so the exact morphology of the raw material used is limited to analyses of the blade *débitage* (see below). However, given differences in the raw material types, and the variety of raw material morphologies utilised throughout the assemblage (Adam, 1991), it can be hypothesised that nodules of differing raw material morphologies were utilised throughout the production of blades.

8.3.3.2.4. Technology: Extended Analysis

All evidence originates from a Levallois-based strategy with no evidence for either Laminar technological blade cores or products present. As the blades feature a more complex dorsal scar pattern, with more varied arrise patterns, and the present of wide platforms, it was concluded that all artefacts were Levallois in nature, agreeing with the greater Levallois component of Le Rissori (IV).

Levallois blade *débitage* is in most cases complete with only two breakages present: one medial and one distal fragment. The products are of varying form (Table 8.13) with products ranging in weight (118.70g), and length (83.49mm) considerably. The blade *débitage* is however fairly standardised in elongation, with a coefficient of variation value of 15.23% and a low standard deviation. Furthermore, blade *débitage* features a relatively standardised flattening index, with a CV value of 19.26%. In its nature, the flattening index corresponds with other known experimental and archaeological values of Levallois blades documented throughout the thesis. Core surfaces and convexities can be hypothesised through an examination of the blank's curvature. Blade products are predominantly straight with a small percentage of curved blades present (see Chapter 10 for more information), suggestive of the 'peeling off' of blades from a gently convex delineated surface.

The blades are typically polyhedral or trapezoidal in cross-section (Figure 8.8) and are produced through a hard hammer technique, with over four-fifths (81.25%) of all complete blades demonstrating well defined and pronounced bulbar scar features (Table 8.14). The Levallois blade *débitage* features a relatively complex dorsal scar profile, despite only featuring one or two dorsal ridges/arrises, with more than half (55.56%) of all blades featuring more than five scars greater than 10mm. Both unidirectional and bidirectional strategies are attested with three-fifths of all products featuring a unidirectional (convergent/lineal) dorsal scar pattern. The blades appear to have been exploited to varying degrees of success with less than half (44.44%) of examples feathered, and a fifth (22.22%) of examples overshot in nature. This is perhaps due to the lack of preparation prior exploitation with no examples of facetting platforms present; mixed (33.33%) and plain (27.78%) platforms make up the main platform types documented.

A considerable number of artefacts feature retouch, with seven examples (38.89%) featuring transformation following exploitation (Table 8.15). As the retouch is invasive and sometimes localised, it was concluded that this anthropogenic in nature. This is further supported through the lack of arrise damage documented. In its nature, all retouch is direct from the dorsal surface and is largely invasive with significant coverage around the blade edge. Four of the seven products feature complete retouch, typically scaled and continuous in morphology. Examples of notches are also documented. Examples of notches feature high retouch coverage, all around the blade edge, and are typically less than 10mm in maximum size (width).

For examples of Levallois blade *débitage* see Figure 8.9.

Weight (g)	Min.	Max.	Mean	S.D.	Med.	CV
Complete Laminar blade	-	-	-	-	-	-
Complete Levallois blade	4.50	123.20	35.33	32.19	25.90	91.10
Broken Laminar blade	-	-	-	-	-	-
Broken Levallois blade	7.30	21.60	14.45	10.11	14.45	69.97
Length (mm)	Min.	Max.	Mean	S.D.	Med.	CV
Complete Laminar blade	-	-	-	-	-	-
Complete Levallois blade	44.50	127.99	74.79	21.70	71.66	29.02
Broken Laminar blade	-	-	-	-	-	-
Broken Levallois blade	51.49	51.70	51.60	0.15	51.60	0.29
Width (mm)	Min.	Max.	Mean	S.D.	Med.	CV
Complete Laminar blade	-	-	-	-	-	-
Complete Levallois blade	19.13	65.10	37.25	11.02	33.93	29.58
Broken Laminar blade	-	-	-	-	-	-
Broken Levallois blade	26.53	34.02	30.28	5.30	30.28	17.49
Elongation Index (L/W)	Min.	Max.	Mean	S.D.	Med.	CV
Complete Laminar blade	-	-	-	-	-	-
Complete Levallois blade	1.75	2.86	2.08	0.32	1.97	15.23
Broken Laminar blade	-	-	-	-	-	-
Broken Levallois blade	1.52	1.94	1.73	0.30	1.73	17.21
Thickness (mm)	Min.	Max.	Mean	S.D.	Med.	CV
Complete Laminar blade	-	-	-	-	-	-
Complete Levallois blade	4.49	15.02	8.22	2.88	7.77	34.98
Broken Laminar blade	-	-	-	-	-	-
Broken Levallois blade	9.49	13.75	11.62	3.01	11.62	25.92
Working edge/edge circum. (mm)	Min.	Max.	Mean	S.D.	Med.	CV
Complete Laminar blade	-	-	-	-	-	-
Complete Levallois blade	118.06	336.10	210.06	57.55	206.27	27.40
Broken Laminar blade	-	-	-	-	-	-
Broken Levallois blade	144.73	172.33	158.53	19.52	158.53	12.31
Cutting edge per weight (mm/g)	Min.	Max.	Mean	S.D.	Med.	CV
Complete Laminar blade	-	-	-	-	-	-
Complete Levallois blade	2.72	26.24	9.30	5.74	8.70	61.70
Broken Laminar blade	-	-	-	-	-	-
Broken Levallois blade	7.97	19.83	13.90	8.37	13.90	60.26
Flattening index (mT/mW)	Min.	Max.	Mean	S.D.	Med.	CV
Complete Laminar blade	-	-	-	-	-	-
Complete Levallois blade	0.24	0.53	0.39	0.08	0.40	19.26

Table 8.13. Metric data for complete and broken Levallois blades analysed (n=18)

Despite the presence of Levallois blades, and Levalloisian strategies, no *éclats débordants* or Levallois cores were identified within the analysis.

Le Rissori (IV): technological analysis (n=18)										
Percussion strategy:	Levallois (18)		Laminar (0)		Bulbar scar features:	Levallois (18)		Laminar (0)		
Hard	16	88.89%	0	0.00%	Well defined	13	72.22%	0	0.00%	
Soft	0	0.00%	0	0.00%	Diffused	3	16.67%	0	0.00%	
Mixed/Indeterminable	0	0.00%	0	0.00%	Absent/missing	2	11.11%	0	0.00%	
Absent	2	11.11%	0	0.00%	Removed	0	0.00%	0	0.00%	
Cortex percentage:					Number of dorsal scars:					
Absent	14	77.78%	0	0.00%	Absent	0	0.00%	0	0.00%	
1-24%	4	22.22%	0	0.00%	1-2	1	5.88%	0	0.00%	
25-49%	0	0.00%	0	0.00%	3-4	6	35.29%	0	0.00%	
50-74%	0	0.00%	0	0.00%	5-6	5	29.41%	0	0.00%	
75-99%	0	0.00%	0	0.00%	7+	5	29.41%	0	0.00%	
Complete	0	0.00%	0	0.00%						
Number of elongated scars:					Number of ridges/arrises:					
Absent	0	0.00%	0	0.00%	Absent	0	0.00%	0	0.00%	
1-2	10	55.56%	0	0.00%	1	10	55.56%	0	0.00%	
3-4	8	44.44%	0	0.00%	2	8	44.44%	0	0.00%	
5-6	0	0.00%	0	0.00%	3	0	0.00%	0	0.00%	
7+	0	0.00%	0	0.00%	4	0	0.00%	0	0.00%	
					5+	0	0.00%	0	0.00%	
Dorsal ridge/arise shape:					Flake scar pattern:					
Singular	3	16.67%	0	0.00%	Unidirectional	6	33.33%	0	0.00%	
Parallel	3	16.67%	0	0.00%	Centripetal	0	0.00%	0	0.00%	
Irregular	5	27.78%	0	0.00%	3-way centripetal	0	0.00%	0	0.00%	
Regular converging	3	16.67%	0	0.00%	Bidirectional	6	33.33%	0	0.00%	
Regular diverging	2	11.11%	0	0.00%	Lateral left	0	0.00%	0	0.00%	
Y-shape	0	0.00%	0	0.00%	Lateral right	0	0.00%	0	0.00%	
Inverted Y-shape	0	0.00%	0	0.00%	Convergent unidirectional	5	27.78%	0	0.00%	
Offset left/right	0	0.00%	0	0.00%	Convergent bidirectional	1	5.56%	0	0.00%	
Partial	2	11.11%	0	0.00%	Convergent and perpendicular	0	0.00%	0	0.00%	
Central converging	0	0.00%	0	0.00%	Double perpendicular	0	0.00%	0	0.00%	
Absent	0	0.00%	0	0.00%	Straight and perpendicular	0	0.00%	0	0.00%	
					Cortical	0	0.00%	0	0.00%	
					Indeterminable	0	0.00%	0	0.00%	
Distal end-type:					Butt type:					
Feathered	8	44.44%	0	0.00%	Plain/flat	5	27.78%	0	0.00%	
Stepped	2	11.11%	0	0.00%	Dihedral	2	11.11%	0	0.00%	
Hinged	3	16.67%	0	0.00%	Cortical	0	0.00%	0	0.00%	
Overshot	4	22.22%	0	0.00%	Natural (but non-cortical)	0	0.00%	0	0.00%	
Present but indeterminable	0	0.00%	0	0.00%	Marginal	3	16.67%	0	0.00%	
Missing	1	5.56%	0	0.00%	Mixed	6	33.33%	0	0.00%	
					Facetted	0	0.00%	0	0.00%	
					Missing (proximal missing)	2	11.11%	0	0.00%	
					Trimmed	0	0.00%	0	0.00%	
					C*hapeau de Gendarme*	0	0.00%	0	0.00%	
					Damaged/unidentifiable	0	0.00%	0	0.00%	

Table 8.14. Technological observations from Le Rissori (IV) (blade attributes)

Le Rissori (IV): retouch analysis (n=18)									
Presence of retouch:	Levallois (18)		Laminar (0)		Location of retouch:	Levallois (18)		Laminar (0)	
Yes	7	38.89%	0	0.00%	Proximal left	1	7.14%	0	0.00%
No	11	61.11%	0	0.00%	Proximal right	1	7.14%	0	0.00%
					Medial left	1	7.14%	0	0.00%
					Medial right	3	21.43%	0	0.00%
					Distal left	2	14.29%	0	0.00%
					Distal right	2	14.29%	0	0.00%
					Complete/continuous	4	28.57%	0	0.00%
Position of retouch:					Retouch coverage (%):				
Direct	7	100.00%	0	0.00%	No retouch	0	0.00%	0	0.00%
Inverse	0	0.00%	0	0.00%	1-25%	1	14.29%	0	0.00%
Alternate	0	0.00%	0	0.00%	26-50%	1	14.29%	0	0.00%
Bifacial	0	0.00%	0	0.00%	51-75%	1	14.29%	0	0.00%
Crossed	0	0.00%	0	0.00%	76-99%	0	0.00%	0	0.00%
Proximal (i.e. burin)	0	0.00%	0	0.00%	Complete retouch	4	57.14%	0	0.00%
Presence of burination:					Distribution of retouch:				
Yes	0	0.00%	0	0.00%	Continuous	5	71.43%	0	0.00%
No	18	100.00%	0	0.00%	Discontinuous	2	28.57%	0	0.00%
					Partial	0	0.00%	0	0.00%
Form of retouched edge:					Morphology of retouch:				
Rectilinear	1	14.29%	0	0.00%	Scaled	7	70.00%	0	0.00%
Concave	0	0.00%	0	0.00%	Stepped	0	0.00%	0	0.00%
Convex	1	14.29%	0	0.00%	Sub-parallel	0	0.00%	0	0.00%
Single removal i.e. notch or burin	1	14.29%	0	0.00%	Parallel	0	0.00%	0	0.00%
Denticulate	2	28.57%	0	0.00%	Notch/Denticulate	3	30.00%	0	0.00%
Multiple	2	28.57%	0	0.00%	Burin	0	0.00%	0	0.00%

Table 8.15. Technological observations from Le Rissori (IV) (retouch attributes)

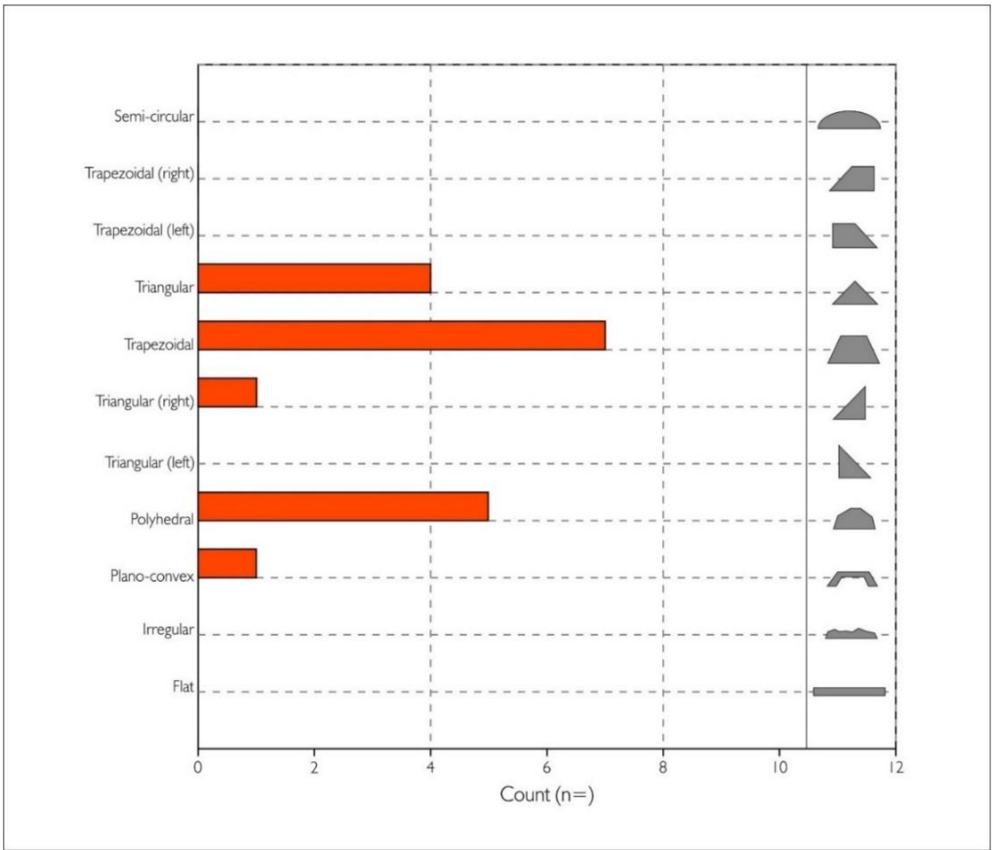


Figure 8.8. A bar-chart exemplifying the different cross-sections throughout Le Rissori (IV) (Orangered: Levallois)

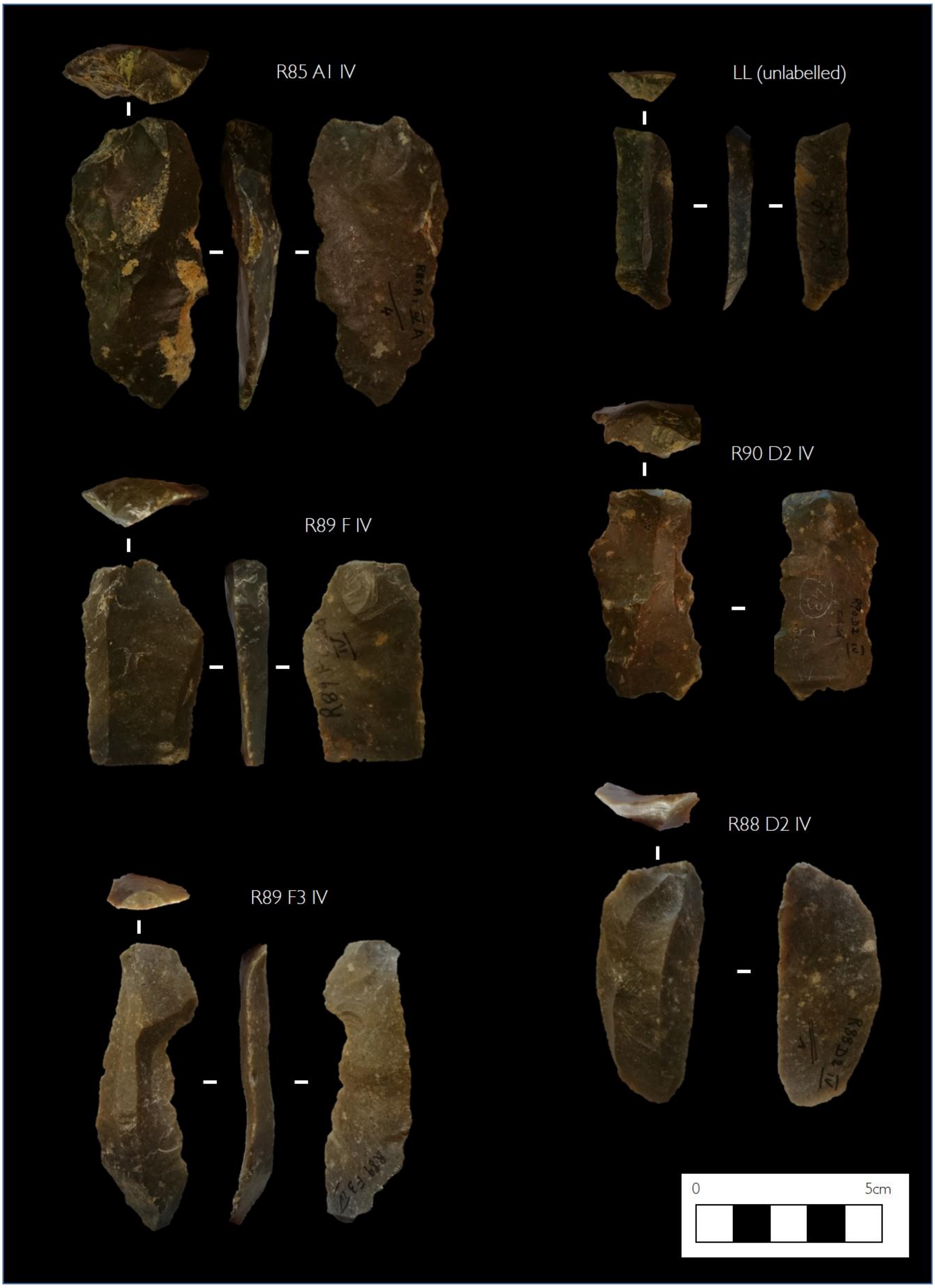


Figure 8.9. Examples from Le Rissori (IV): Levallois unretouched and retouched blades

8.3.3.3. Le Rissori (IIIB)

8.3.3.3.1. Technological Overview

A total of eight-five products were confidently identified as originating from Levallois or Laminar technological blade strategies, with a further five possibly identified as blade products (Table 8.16; Table 8.17). Technological analyses of both the blades and cores identified suggest that a Levallois strategy was the most commonly employed blade strategy among the sample analysed, with nine Levallois cores and seventy examples of Levallois blade products noted. A further five *éclat débordants* were identified, however it is unknown whether these originate from Levallois recurrent elongated strategies or other centripetal recurrent, recurrent (non-elongated), unidirectional convergent (as noted by Adam 2002), or lineal/preferential strategies. While most artefacts are Levallois in nature, three Laminar blade cores and three crested blades were recorded among the assemblage, exemplifying the use of both technological blade strategies. No further Laminar blade *débitage* was recorded.

8.3.3.3.2. Taphonomic History

A recording of the context's taphonomic history (Table 8.18) highlights the existence of a low-moderate energy environment like that of Le Rissori (IV), with a similar percentage of artefacts featuring edge damage and rolling. Within the Le Rissori (IIIB) assemblage just over two-thirds (67.86%) of all Levallois technological blade *débitage* feature some degree of edge damage, most often light in nature. A much higher percentage (83.33%) of Laminar products also feature edge damage, however this is a much smaller data (n = 6), and comparisons of taphonomy are therefore problematic. A similar pattern is apparent for rolling with less than ten percent (6.67%) featuring some degree of rolling. Despite this, there is limited/minor scratching, abrasion and damage to the arrises and ridges of the blade *débitage* present.

A similar degree of patination is also apparent to that of Le Rissori (IV), with just over a quarter of examples featuring some form of chemical transformation or patination. The notable brown staining, resulting from leaching of overlying/adjacent brown-soil palaeosols is also documented.

Cortex is retained on just over a quarter (31.7%) of all blade *débitage* recorded (excluding *éclats débordants*). In most examples (88.89%) the cortex retained is unstained and appears to be gently worn.

Artefact	n	Percentage
Laminar blade (unretouched)	0	0.00%
Laminar blade (retouched)	0	0.00%
Laminar blade fragment (unretouched)	0	0.00%
Laminar blade fragment (retouched)	0	0.00%
Laminar crested blade (unretouched)	1	1.11%
Laminar crested blade (retouched)	0	0.00%
Laminar crested blade fragment (unretouched)	2	2.22%
Laminar crested blade fragment (retouched)	0	0.00%
Laminar blade core	3	3.33%
Levallois blade (unretouched)	37	41.10%
Levallois blade (retouched)	31	34.44%
Levallois blade fragment (unretouched)	0	0.00%
Levallois blade fragment (retouched)	2	2.22%
Levallois *éclat débordant* (unretouched)	3	3.33%
Levallois *éclat débordant* (retouched)	2	2.22%
Levallois *éclat débordant* fragment (unretouched)	0	0.00%
Levallois *éclat débordant* fragment (retouched)	0	0.00%
Levallois recurrent blade core	9	10.00%
Total:	90	100.00%

Table 8.16. Technological overview of the artefacts studied

Confidence	Laminar core	Levallois core	Laminar product	Levallois product
A (definite)	2 (66.67%)	7 (77.78%)	3 (100.00%)	65 (86.67%)
B (probable)	1 (33.33%)	2 (22.22%)	0 (0.00%)	10 (13.33%)
C (possible)	0 (0.00%)	0 (0.00%)	0 (0.00%)	0 (0.00%)

Table 8.17. Confidence categories for the artefacts studied

In their condition, the assemblage retains a low breakage rate with only two examples (2.38%) noted. These do not appear to be anthropogenic in nature and are resulting from the specific core reduction technique undertaken.

One example features discolouring akin to high temperature burning, however given that this is an isolated example this may be misinterpreted, with staining resulting from other environmental factors.

Le Rissori (IIIB): artefact condition (n=90)									
	Levallois (84)		Laminar (6)			Levallois (84)		Laminar (6)	
Whole/broken:					Degree of patination:				
Whole	82	97.62%	6	100.00%	Unpatinated	60	71.43%	6	100.00%
Broken	2	2.38%	0	0.00%	Lightly patinated	19	22.62%	0	0.00%
					Moderately patinated	5	5.95%	0	0.00%
					Heavily patinated	0	0.00%	0	0.00%
Degree of edge damage:					Degree of burning:				
No edge damage	27	32.14%	1	16.67%	Unburned	83	98.81%	6	100.00%
Lightly damaged	56	66.67%	5	83.33%	Lightly burned	1	1.19%	0	0.00%
Moderately damaged	1	1.19%	0	0.00%	Moderately burned	0	0.00%	0	0.00%
Heavily damaged	0	0.00%	0	0.00%	Heavily burned	0	0.00%	0	0.00%
Degree of rolling:					Portion/break:				
Unrolled	78	92.86%	6	100.00%	Complete	82	97.62%	6	100.00%
Lightly rolled	6	7.14%	0	0.00%	Proximal fragment	1	1.19%	0	0.00%
Moderately rolled	0	0.00%	0	0.00%	Medial fragment	0	0.00%	0	0.00%
Heavily rolled	0	0.00%	0	0.00%	Distal fragment	1	1.19%	0	0.00%
					Siret	0	0.00%	0	0.00%
Observations: Minor staining and scratching throughout; some abrasion and damage to ridges and arrises									

Table 8.18. Detailed taphonomic characteristics of material analysed at Le Rissori (IIIB)

8.3.3.3.3. Raw Material

Similar to blade *débitage* from Le Rissori (IV) fairly fine homogeneous flint, with some silicification, microfossils, and anomalous structures is used throughout. No petrological or provenance studies have been undertaken and, similarly to Le Rissori (IV), the material is assumed to be of local origin within the immediate landscape (Adam and Tuffreau, 1973; Adam, 1991).

Both blade and core morphologies suggest the use of a variety of different-sized raw materials, typically non-elongated in form (see next section). Some of the cores used in the production of Levallois material are relatively flat with cortex retained on both surfaces, indicative of their size and original shape. For Laminar cores, these are typically globular and elongated.

8.3.3.3.4. Technology: Extended Analysis

The Le Rissori (IIIB) material archived in the IRSNB boasts a large Levallois blade component, with only minor evidence for the adoption of a Laminar blade strategy (Table 8.19).

Three Laminar cores were identified in association with no Laminar *débitage*, or adjoining material. These are relatively standardised in terms of their dimensions, with relatively low coefficient of variation values for their length, width, and elongation index (Table 8.20). The cores feature a low elongation index (mean: 0.82), resulting in a globular morphology. Cortex is retained on all three core platforms, with two examples featuring between 1-25% cortex coverage, and one further example featuring between 25-50% In terms of their preparation, platforms feature minimal modification with one large lineal removal producing a relatively flat/slightly convex platform morphology.

Le Rissori (IIIB): technological core observations (n=12)							
Core strategy:			Number of scars/core:				
Laminar	3	25.00%	Laminar: Min: 7, Max: 11, Mean: 9.25 (CV: 18.46)				
Levallois	9	75.00%	Levallois: Min: 9, Max: 22, Mean: 13 (CV: 28.78)				
			Number of elongated (L/W = 1.75>) scars/core:				
			Laminar: Min: 3, Max: 4, Mean: 3.33 (CV: 17.32)				
			Levallois: Min: 2, Max: 7, Mean: 3.44 (CV: 48.39)				
Levallois strategy:			Laminar core shape:				
Recurrent unidirectional	7	77.78%	Orthogonal/prismatic			0	0.00%
Recurrent bidirectional	2	22.22%	Semi-orthogonal/semi-prismatic			2	66.67%
			Pyramidal			1	33.33%
Laminar strategy:			Laminar platform preparation strategy:				
Semi-tournant/semi-rotating	0	0.00%	Single Lineal			3	100.00%
Tournant/rotating	0	0.00%	Multiple Lineal			0	0.00%
Facial	2	66.67%	Bidirectional			0	0.00%
Frontal	1	33.33%	3-way centripetal			0	0.00%
Multiple (combination)	0	0.00%	Centripetal			0	0.00%
			Lateral (left/right)			0	0.00%
			Perpendicular (left/right)			0	0.00%
Laminar core volume utilised:			Distal end types:	Levallois (9)		Laminar (3)	
1-25%	1	33.33%	Feathered	9	69.23%	3	100.00%
26-50%	1	33.33%	Stepped	1	7.69%	0	0.00%
51-75%	1	33.33%	Hinged	2	15.38%	0	0.00%
76-100%	0	0.00%	Reverse Hinged	0	0.00%	0	0.00%
			Overshot	1	7.69%	0	0.00%
Levallois core preparation strategy:			Number of platforms:				
Unidirectional	2	22.22%	1	7	77.78%	2	66.67%
Bidirectional	2	22.22%	2	2	22.22%	1	33.33%
Convergent unidirectional	4	44.44%	Cortex percentage:				
Centripetal	0	0.00%	Absent	4	44.44%	0	0.00%
Unidirectional left	1	11.11%	1-25%	2	22.22%	2	66.67%
Unidirectional right	0	0.00%	26-50%	3	33.33%	1	33.33%
Bidirectional lateral	0	0.00%	51-75%	0	0.00%	0	0.00%
Unidirectional distal	0	0.00%	76-100%	0	0.00%	0	0.00%

Table 8.19. Technological observations from Le Rissori (IIIB) (core attributes)

Three artefacts feature perpendicular removals from the ridge and retain a morphology typical of crested blades. In two examples, their dimensions exceed that of the cores present, and feature platforms which are wide and facetted. It is more likely that these are *éclats débordants* and not representative of cresting behaviour. One example is much smaller, similar to the size of the cores produced (despite being a differing raw material) and features a greater degree of working, despite being a *lame â créte partielle sensu stricto*. On this example, scars are typically 15-20mm in maximum dimension, with no further modification following its removal. This example, while not conclusive of cresting, is more likely to result from cresting behaviour, however further work is needed to conclude the technological nature of this crested blade.

Following possible semi-cresting both facial and frontal systems are then adopted, with surfaces left cortical and unworked. Varying levels of core volume are utilised, with both single and multiple opposed platforms exemplified, creating cores which are semi-orthogonal/semi-prismatic and pyramidal in form. All examples exemplify the successful of removals with only feathered distal end-types documented throughout analysis. In terms of maintenance, no evidence for platform rejuvenation or core tabletting is documented.

Weight (g)	Min.	Max.	Mean	S.D.	Med.	CV
Levallois	85.40	710.40	262.21	232.28	122.40	88.58
Laminar	105.40	195.30	162.03	49.30	185.40	30.42
Length (mm)	Min.	Max.	Mean	S.D.	Med.	CV
Levallois	26.88	111.80	67.36	33.90	57.35	50.33
Laminar	72.41	100.35	88.92	14.65	94.01	16.47
Width (mm)	Min.	Max.	Mean	S.D.	Med.	CV
Levallois	81.33	111.60	95.57	11.08	97.88	11.59
Laminar	90.48	134.28	112.89	21.92	113.91	19.20
Elongation index (L/W)	Min.	Max.	Mean	S.D.	Med.	CV
Levallois	0.32	1.19	0.72	0.38	0.62	53.15
Laminar	0.54	1.04	0.82	0.26	0.88	31.16
Thickness (mm)	Min.	Max.	Mean	S.D.	Med.	CV
Levallois	32.7	114.4	73.50	26.44	74.55	35.97
Laminar	36.91	99.72	59.14	35.19	40.80	59.50
Core flattening index (thickness/width)	Min.	Max.	Mean	S.D.	Med.	CV
Levallois	0.40	1.36	0.79	0.29	0.77	36.39
Laminar	0.36	0.74	0.50	0.21	0.41	41.57

Table 8.20. Metric data for complete cores analysed (n=12)

The greater amount of evidence for technological blade strategies originate from a Levallois operational system, with nine cores, and seventy examples of Levallois blade *débitage* documented. Cores feature varying levels of preparation and intensity with four cores retaining no cortex, and five cores retaining less than fifty percent cortex coverage. In their preparation, a convergent unipolar strategy is most common, with just under half of all cores (44.44%) exemplifying this technique; no examples of the more common centripetal preparation strategy were documented. Further preparation in the form of grinding and platform preparation can also be documented on seven of the nine Levallois cores. A recurrent unidirectional elongated strategy dominates with only two examples featuring two platforms and a bidirectional technique. In their execution, the core evidence highlights a variety of different distal end-types present, with stepped, hinged, and overshot end-types recorded. In their size, cores tend to be more varied, in contrast to Laminar cores, with high coefficient of variation values and varying weights and dimensions documented.

Weight (g)	Min.	Max.	Mean	S.D.	Med.	CV
Complete Laminar blade	-	-	-	-	-	-
Complete Levallois blade	4.41	234.80	43.54	46.42	29.80	106.60
Broken Laminar blade	-	-	-	-	-	-
Broken Levallois blade	19.01	24.53	21.75	3.89	21.75	17.88
Length (mm)	Min.	Max.	Mean	S.D.	Med.	CV
Complete Laminar blade	-	-	-	-	-	-
Complete Levallois blade	44.42	148.26	82.95	24.28	78.02	29.27
Broken Laminar blade	-	-	-	-	-	-
Broken Levallois blade	56.94	73.10	65.02	11.43	65.02	17.57
Width (mm)	Min.	Max.	Mean	S.D.	Med.	CV
Complete Laminar blade	-	-	-	-	-	-
Complete Levallois blade	17.21	77.63	39.14	12.64	36.55	32.28
Broken Laminar blade	-	-	-	-	-	-
Broken Levallois blade	32.99	41.00	36.70	5.66	36.70	15.31
Elongation Index (L/W)	Min.	Max.	Mean	S.D.	Med.	CV
Complete Laminar blade	-	-	-	-	-	-
Complete Levallois blade	1.76	3.35	2.28	0.32	2.26	13.88
Broken Laminar blade	-	-	-	-	-	-
Broken Levallois blade	1.39	2.22	1.80	0.58	1.80	32.44
Thickness (mm)	Min.	Max.	Mean	S.D.	Med.	CV
Complete Laminar blade	-	-	-	-	-	-
Complete Levallois blade	3.37	23.35	8.77	3.84	8.06	43.73
Broken Laminar blade	-	-	-	-	-	-
Broken Levallois blade	14.65	29.51	22.08	10.51	22.08	47.59
Working edge/edge circum. (mm)	Min.	Max.	Mean	S.D.	Med.	CV
Complete Laminar blade	-	-	-	-	-	-
Complete Levallois blade	113.11	417.01	227.99	69.48	209.62	30.47
Broken Laminar blade	-	-	-	-	-	-
Broken Levallois blade	179.39	219.43	199.41	28.31	199.41	14.20
Cutting edge per weight (mm/g)	Min.	Max.	Mean	S.D.	Med.	CV
Complete Laminar blade	-	-	-	-	-	-
Complete Levallois blade	1.56	25.92	9.09	5.68	7.24	62.47
Broken Laminar blade	-	-	-	-	-	-
Broken Levallois blade	7.32	11.55	9.44	2.99	9.44	31.67
Flattening index (mT/mW)	Min.	Max.	Mean	S.D.	Med.	CV
Complete Laminar blade	-	-	-	-	-	-
Complete Levallois blade	0.15	0.77	0.41	0.01	0.41	27.30

Table 8.21. Metric data for complete and broken Levallois blades analysed (n=18)

Le Rissori (IIIB): technological analysis (n=70)									
Percussion strategy:	Levallois (70)		Laminar (0)		Bulbar scar features:	Levallois (70)		Laminar (0)	
Hard	69	98.57%	0	0.00%	Well defined	49	70.00%	0	0.00%
Soft	0	0.00%	0	0.00%	Diffused	20	28.57%	0	0.00%
Mixed/Indeterminable	1	1.43%	0	0.00%	Absent/missing	1	1.43%	0	0.00%
Absent	0	0.00%	0	0.00%	Removed	0	0.00%	0	0.00%
Cortex percentage:					Number of dorsal scars:				
Absent	51	72.86%	0	0.00%	Absent	0	0.00%	0	0.00%
1-24%	15	21.43%	0	0.00%	1-2	50	71.43%	0	0.00%
25-49%	4	5.71%	0	0.00%	3-4	14	20.00%	0	0.00%
50-74%	0	0.00%	0	0.00%	5-6	5	7.14%	0	0.00%
75-99%	0	0.00%	0	0.00%	7+	1	1.43%	0	0.00%
Complete	0	0.00%	0	0.00%					
Number of elongated scars:					Number of ridges/arrises:				
Absent	0	0.00%	0	0.00%	Absent	0	0.00%	0	0.00%
1-2	53	75.71%	0	0.00%	1	59	84.29%	0	0.00%
3-4	15	21.43%	0	0.00%	2	10	14.29%	0	0.00%
5-6	2	2.86%	0	0.00%	3	1	1.43%	0	0.00%
7+	0	0.00%	0	0.00%	4	0	0.00%	0	0.00%
					5+	0	0.00%	0	0.00%
Dorsal ridge/arise shape:					Flake scar pattern:				
Singular	54	77.14%	0	0.00%	Unidirectional	25	35.71%	0	0.00%
Parallel	8	11.43%	0	0.00%	Centripetal	1	1.43%	0	0.00%
Irregular	3	4.29%	0	0.00%	3-way centripetal	2	2.86%	0	0.00%
Regular converging	0	0.00%	0	0.00%	Bidirectional	11	15.71%	0	0.00%
Regular diverging	0	0.00%	0	0.00%	Lateral left	0	0.00%	0	0.00%
Y-shape	2	2.86%	0	0.00%	Lateral right	0	0.00%	0	0.00%
Inverted Y-shape	2	2.86%	0	0.00%	Convergent unidirectional	19	27.14%	0	0.00%
Offset left/right	0	0.00%	0	0.00%	Convergent bidirectional	5	7.14%	0	0.00%
Partial	1	1.43%	0	0.00%	Convergent and perpendicular	1	1.43%	0	0.00%
Central converging	0	0.00%	0	0.00%	Double perpendicular	1	1.43%	0	0.00%
Absent	0	0.00%	0	0.00%	Straight and perpendicular	5	7.14%	0	0.00%
					Cortical	0	0.00%	0	0.00%
					Indeterminable	0	0.00%	0	0.00%
Distal end-type:					Butt type:				
Feathered	44	62.86%	0	0.00%	Plain/flat	23	32.86%	0	0.00%
Stepped	5	7.14%	0	0.00%	Dihedral	3	4.29%	0	0.00%
Hinged	16	22.86%	0	0.00%	Cortical	2	2.86%	0	0.00%
Overshot	4	5.71%	0	0.00%	Natural (but non-cortical)	0	0.00%	0	0.00%
Present but indeterminable	0	0.00%	0	0.00%	Marginal	12	17.14%	0	0.00%
Missing	1	1.43%	0	0.00%	Mixed	20	28.57%	0	0.00%
					Facetted	6	8.57%	0	0.00%
					Missing (proximal missing)	1	1.43%	0	0.00%
					Trimmed	0	0.00%	0	0.00%
					Chapeau de Gendarme	2	2.86%	0	0.00%
					Damaged/unidentifiable	1	1.43%	0	0.00%

Table 8.22. Technological observations from Le Rissori (IIIB) (blade observations)

While the Levallois products vary considerably in size, from 234.80g to 4.41g, they are typically much larger than blades documented through the experimental framework. Despite this, the Levallois products are somewhat standardised in their elongation with a coefficient of variation value of 13.88% (Table 8.21). A flattening index comparable to other Levallois contexts (archaeological and experimental frameworks) is also observed. The blades are typically triangular (38.57%) in cross-section (Figure 8.10), and are of similar convexity to Le Rissori (IV), with a similar percentage of straight, curved and twisted profiles (see Chapter 10), further exemplifying the 'peeling off' of blades on Levallois cores. It is perhaps interesting to note the absence of plano-convex cross-sections, typically a signature of Levallois blades (Inizan et al., 1999, Bar-Yosef and Kuhn, 1999).

All blades retain characteristics of hard hammer production, with most blades (n = 49, 70.00%) featuring well-defined bulbar scar features; only the two broken blades cannot be determined (Table 8.22). The blades are typically from further in the technological sequence, with just a quarter of all blades retaining cortex (27.14%), and a large proportion of blades featuring a low number of scars, elongated scars, and dorsal arrises. The arrises are typically singular (77.14%) with a small number parallel or partial arrises also documented. Like the cores identified, the majority of blades feature a unidirectional (convergent/non-convergent) sequence (62.85%). In contrast to blades at Le Rissori (IV), there is evidence for facetting with six blades featuring facetting, and a further two examples demonstrating a *chapeau de gendarme* platform. Despite this, most blades are plain/flat (32.86%) or mixed (28.57%).

Le Rissori (IIIB): retouch analysis (n=70)									
Presence of retouch:	Levallois (70)		Laminar (0)		Location of retouch:	Levallois (70)		Laminar (0)	
Yes	33	47.14%	0	0.00%	Proximal left	11	16.42%	0	0.00%
No	37	52.86%	0	0.00%	Proximal right	7	10.45%	0	0.00%
					Medial left	9	13.43%	0	0.00%
					Medial right	7	10.45%	0	0.00%
					Distal left	7	10.45%	0	0.00%
					Distal right	7	10.45%	0	0.00%
					Complete/continuous	19	28.36%	0	0.00%
Position of retouch:					Retouch coverage (%):				
Direct	33	100.00%	0	0.00%	No retouch	37	52.86%	0	0.00%
Inverse	0	0.00%	0	0.00%	1-25%	3	4.29%	0	0.00%
Alternate	0	0.00%	0	0.00%	26-50%	5	7.14%	0	0.00%
Bifacial	0	0.00%	0	0.00%	51-75%	5	7.14%	0	0.00%
Crossed	0	0.00%	0	0.00%	76-99%	5	7.14%	0	0.00%
Proximal (i.e. burin)	0	0.00%	0	0.00%	Complete retouch	15	21.43%	0	0.00%
Presence of burination:					Distribution of retouch:				
Yes	0	0.00%	0	0.00%	Continuous	27	84.38%	0	0.00%
No	70	100.00%	0	0.00%	Discontinuous	2	6.25%	0	0.00%
					Partial	3	9.38%	0	0.00%
Form of retouched edge:					Morphology of retouch:				
Rectilinear	4	12.12%	0	0.00%	Scaled	32	64.00%	0	0.00%
Concave	3	9.09%	0	0.00%	Stepped	0	0.00%	0	0.00%
Convex	6	18.18%	0	0.00%	Sub-parallel	0	0.00%	0	0.00%
Single removal (notch/burin)	0	0.00%	0	0.00%	Parallel	0	0.00%	0	0.00%
Denticulate	8	24.24%	0	0.00%	Notch/Denticulate	18	36.00%	0	0.00%
Multiple	12	36.36%	0	0.00%	Burin	0	0.00%	0	0.00%

Table 8.23. Technological observations from Le Rissori (IIIB) (retouch observations)

The assemblage features a higher percentage of retouched blades in comparison to previous contexts analysed, with thirty-three examples of Levallois blades accounting for just under half of all blades (47.14%). All examples are direct, do not feature burination, and typically feature continuous coverage around the edge circumference, with just over half (51.35%) featuring complete retouch (Table 8.23). The retouch is typically invasive and focused on the production of denticulate and notched edges.

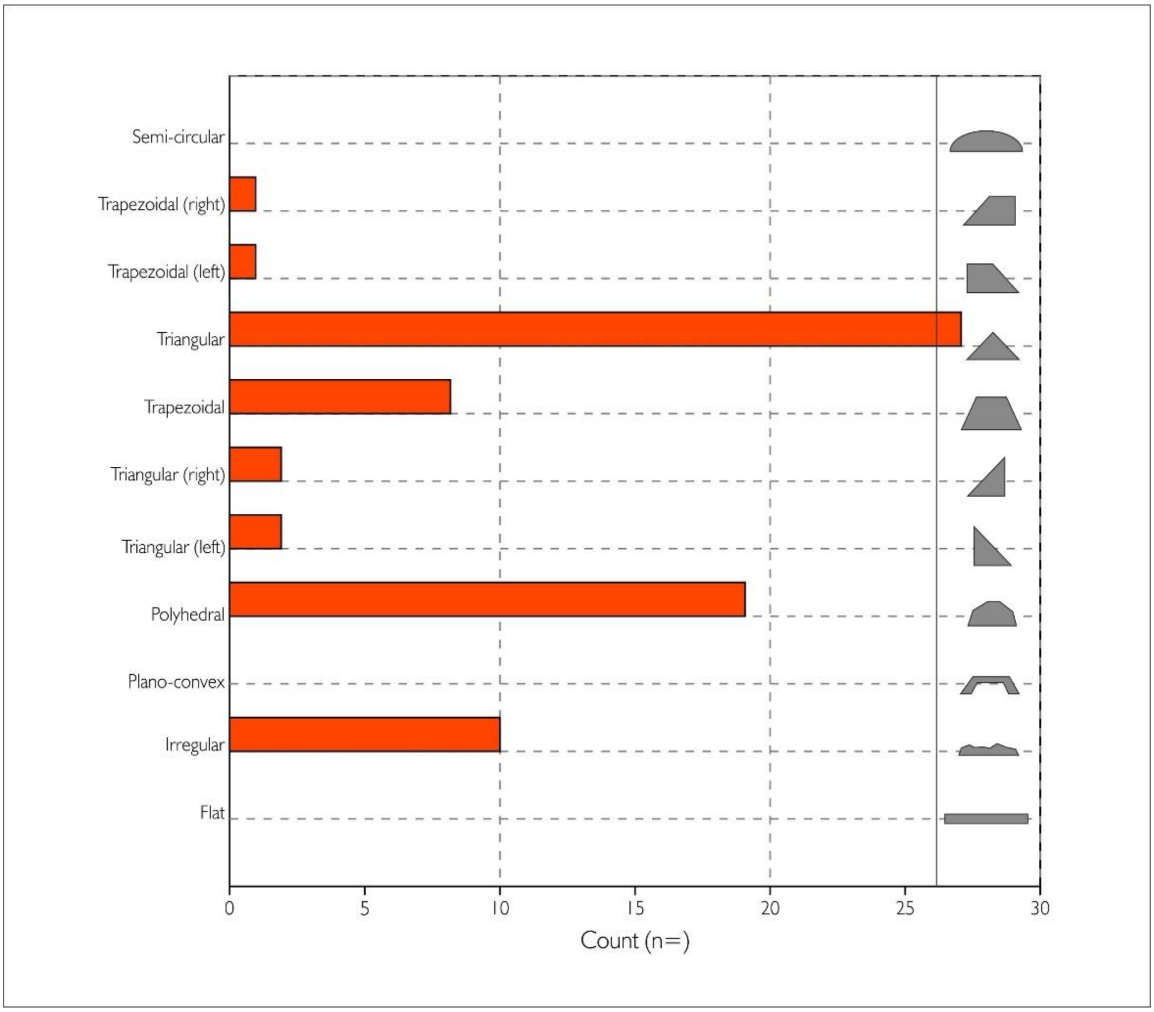


Figure 8.10. A bar-chart of the different cross-sections documented throughout Le Rissori (IIIB) (Orangered: Levallois)

Five *éclats débordants* are also recorded, these are complete and all feature facetting with two examples featuring retouch (notching) on the exterior edge of the blade. It does not appear that the retouch was designed to make the backed-edge flatter but rather to use that edge, in addition to the interior edge, for a variety of unknown activities. Again, it must be stressed that these products may originate from other known Levallois strategies present on site, however these do represent the converging of behaviours with *éclats débordants* transformed in a similar manner to Levallois blades identified. For examples of blade *débitage* see Figure 8.11 and 8.12.

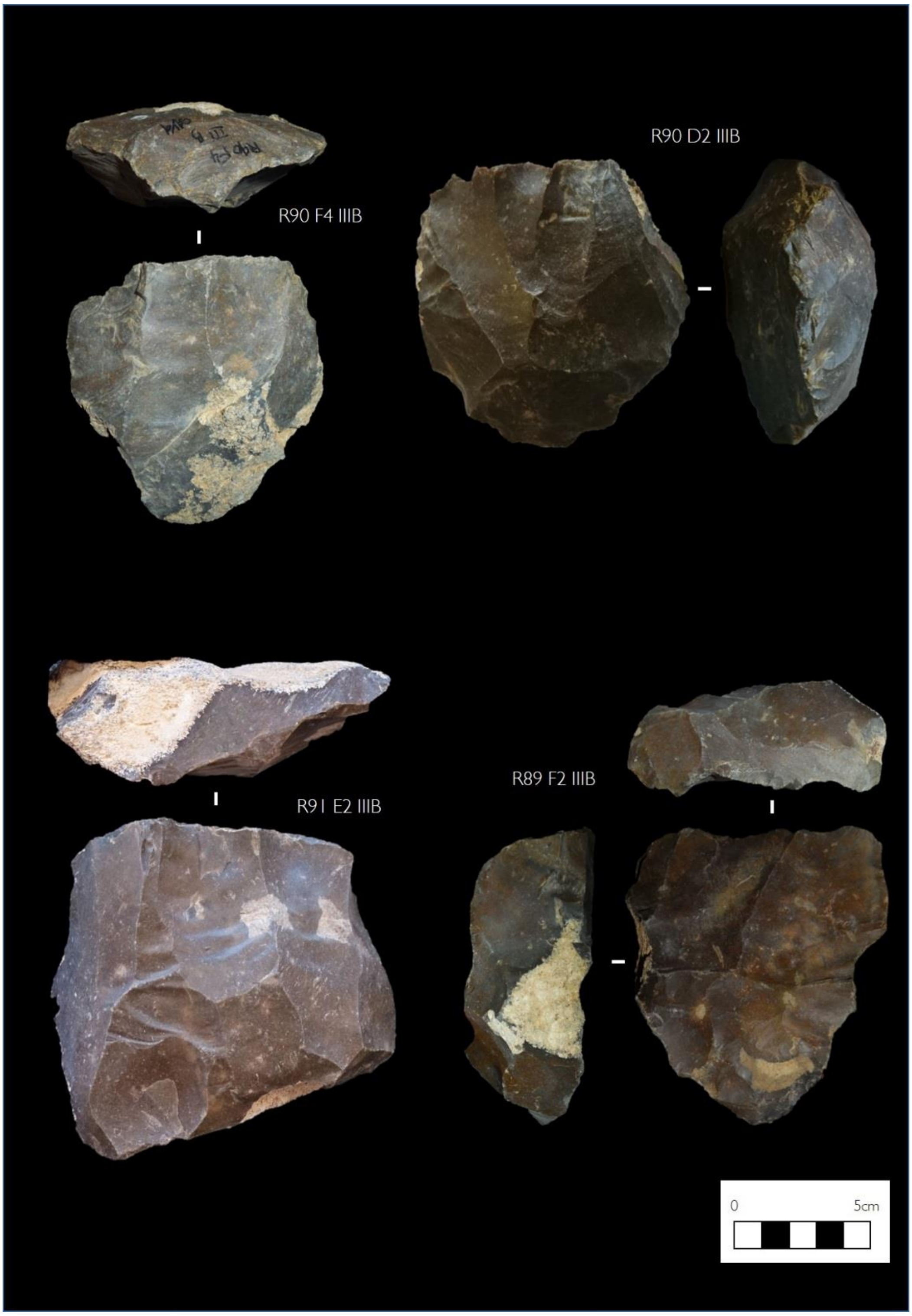


Figure 8.11. Examples from Le Rissori (IIIB). Top left: Levallois unidirectional blade cores; Top right: Levallois unidirectional blade cores; Bottom left: Laminar facial blade core; Bottom right: Laminar facial blade core

Figure 8.12. Examples from Le Rissori (IIIB): Levallois unretouched and retouched blades

8.3.3.4. Le Rissori (IIIA)

8.3.3.4.1. Technological Overview

In total, eighty-seven artefacts were identified as originating from a technological blade strategy, with a further twenty-two examples of *éclats débordants*, possibly originating from Levallois recurrent elongated strategies identified (Table 8.24).

Artefact	n	Percentage
Laminar blade (unretouched)	2	1.83%
Laminar blade (retouched)	0	0.00%
Laminar blade fragment (unretouched)	0	0.00%
Laminar blade fragment (retouched)	0	0.00%
Laminar crested blade (unretouched)	1	0.92%
Laminar crested blade (retouched)	0	0.00%
Laminar crested blade fragment (unretouched)	0	0.00%
Laminar crested blade fragment (retouched)	0	0.00%
Laminar blade core	1	0.92%
Levallois blade (unretouched)	34	31.19%
Levallois blade (retouched)	29	26.61%
Levallois blade fragment (unretouched)	12	11.01%
Levallois blade fragment (retouched)	4	3.67%
Levallois *éclat débordant* (unretouched)	12	11.01%
Levallois *éclat débordant* (retouched)	5	4.59%
Levallois *éclat débordant* fragment (unretouched)	3	2.75%
Levallois *éclat débordant* fragment (retouched)	2	1.83%
Levallois recurrent blade core	4	3.67%
Total:	109	100.00%

Table 8.24. Technological overview of the artefacts studied

Prior to examination, the existence for crested blades and Laminar technological blade cores were identified and noted by Adam (1991). In the collections at the IRSNB, one further Laminar core was documented, with three pieces of Laminar *débitage* also noted: one crested blade (unretouched) and two unretouched Laminar blades. While the core is categorically Laminar in nature, possessing a core volume management strategy akin to Laminar production, the products are more difficult to identify (Table 8.25) and it cannot be concluded at present whether these three instances are Laminar or Levallois in nature (see below for more information). With respect to the evidence for Levallois technological blade strategies, four recurrent blade cores and over seventy-nine examples of Levallois blades were documented. The blades are typically whole, with a low breakage rate and feature a high retouch percentage, similarly to Le Rissori (IIIB).

The nature of the blades produced through a Levallois technique, specifically their morphology and raw material, do not match the cores documented. No refits were also demonstrated. It is unsure at present whether the cores for the blades in question are within the collections at the SRPH, or transported off-site. More extensive analyses of both collections are essential.

Twenty-two *éclats débordants* were also identified, and it is unknown as to whether these originate from Levallois recurrent elongated strategies or other Levalloisian strategies. However, similarly to Le Rissori (IIIB), several *éclats débordants* exemplify retouch similar to the blades produced.

Confidence	Laminar core	Levallois core	Laminar product	Levallois product
A (definite)	1 (100.00%)	2 (50.00%)	1 (33.33%)	70 (69.30)
B (probable)	0 (0.00%)	2 (50.00%)	2 (66.67%)	31 (30.69%)
C (possible)	0 (0.00%)	0 (0.00%)	0 (0.00%)	0 (0.00%)

Table 8.25. Confidence categories for the artefacts studied

Given the nature of the material recorded, specifically similarities in their taphonomic histories, the presence of retouched *éclats débordants*, similar percentages of retouched and unretouched blades, the nature of the retouch present, and the technological characteristics and composition of the assemblages, it is possible to suggest that similar technological blade behaviours are apparent within the Le Rissori (IIIA/IIIB) contexts, representing similar behaviours between two sub-stages. Alternatively, this may support arguments of admixture (see previous), with Le Rissori (IIIB) and Le Rissori (IIIA) resembling one strategy. This is discussed in more detail towards the end of this sub-section.

8.3.3.4.2. Taphonomic History

An examination of the assemblage condition (Table 8.26) highlights a low-moderate energy environment akin to the previous two Le Rissori horizons, with analyses of the overall condition of the assemblage demonstrating further inter-context commonalities.

In their overall condition, the assemblage features a higher break percentage than Le Rissori (IIIB), with just under a fifth of all artefacts broken. They are frequently distal fragments, and appear to be non-anthropogenic in their breakage. Despite this there are a significant number of commonalities in their condition with the Le Rissori (IIIB) assemblage. Both Le Rissori (IIIA) and Le Rissori (IIIB) feature a similar degree of mechanical damage, with 68.89% of all artefacts featuring some degree of edge damage (Le Rissori IIIB: 65.14%). Both occupational layers also feature a similar percentage presence of rolling damage on the ridges, arrises and surfaces, with Le Rissori (IIIA) featuring 2.75% of the overall blade assemblage (Le Rissori IIIB: 5.51%). With respect to the chemical alteration of artefacts, just over a quarter (29.36%) of all artefacts feature some degree of patination, with two artefacts (both Levallois blades) heavily patinated in nature. This again, is similar to Le Rissori (IIIB), where patination is recorded on 26.67% of the overall blade assemblage component.

Le Rissori (IIIA): artefact condition (n=109)									
	Levallois (105)		Laminar (4)			Levallois (105)		Laminar (4)	
Whole/broken:					Degree of patination:				
Whole	85	80.95%	4	100.00%	Unpatinated	74	70.48%	3	75.00%
Broken	20	19.05%	0	0.00%	Lightly patinated	27	25.71%	1	25.00%
					Moderately patinated	2	1.90%	0	0.00%
					Heavily patinated	2	1.90%	0	0.00%
Degree of edge damage:					Degree of burning:				
No edge damage	36	34.29%	2	50.00%	Unburned	105	0.00%	4	0.00%
Lightly damaged	69	65.71%	2	50.00%	Lightly burned	0	0.00%	0	0.00%
Moderately damaged	0	0.00%	0	0.00%	Moderately burned	0	0.00%	0	0.00%
Heavily damaged	0	0.00%	0	0.00%	Heavily burned	0	0.00%	0	0.00%
Degree of rolling:					Portion/break:				
Unrolled	102	97.14%	4	100.00%	Complete	85	80.95%	4	100.00%
Lightly rolled	3	2.86%	0	0.00%	Proximal fragment	6	5.71%	0	0.00%
Moderately rolled	0	0.00%	0	0.00%	Medial fragment	4	3.81%	0	0.00%
Heavily rolled	0	0.00%	0	0.00%	Distal fragment	10	9.52%	0	0.00%
					Siret	0	0.00%	0	0.00%
Observations: minor scratching and abrasion throughout.									

Table 8.26. Detailed taphonomic characteristics of material analysed at Le Rissori (IIIA)

Cortex was present on all blade cores identified, and just over a quarter of all blade *débitage* (see below). Cortex is of varying levels of freshness, with cortex appearing grainy and fresh on a number of examples, and worn with some minor staining on a smaller number of examples.

No evidence of burning was recorded throughout the blade assemblage component of material studied.

8.3.3.4.3. Raw Material

Similar to other blade *débitage* from the Le Rissori occupational layer(s), a fine-grained and highly silicified type of flint is used, and again, similarly to previous contexts, it is assumed to be of local origin within the immediate landscape (Adam and Tuffreau, 1973; Adam, 1991).

The raw material in its final form on site appears somewhat standardised in morphology, with low coefficient of variation values for their mass (see below). In producing blades through a Laminar technique, a small globular nodule completely cortical in form, is adopted, with cortex retained on the platform, and around the core's circumference. In other cores documented for this layer, Adam (1991) notes the use of cortical elongated nodules for producing Laminar blades to varying degrees of exhaustion. For Levallois blade production, flint relatively flat in morphology is transformed with cortex retained.

Cortex is also retained on a quarter of all blades produced (see below) to varying degrees with typically 1-25% cortex coverage retained, and a few examples (n = 3) retaining up to 50% cortex.

8.3.3.4.4. Technology: Extended Analysis

The evidence for technological blade strategies, within the material studied, attests to the use of a predominantly Levallois blade technique, both unidirectional and bidirectional in nature, with products fairly standardised and retouched in form. In spite of this, Levallois technological blade core strategies present are irregular, retain cortex, and are of differing morphology and raw material in contrast to the blades produced. Without examination of collections housed at the SRPH, it is difficult to conclude whether cores of similar morphology are retained, or whether these blades were curated and brought to site. Additionally, contrasting with Adam's (1991) study of material at the SRPH, only a small amount of evidence is documented for the production of blades through a Laminar technological strategy. The material appears fortuitous, irregular, and contrasts the material noted by Adam (1991).

Evidence for stereotyped elongated material, through a Laminar technique, within the IRSNB collection of Le Rissori (IIIA) is attested by one blade core, and three Laminar products: two unretouched blades, and one crested blade. The blade core, as highlighted previously, is a nodule pyramidal in morphology with cortex retained on over three-quarters of the core's circumference and the edge of a large flat platform, created through a single lineal removal, prior to the initiation of the blade sequence. As the core is unprepared, and appears to not have been extensively worked, it is assumed that the sequence is initiated through the natural exploitation of ridges and not anthropogenic ridging. Following platform creation, the broadest face of the core is exploited with 26-50% of the core's circumference reduced in total (Table 8.27). No refits were recovered in association with the core.

Le Rissori (IIIA): technological core observations (n=5)							
Core strategy:			Number of scars/core:				
Laminar	1	20.00%	Laminar: Min: 8, Max: 8, Mean: 8 (CV: 0.00)				
Levallois	4	80.00%	Levallois: Min: 10, Max: 17, Mean: 13.25 (CV: 24.94)				
			Number of elongated (L/W = 1.75>) scars/core:				
			Laminar: Min: 4 Max: 4, Mean: 4 (CV: 0.00)				
			Levallois: Min: 2, Max: 4, Mean: 3 (CV: 27.22)				
Levallois strategy:			Laminar core shape:				
Recurrent unidirectional	2	50.00%	Orthogonal/prismatic			0	0.00%
Recurrent bidirectional	2	50.00%	Semi-orthogonal/semi-prismatic			0	0.00%
			Pyramidal			1	100.00%
Laminar strategy:			Laminar platform preparation strategy:				
Semi-tournant/semi-rotating	0	0.00%	Single Lineal			1	100.00%
Tournant/rotating	0	0.00%	Multiple Lineal			0	0.00%
Facial	1	100.00%	Bidirectional			0	0.00%
Frontal	0	0.00%	3-way centripetal			0	0.00%
Multiple (combination)	0	0.00%	Centripetal			0	0.00%
			Lateral (left/right)			0	0.00%
			Perpendicular (left/right)			0	0.00%
Laminar core volume utilised:			Distal end-types:	Levallois (4)		Laminar (1)	
1-25%	0	0.00%	Feathered	3	75.00%	1	100.00%
26-50%	1	100.00%	Stepped	0	0.00%	0	0.00%
51-75%	0	0.00%	Hinged	1	25.00%	0	0.00%
76-100%	0	0.00%	Reverse Hinged	0	0.00%	0	0.00%
			Overshot	0	0.00%	0	0.00%
Levallois core preparation strategy:			Number of platforms:				
Unidirectional	0	0.00%	1	2	50.00%	1	100.00%
Bidirectional	0	0.00%	2	2	50.00%	0	0.00%
Convergent unidirectional	3	75.00%	Cortex percentage:				
Centripetal	0	0.00%	Absent	0	0.00%	0	0.00%
Unidirectional left	0	0.00%	1-25%	1	25.00%	0	0.00%
Unidirectional right	1	25.00%	26-50%	2	50.00%	1	100.00%
Bidirectional lateral	0	0.00%	51-75%	1	25.00%	0	0.00%
Unidirectional distal	0	0.00%	76-100%	0	0.00%	0	0.00%

Table 8.27. Technological observations from Le Rissori (IIIA) (core attributes)

Three artefacts from a Laminar blade technique were also identified: two Laminar unretouched blades and one crested blade. The blades feature a central singular ridge with a simple scar pattern and a triangular and trapezoidal cross-section (Figure 8.13). Furthermore, they feature a high flattening index, parallel to the experimental blades produced (Table 8.29). It is difficult to assert, without refitting, whether these originate from a Laminar technological blade strategy, particularly when they are of differing morphology and raw material to the Laminar blade core examined. The blade also features a bidirectional technique, mirroring many of the cores in collections with the SRPH, and not the core examined here. It is therefore difficult without inter-collection analyses to confidently classify the blades as originating from a Laminar technique and caution in any inter-site analysis needs to be treated with caution. In addition to two unretouched blades, a patinated non-cortical crested blade was recorded. The crested blade, features scarring on both faces of the blank, in a regular pattern, with scars typically 15-20mm in size. Again, this is of differing morphology and raw material, and may represent a crested blade from a core within the SRPH collection. Beyond its presence and technological characteristics, behavioural interpretations are therefore limited until further analyses are undertaken.

Weight (g)	Min.	Max.	Mean	S.D.	Med.	CV
Levallois	89.42	120.36	102.58	12.92	100.30	12.59
Laminar*	102.46	102.46	102.46	0.00	102.46	0.00
Length (mm)	Min.	Max.	Mean	S.D.	Med.	CV
Levallois	26.49	89.59	58.25	34.24	58.46	58.79
Laminar*	76.51	76.51	76.51	0.00	76.51	0.00
Width (mm)	Min.	Max.	Mean	S.D.	Med.	CV
Levallois	30.12	115.06	75.87	35.38	79.14	46.64
Laminar*	82.45	82.45	82.45	0.00	82.45	0.00
Elongation index (L/W)	Min.	Max.	Mean	S.D.	Med.	CV
Levallois	0.31	1.20	0.83	0.39	0.90	46.80
Laminar*	0.93	0.93	0.93	0.00	0.93	0.00
Thickness (mm)	Min.	Max.	Mean	S.D.	Med.	CV
Levallois	34.89	114.20	58.93	37.54	43.31	63.70
Laminar*	61.26	61.26	61.26	0.00	61.26	0.00
Core flattening index (thickness/width)	Min.	Max.	Mean	S.D.	Med.	CV
Levallois	0.30	1.68	0.95	0.66	0.91	68.95
Laminar*	1.25	1.25	1.25	0.00	1.25	0.00

Table 8.28. Metric data for complete cores analysed (n=5);
asterisk: individual example

The archaeological evidence for Levallois blade production within the IRSNB collection is more substantial, with four Levallois recurrent elongated cores and evidence for seventy-nine Levallois blades.

All cores retain evidence for cortex to varying degrees, typically on the preparation surface, and are of varying core morphology, with high coefficient of variation values for core dimensions. In their flaking, a unidirectional core preparation strategy is observed with three cores featuring a convergent unidirectional strategy, and a further core demonstrating a unidirectional right strategy. Platform edge preparation is observed on all cores through abrasion and flaking. Following this, blades are then exploited through both unidirectional and bidirectional exploitation schemes, to equal measures with two of each strategy documented. In their exploitation feathered removals are documented with one core exemplifying a hinged end-type.

Weight (g)	Min.	Max.	Mean	S.D.	Med.	CV
Complete Laminar blade	4.50	13.70	9.10	6.51	9.10	71.49
Complete Levallois blade	2.30	182.10	51.67	49.46	32.90	95.70
Broken Laminar blade	-	-	-	-	-	-
Broken Levallois blade	18.40	125.43	69.37	42.69	48.70	61.54
Length (mm)	Min.	Max.	Mean	S.D.	Med.	CV
Complete Laminar blade	53.88	100.59	77.24	33.03	77.24	42.76
Complete Levallois blade	46.15	145.92	88.01	24.83	83.89	28.21
Broken Laminar blade	-	-	-	-	-	-
Broken Levallois blade	41.32	102.41	71.39	15.89	70.42	22.25
Width (mm)	Min.	Max.	Mean	S.D.	Med.	CV
Complete Laminar blade	19.35	28.33	23.84	6.35	23.84	26.64
Complete Levallois blade	13.04	72.96	37.75	14.06	39.22	37.24
Broken Laminar blade	-	-	-	-	-	-
Broken Levallois blade	28.86	60.37	40.57	10.71	38.82	26.41
Elongation Index (L/W)	Min.	Max.	Mean	S.D.	Med.	CV
Complete Laminar blade	2.78	3.55	3.17	0.54	3.16	17.10
Complete Levallois blade	1.76	4.04	2.51	0.52	2.37	20.62
Broken Laminar blade	-	-	-	-	-	-
Broken Levallois blade	1.40	2.93	1.81	0.44	1.68	24.23
Thickness (mm)	Min.	Max.	Mean	S.D.	Med.	CV
Complete Laminar blade	6.77	13.37	10.07	4.67	10.07	46.34
Complete Levallois blade	2.95	19.29	8.48	3.81	7.39	44.94
Broken Laminar blade	-	-	-	-	-	-
Broken Levallois blade	8.15	19.26	13.22	3.82	13.54	28.89
Working edge/edge circum. (mm)	Min.	Max.	Mean	S.D.	Med.	CV
Complete Laminar blade	146.41	249.61	198.01	72.97	198.01	36.85
Complete Levallois blade	110.80	384.06	238.07	69.52	228.59	29.20
Broken Laminar blade	-	-	-	-	-	-
Broken Levallois blade	141.23	291.61	216.48	43.50	215.66	20.10
Cutting edge per weight (mm/g)	Min.	Max.	Mean	S.D.	Med.	CV
Complete Laminar blade	7.63	22.29	14.96	10.37	14.96	69.32
Complete Levallois blade	2.05	48.17	9.84	9.38	7.18	95.37
Broken Laminar blade	-	-	-	-	-	-
Broken Levallois blade	2.33	10.31	4.80	2.80	4.81	58.44
Flattening index (mT/mW)	Min.	Max.	Mean	S.D.	Med.	CV
Complete Laminar blade	0.46	0.50	0.48	0.03	0.48	6.26
Complete Levallois blade	0.19	0.64	0.38	0.10	0.38	25.61

Table 8.29. Metric data for complete and broken Levallois and Laminar blades analysed (n=81)

The Levallois blades produced attest to a hard hammer percussion strategy, with a high percentage of blades (70.00%) exemplifying well-defined and pronounced bulbar scar features (Table 8.30). Blades appear to be from varying degrees of the production sequence with just under a fifth (18.99%) of all Levallois blades retaining cortex, in most instances on their distal portion. In their morphology, blades are triangular or polyhedral in cross-section, and typically feature one arrise, with 77.22% of all examples featuring an individual arrise.

In their morphology, Levallois blades demonstrate a high degree of standardisation, with low elongation and dimension standard deviations and CV values.

Le Rissori (IIIA): technological analysis (n=81)									
Percussion strategy:	Levallois (79)		Laminar (2)		Bulbar scar features:	Levallois (79)		Laminar (2)	
Hard	70	88.61%	1	50.00%	Well defined	47	59.49%	0	0.00%
Soft	0	0.00%	0	0.00%	Diffused	21	26.58%	2	100.00%
Mixed/Indeterminable	0	0.00%	1	50.00%	Absent/missing	10	12.66%	0	0.00%
Absent	9	11.39%	0	0.00%	Removed	1	1.27%	0	0.00%
Cortex percentage:					Number of dorsal scars:				
Absent	55	69.62%	2	100.00%	Absent	0	0.00%	0	0.00%
1-24%	21	26.58%	0	0.00%	1-2	26	32.91%	0	0.00%
25-49%	3	3.80%	0	0.00%	3-4	40	50.63%	1	50.00%
50-74%	0	0.00%	0	0.00%	5-6	8	10.13%	0	0.00%
75-99%	0	0.00%	0	0.00%	7+	5	6.33%	1	50.00%
Complete	0	0.00%	0	0.00%					
Number of elongated scars:					Number of ridges/arrises:				
Absent	0	0.00%	0	0.00%	Absent	0	0.00%	0	0.00%
1-2	64	81.01%	1	50.00%	1	61	77.22%	1	50.00%
3-4	14	17.72%	1	50.00%	2	9	11.39%	1	50.00%
5-6	1	1.27%	0	0.00%	3	5	6.33%	0	0.00%
7+	0	0.00%	0	0.00%	4	4	5.06%	0	0.00%
					5+	0	0.00%	0	0.00%
Dorsal ridge/arise shape:					Flake scar pattern:				
Singular	43	54.43%	1	50.00%	Unidirectional	39	49.37%	1	50.00%
Parallel	15	18.99%	0	0.00%	Centripetal	1	1.27%	0	0.00%
Irregular	6	7.59%	1	50.00%	3-way centripetal	1	1.27%	0	0.00%
Regular converging	0	0.00%	0	0.00%	Bidirectional	13	16.46%	1	50.00%
Regular diverging	1	1.27%	0	0.00%	Lateral left	0	0.00%	0	0.00%
Y-shape	4	5.06%	0	0.00%	Lateral right	0	0.00%	0	0.00%
Inverted Y-shape	0	0.00%	0	0.00%	Convergent unidirectional	16	20.25%	0	0.00%
Offset left/right	7	8.86%	0	0.00%	Convergent bidirectional	3	3.80%	0	0.00%
Partial	3	3.80%	0	0.00%	Convergent and perpendicular	0	0.00%	0	0.00%
Central converging	0	0.00%	0	0.00%	Double perpendicular	1	1.27%	0	0.00%
Absent	0	0.00%	0	0.00%	Straight and perpendicular	5	6.33%	0	0.00%
					Cortical	0	0.00%	0	0.00%
					Indeterminable	0	0.00%	0	0.00%
Distal end type:					Butt type:				
Feathered	39	49.37%	2	100.00%	Plain/flat	16	20.25%	1	50.00%
Stepped	12	15.19%	0	0.00%	Dihedral	11	13.92%	0	0.00%
Hinged	12	15.19%	0	0.00%	Cortical	1	1.27%	0	0.00%
Overshot	4	5.06%	0	0.00%	Natural (but non-cortical)	0	0.00%	0	0.00%
Present but indeterminable	2	2.53%	0	0.00%	Marginal	11	13.92%	1	50.00%
Missing	10	12.66%	0	0.00%	Mixed	16	20.25%	0	0.00%
					Facetted	13	16.46%	0	0.00%
					Missing (proximal missing)	10	12.66%	0	0.00%
					Trimmed	0	0.00%	0	0.00%
					Chapeau de Gendarme	0	0.00%	0	0.00%
					Damaged/unidentifiable	1	1.27%	0	0.00%

Table 8.30. Technological observations from Le Rissori (IIIA) (blade attributes)

Analyses of scar direction highlights the use of both unidirectional and bidirectional blade production, similarly to the evidence for Levallois blade cores within the material analysed. In their preparation, facetting is observed on 16.46% (n = 13) of all blades, with plain and mixed butts the most common platform type, accounting for 20.25% of the assemblage each.

In their retouch, similarities with previous contexts can be observed in their morphology and quantity (Table 8.31). In total, thirty-three Levallois blades feature retouch, accounting for 41.77% of the overall Levallois blade assemblage. This, as noted previously, echoes similarities with the Le Rissori (IIIB) blades analysed, which featured retouch on 47.14% of the Levallois blade assemblage. The blades feature a high percentage of complete continuous retouch around the blade's edge, with twenty-three (29.11%) examples noted, in addition to featuring a predominantly direct retouch scheme also akin to Le Rissori (IIIB). In form, retouch is typically notch or denticulate in nature, with fourteen examples noted, further mirroring Le Rissori (IIIB). The use of notch-based retouching is echoed in the twenty-two *éclats débordants* examined, with notch and denticulate morphologies observed in five of the seven retouched examples.

For diagrams of Levallois and Laminar core *débitage* see Figure 8.14 and 8.15.

Le Rissori (IIIA): retouch analysis (n=81)									
Presence of retouch:	Levallois (79)		Laminar (2)		Location of retouch:	Levallois (79)		Laminar (2)	
Yes	33	41.77%	0	0.00%	Proximal left	7	14.00%	0	0.00%
No	46	58.23%	2	100.00%	Proximal right	3	6.00%	0	0.00%
					Medial left	4	8.00%	0	0.00%
					Medial right	2	4.00%	0	0.00%
					Distal left	6	12.00%	0	0.00%
					Distal right	5	10.00%	0	0.00%
					Complete/continuous	23	46.00%	0	0.00%
Position of retouch:					Retouch coverage (%):				
Direct	28	84.85%	0	0.00%	No retouch	46	58.23%	2	100.00%
Inverse	2	6.06%	0	0.00%	1-25%	2	2.53%	0	0.00%
Alternate	0	0.00%	0	0.00%	26-50%	2	2.53%	0	0.00%
Bifacial	3	9.09%	0	0.00%	51-75%	2	2.53%	0	0.00%
Crossed	0	0.00%	0	0.00%	76-99%	4	5.06%	0	0.00%
Proximal (i.e. burin)	0	0.00%	0	0.00%	Complete retouch	23	29.11%	0	0.00%
Presence of burination:					Distribution of retouch:				
Yes	0	0.00%	0	0.00%	Continuous	28	84.85%	0	0.00%
No	79	100.00%	2	100.00%	Discontinuous	1	3.03%	0	0.00%
					Partial	4	12.12%	0	0.00%
Form of retouched edge:					Morphology of retouch:				
Rectilinear	3	9.09%	0	0.00%	Scaled	33	70.21%	0	0.00%
Concave	5	15.15%	0	0.00%	Stepped	0	0.00%	0	0.00%
Convex	11	33.33%	0	0.00%	Sub-parallel	0	0.00%	0	0.00%
Single removal (notch/burin)	1	3.03%	0	0.00%	Parallel	0	0.00%	0	0.00%
Denticulate	4	12.12%	0	0.00%	Notch/Denticulate	14	29.79%	0	0.00%
Multiple	9	27.27%	0	0.00%	Burin	0	0.00%	0	0.00%

Table 8.31. Technological observations from Le Rissori (IIIA) (retouch attributes)

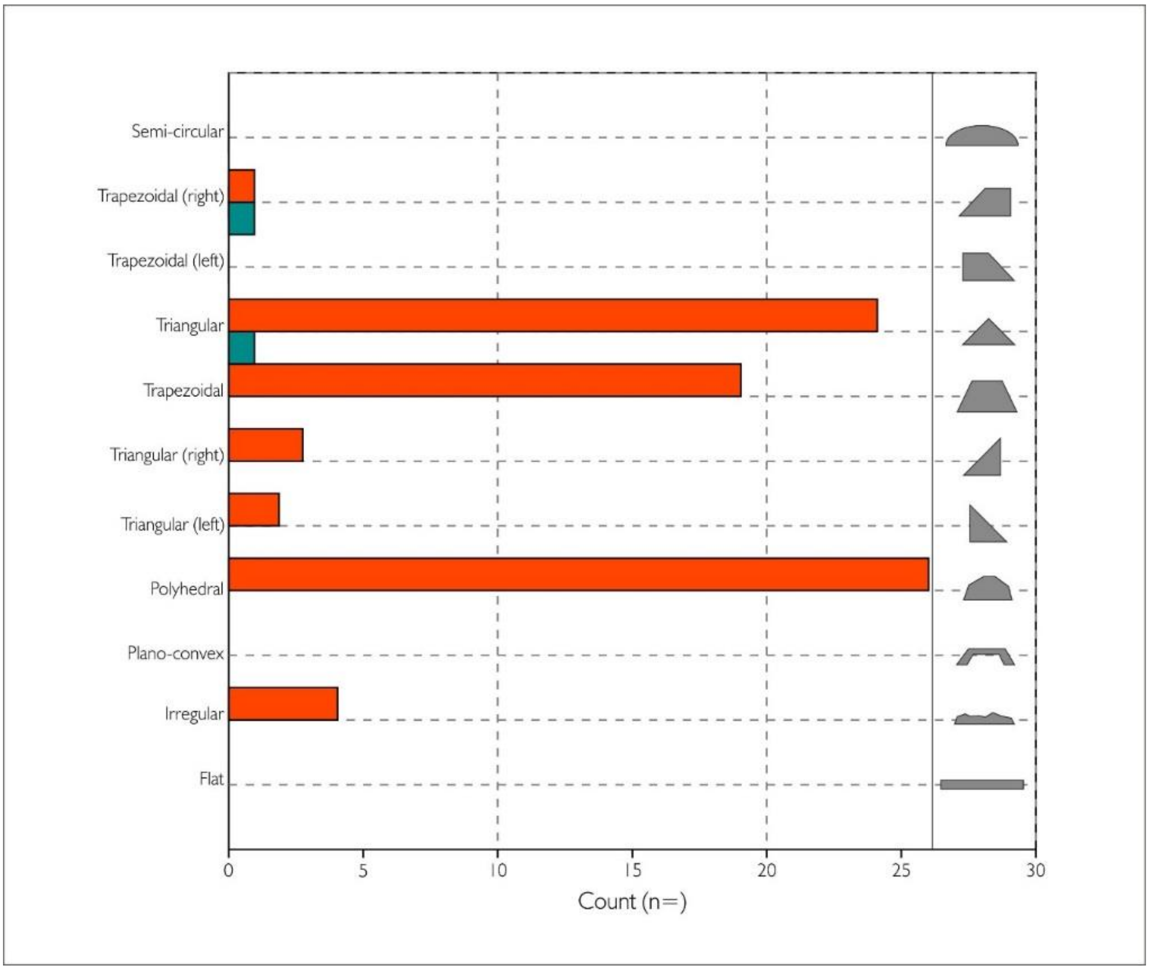


Figure 8.13. A bar-chart of the different cross-sections documented throughout Le Rissori (IIIA) (Orangered: Levallois; Dark Cyan: Laminar)

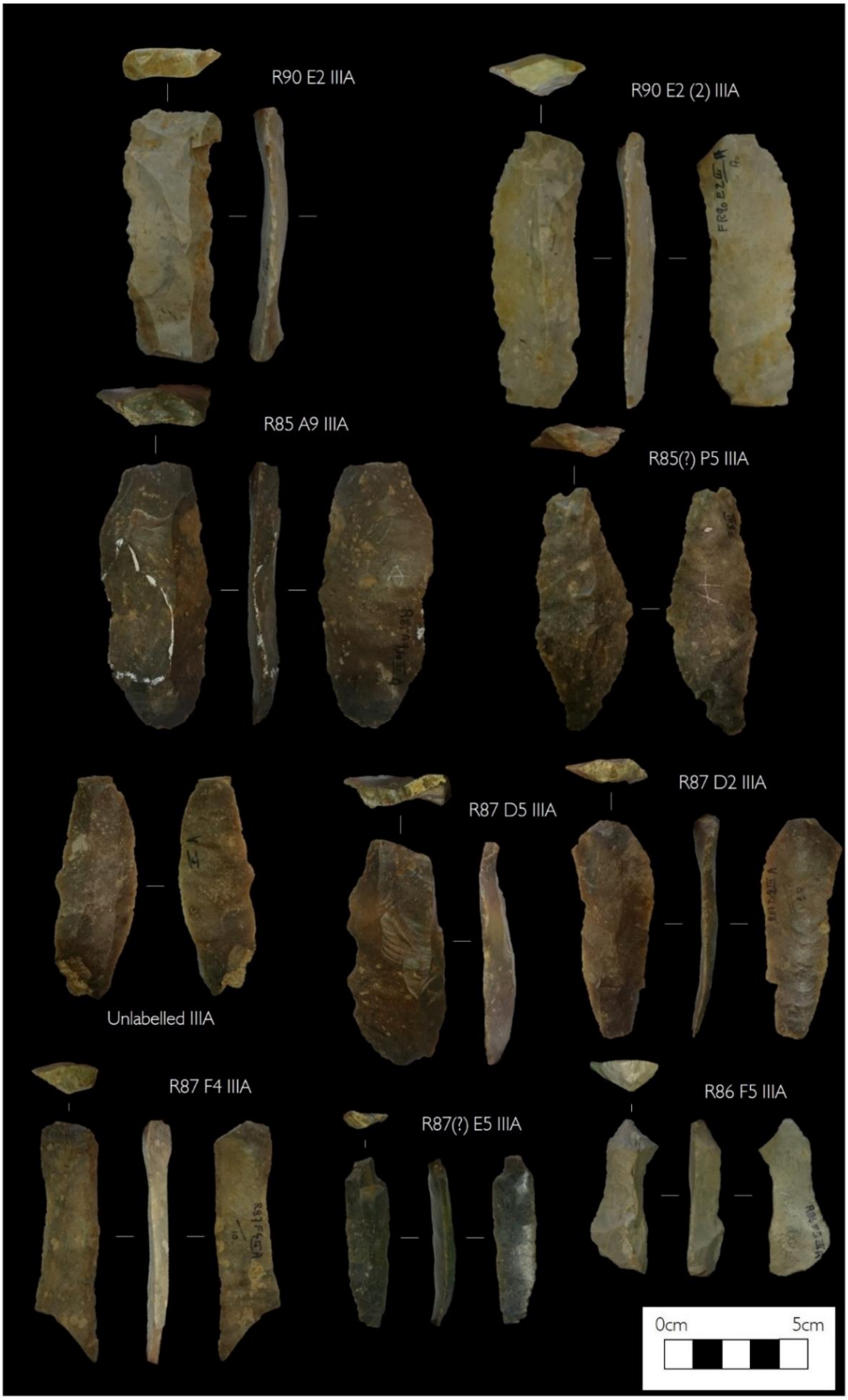


Figure 8.14. Examples from Le Rissori (IIIA): Levallois (top and centre) and Laminar (bottom) blades

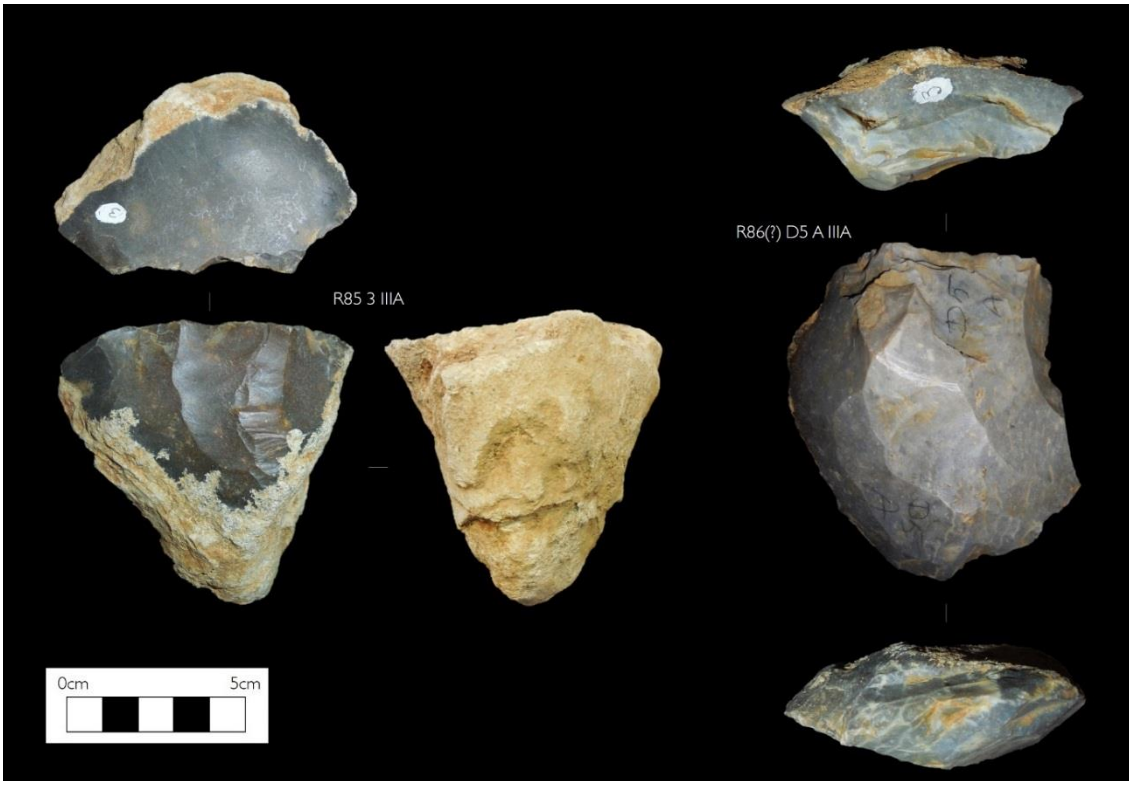


Figure 8.15. Examples from Le Rissori (IIIA). Left: Laminar facial blade core;
Right: Levallois bidirectional blade core

8.3.4. Hominin Behaviour within the Le Rissori Complex

From the material examined among the collections in the IRSNB, demonstrate the use of a predominantly Levallois-based technique at Le Rissori, through three various sub-stages of MOIS 7 (7c/7b/7a), with a small amount of evidence for Laminar technological blade strategies documented in the later Le Rissori (IIIA/IIIB) occupational layer(s). A summary of the three contexts can be viewed in Table 8.32.

Much of the archaeological literature since Adam (1991) has highlighted problems with the chronostratigraphy and the nature of overlap between the three lithostratigraphic layers, specifically the number of contexts in question (see above). While, this thesis has only examined one aspect of only a sample of the three contexts, a variety of commonalities between the two Le Rissori (III) layers are apparent including their morphological similarity, the specific strategies undertaken, and their retouch. Two scenarios are therefore suggested from the lithic analysis. Firstly, it is possible to suggest that similarities in the blade component of the Le Rissori (IIIA) and Le Rissori (IIIB) assemblages represent one context, and one occupational layer, disturbed through the low-medium energy environment. The stratigraphic record does not show the palaeosols directly above each lithostratigraphic layer, and it may be possible to suggest, that the slope context made the sequence more complex, and produced admixture. The alternative hypothesis is that these represent two distinct occupational layers, over several thousands of years, with similar behaviours exemplified throughout.

Irrespective the archaeological evidence at Le Rissori highlights the importance of Levallois blade manufacturing throughout the Early Middle Palaeolithic and the Neanderthal repertoire. It demonstrates great competency in how Neanderthals re-prepared a Levallois core to produce highly standardised Levallois blades, and the homothetic morphology of many of the cores produced. It highlights the use of both fortuitous and proceduralised Laminar techniques, with blades produced from 'expedient-like' core volume management systems, and more extended lithic reduction sequences incorporating extensive cresting. It also highlights the importance of possible core-edge blades within the technological assemblage, paralleling evidence at Mesvin (IV).

How then can we explain the lack of Laminar blades produced, despite the existence of their core volume management systems? It may be possible that the evidence for this technological blade strategy is held within the SRPH collections, and sampling strategy may account for such. Alternatively, it may be the result of recording error, with many of the Levallois blades, in-fact being Laminar. This latter explanation can be excluded given morphological, raw material, and technological differences between the different blades and blade cores identified. It is also possible that the blades may be under-representative within the collections as they were used elsewhere within the immediate landscape. In understanding this relationship in more detail, a holistic analysis of all material from both collections is essential.

The fragmentary nature of the Levallois blade strategy also needs to be addressed, specifically the relationship between Levallois blades stored at the IRSNB and the Levallois material housed at the SRPH. No refits were documented throughout, and differences between the cores and blades were highlighted. A holistic analysis of both collections, coupled with studies into the local raw material economy is necessary to determine whether the Levallois blades were curated products brought to the site/locale, or whether they were made and retouched on-site.

In sum, while the analysis asks more questions than it answers, it does highlight the importance of stereotyped elongated products within the early Neanderthal mindset, and the degree of time and energy invested into the production and curation of blade products. The fragmented nature of the collection does restrict a more whole understanding of these strategies; however the contexts do demonstrate substantial evidence for the great antiquity of sophisticated blade production methods, and proceduralised technological blade behaviour among early Neanderthals in Belgium.

Archaeological summary: blade production systems at the Le Rissori complex

Le Rissori (IV)

From the IRSNB collection:

- Levallois-based but few in number
- No evidence for technological blade cores
- Mean length: 74.79mm (CV: 29.02); mean elongation index: 2.08 (CV: 15.23)
- Break rate:88.89% complete
- Facetting rate: 0.00%
- Relative high Levallois retouch rate (38.89): predominantly scraper-types
- No evidence for the use of Laminar technological blade strategies

Le Rissori (IIIB)

From the IRSNB collection:

- Predominantly Levallois based (92.94%)
- Levallois core strategies: predominantly unidirectional
- Mean length: 82.95mm (CV: 29.27); mean elongation index: 2.28 (CV: 13.88)
- Break rate: 97.62% complete
- Facetting rate: 11.43% facetting
- High Levallois retouch rate (47.14%): predominantly notch and denticulate
- Use of *éclats débordants* exemplified through their retouch
- Some evidence for the use of Laminar core volume management systems (facial and frontal) with little evidence for Laminar technological blades

Other collections: Existence of Laminar core volume management strategies

Le Rissori (IIIA)

From the IRSNB collection:

- Predominantly Levallois based (95.40%)
- Levallois core strategies: mix of unidirectional and bidirectional strategies
- Mean length: 88.01mm (CV: 28.21); mean elongation index: 2.51 (CV: 20.62)
- Break rate: 81.65% complete
- Facetting rate: 16.46% facetting
- High Levallois retouch rate (41.77%): predominantly notch and denticulate
- Use of *éclats débordants* exemplified through their retouch
- Some evidence for the use of Laminar core volume management systems (facial) with little evidence for Laminar technological blades

Other collections: Existence of a variety of Laminar strategies of varying preparation

Table 8.32. A summary of the archaeological evidence for blade technology at Le Rissori

8.4. Rocourt (la Sablière Gritten)

8.4.1. Introduction and Overview of Investigations

The archaeological material from Rocourt originates from the *Sablière Gritten* (named after the owner and operator), within a well-established luvisol horizon on the Belgian loess plateau, either side of the *Chaussée de Tongres* (N20) and five kilometres north-west of Liège (Figure 8.16).

The quarry features a long history of archaeological enquiry and investigation. The earliest documented evidence originates from a visit to the quarry by Victor Commont in 1911, who recognised a sequence of deposits comparable to the Picardy region. Within this sequence Commont (with assistance from Marcel de Puydt) identified fissured silts attributable to the last interglacial (Haesaerts et al., 2011a). Commont also uncovered flakes, with some Levalloisian characteristics while in the Gritten quarry. As Haesaerts et al. (2011a: 360) note, through correspondence (including section diagrams) between Commont and De Puydt (Lohest and Fraipoint, 1911-1912), that it was evident that such findings were in a secondary position.

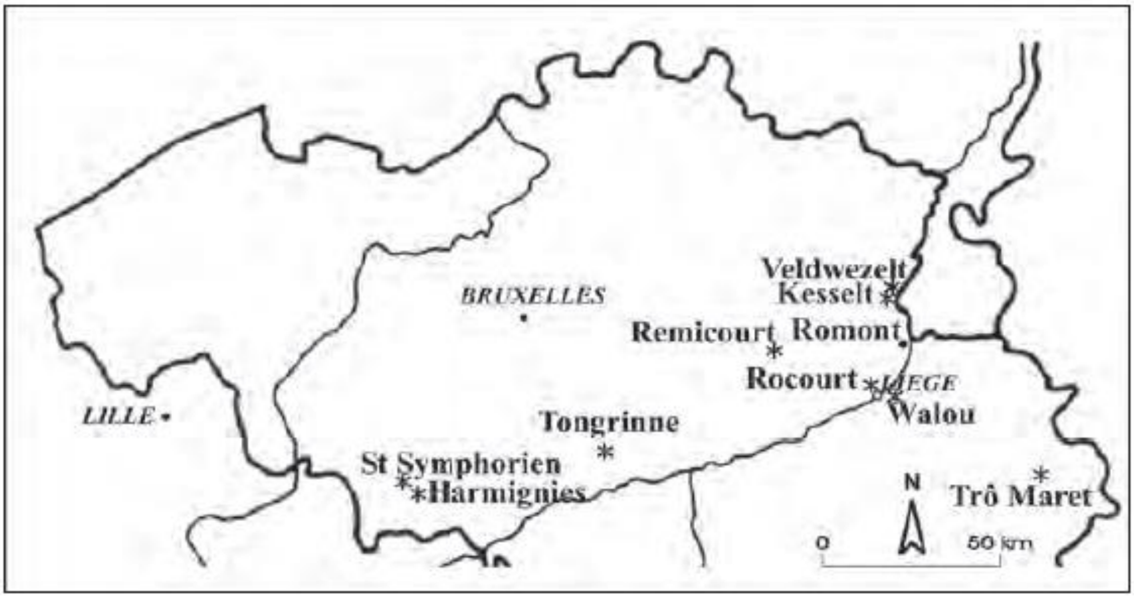


Figure 8.16. The position of Rocourt with respect to other Middle Palaeolithic localities within central and southern Belgium (Juvigné, 2013)

Scientific investigations were first initiated in 1954 through the studies of Frans Gullntops, who, building on from De Puydt, extensively documented and defined the *Sol de Rocourt/Pedocomplexe du Rocour*t (Rocourt soil/Rocourt pedocomplex), a series of deposits attributable to the last interglacial. Following this, several smaller discoveries were observed within the Rocourt gravels. In the company of Frans Gullentops, Jean de Heinzelin discovered evidence of material attributed to the Rocourt soil (with the stratigraphical records archived in the IRSNB), and during an INQUA excursion in 1967, Etienne Paulissen discovered a grey mottled flake fragment *in-situ*, later categorised as an atypical Levallois flake (Vermeersch, 1971).

It was in the 1970s with the extension of the Gritten quarry, when the concentration of lithics typically attributed as the Rocourt assemblage, were discovered (Haesaerts, 1978). Carried out through the IRSNB, the excavations uncovered four-hundred-and-seven artefacts, demonstrating a predominantly Laminar technological blade strategy (Haesaerts, 1978; Otte et al., 1990). This evidence was distributed over thirty square metres of the quarry, within ten centimetres of the DC unit (Haesaerts, 1978; Otte et al., 1990; Haesaerts, 2011a), and was dated between MOIS 5b and mid MOIS 5a (see below for more information). Haesaerts (2011a: 361) notes that as the material can be precisely positioned within a robust stratigraphic sequence, the material uncovered was perhaps the most important assemblage within all material excavated at Rocourt. Alongside the blade strategies excavated at Rheindahlen and Séclin, Rocourt was one of the first assemblages to identify the existence of a Laminar technological blade strategy within a Middle Palaeolithic context (Haesaerts, 1978). Furthermore, the deposits and the existence of an extensive pedosedimentary sequence, first noted by Gullentops (1954) and elaborated further through excavations in the 1970s (Juvigné, 1977; Haesaerts, 1978; Haesaerts et al., 1981; Haesaerts and Van Vliet-Lanoë, 1981), has provided a reference for mineralogical and micro-morphological components of the Hesbaye Upper Pleistocene region, the rest of Belgium and its adjacent regions (Paepe and Vanhoorne, 1967, 1976; Zagwijn and Paepe, 1968; Sommé et al., 1980).

Further research from 1977-1983 into the technological characteristics of the assemblage identified the existence of eighteen unique refitting sequences of varying completion, providing a detailed and invaluable insight into the exact production of Laminar technological blade strategies. Following extensive documentation of the refit sequences (Otte, 1978, 1994; Otte et al., 1990), and later re-evaluation of the material (Révillion, 1995), under ministerial order the quarry was designated as being of vast archaeological importance in February 2001

(Haesaerts et al., 2011a). Since this classification, the material and the history of the context has been summarised in detail (Haesaerts et al., 2011a).

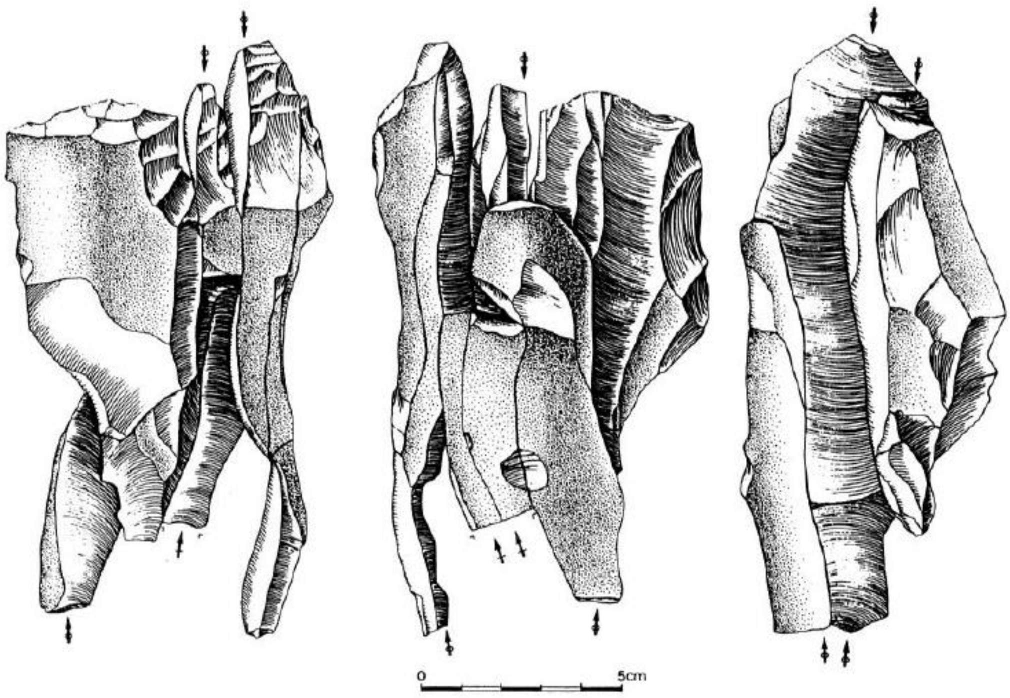


Figure 8.17. A refit sequence from Rocourt exemplifying blade production through the Laminar technique (Otte et al. 1990) - discussed further below

Despite the need for extensive analyses of the lithic material as noted by Haesaerts et al. (2011a), analyses have highlighted the nature of Laminar technological blade production within the Rocourt landscape. Technological analyses have highlighted the co-existence of a frontal-to-semi-rotating Laminar operating scheme (Figure 8.17), using local high-quality elongated nodules and blocks, in association with a variety of other flake-based management strategies, some hypothesised to represent failed blade production (Haesaerts et al., 2011a). The raw material is known to have been exploited through a mix of anthropogenic and natural ridges from the core's narrowest edges, with a frontal scheme undertaken to initiate the blade sequence. Following the creation of blade *débordant* removals, a semi-rotating scheme is undertaken with the cores resulting in a concave morphology. Otte et al. (1990) also notes the careful preparation and maintenance, prior and during blade extraction through the alteration of raw material by fire, the presence of platform preparation and facetting, and the adoption of a bidirectional method of blade production. A variety of what are termed Upper Palaeolithic tools are also excavated, and assumed to be produced on-site. This includes backed blades, burins, a truncated bladelet, and a curved backed bladelet (Otte, 1978, 1994; Otte et al., 1990). Previous discussions (Otte et al. 1990) have discussed the Levalloisian nature of the Rocourt reduction scheme, with the presence of *lames/eclat débordants*, and the convexity/morphology of the *débitage* surface suggestive of a mixed Levallois-Laminar system of management i.e. specialised Levallois. Subsequent analyses by Révillion (1995) have however highlighted that the core volume management strategies adhere to a semi-rotating management strategy without one delineated surface, comparable to other MOIS 5 contexts. Additionally, no Levallois *débitage* was recorded in association with the material excavated from the excavations in the 1970s.

Today, Rocourt continues to be used as an example of a MOIS 5 context exemplifying the extensive reduction of blade production, through a Laminar technological blade production (e.g. Delagnes, 2000; Di Modica, 2010, 2011; Di Modica et al., 2016). Despite the extensive amount of research undertaken into the lithic component of the context, detailed technological analyses for all refits are absent within the literature, with morphometric analyses also absent.

8.4.2. Geological and Chronological Background

The Rocourt locale is situated within a plateau position and does not relate to the contemporary hydrological and fluvial network. In its stratigraphic positioning, the assemblage in question originates from the DC unit (see Figure 8.18), a degraded white clay formation corresponding to the Whitish Horizon of Momalle (Haesaerts et al., 2011a, 2011b). This unit is situated within the Rocourt Pedocomplex, an established luvisol horizon spanning MOIS 5, named after its first observation within the Rocourt locality (Gullentops, 1954). Thermoluminescence dating of this horizon by Van den Haute et al. (2003) has since confirmed its assignment to MOIS 5. The DC unit rests above two further illuvial layers, units DA and DB, two red-brown loamy-clay units with lamellar and polyhedral morphologies (Van Vliet, 1975; Haesaerts and Van Vliet-Lanoë, 1981, 1983). While similar in appearance, both units can be distinguished by their micromorphological components (see Haesaerts et al., 2011a).

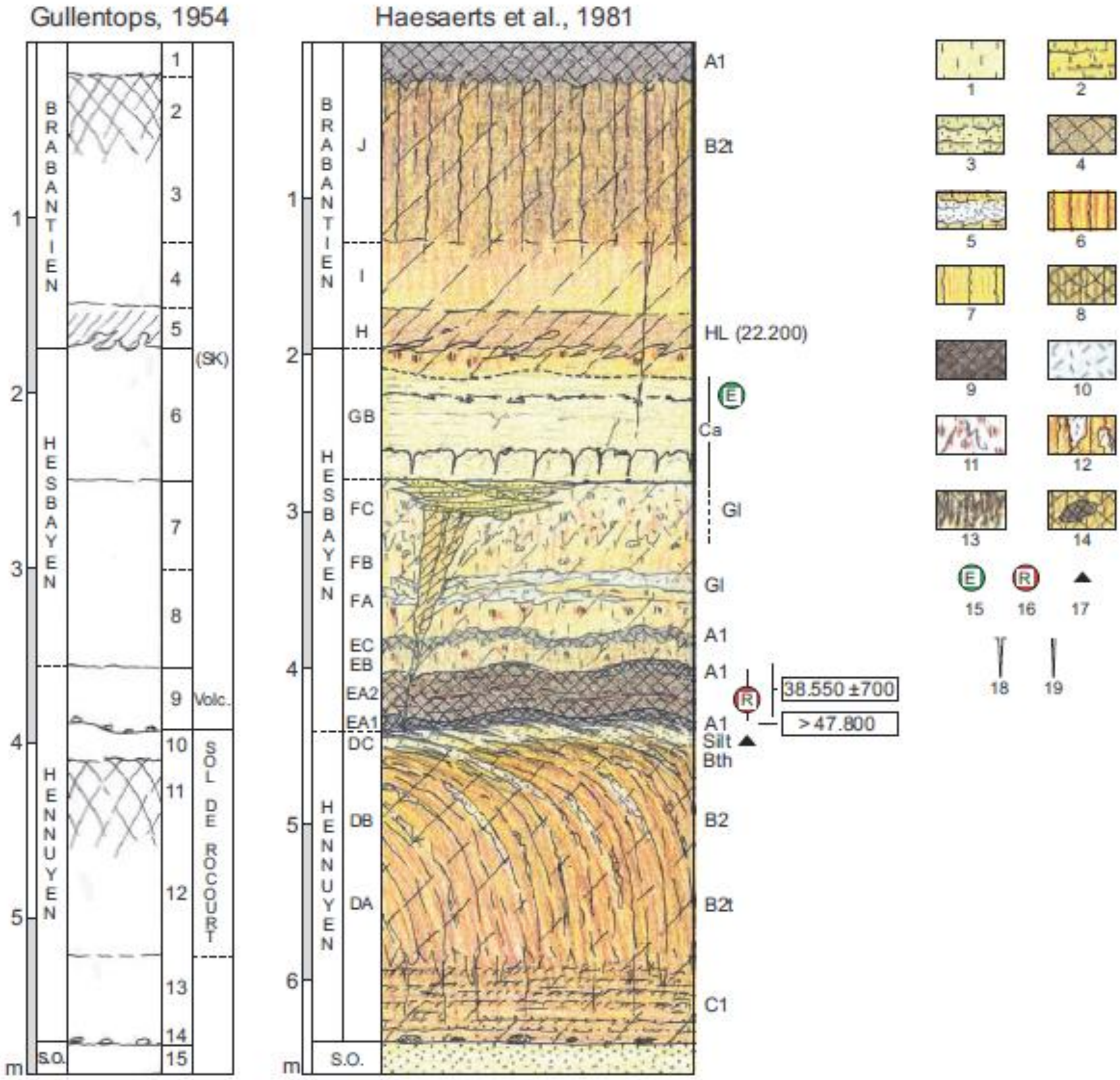


Figure 8.18. A comparative stratigraphic sequence for the Rocourt complex (modified from Haesaerts et al. 2011a). Legend: 1: loess; 2: silt; 3: sand; 4: eolian humiferous silt; 5: silt; 6: B2T horizon (soil leaching); 7: B/B2 horizon (brown soil/brown leached soil); 8: Bth horizon (Grey Forest Soil); 9: humiferous horizon; 10: eluviated tundra or gley horizon; 11: iron hydroxides; 12: glossic luvisol; 13: biogaleries; 14: krotovines; 15: Eltville tuff; 16: Rocourt tephra; 17: artefact horizon; 18: gelifraction; 19: ice wedge

Abbreviations: SK: Kesselt Soil; Volc: volcanic minerals; SO.: oligocene sands; HL: the horizon à langues de Nagelbeek; Ca.: carbonates, Gl: tundra glay

The Rocourt Pedocomplex is overlain by a unit of humic deposits - the Humiferous Complex of Remicourt - attributed to the end of the Weichselian Early Glacial Period i.e. MOIS 5a (Juvigne, 1977; Haesaerts et al., 1999; Haesaerts and Mestdagh, 2000; Pouclet et al., 2008; Jouanic et al., 2016). Within the Humiferous Complex of Remicourt, reworked tephra minerals (cryptotephra) were observed, featuring a high volcanic and mafic mineraological composition Gullentops, 1954; Juvigne, 1977; Haesaerts et al., 1997; Juvigne et al., 2013). The positioning of the cryptotephra within the Humiferous Complex of Remicourt allowed Juvigne et al. (2013) to conclude that the material can be linked to one of the numerous phreatomagmatic eruptions known to have taken place in the West Eifel volcanic fields, allowing for a dating of between 80,000-78,000 years ago.

While a *terminus post quem* of mid MOIS 5a can be identified, two hypotheses exist in determining the specific age of the Rocourt assemblage. Given strong cryogenic deformation within the Whitish Horizon of Momalle and its relationship to the two illuvial layers (DA/DB), the assemblage can be either attributed to mid MOIS 5a or MOIS 5b (Pirson and Di Modica, 2011; Haesaerts et al., 2011a).

For a more detailed description of the geological and chronological framework within the Rocourt Pedocomplex and the DC unit see Haesaerts et al. (2011a, 2011b).

8.4.3. Artefact Analysis

8.4.3.1. Treatment and Selection of the Collection(s)

All 407 artefacts from the main excavation undertaken in February 1977 are archived among collections in IRSNB. Analyses undertaken on the Rocourt assemblage have focused on narrative-based analyses of the refits, and not the technological components of all blades within the assemblage (Haesaerts et al., 2011a). This assemblage was therefore chosen to provide a Belgian context with which the French MOIS contexts can be compared for their Laminar reduction strategy, and the specific technological behaviours present.

The assemblage was assessed along excavation notes, cross-sections and diagrams also stored in the collections at the IRSNB. Given several refits were glued, geometric morphometric analyses could only be undertaken on a percentage of artefacts (see Chapter 10).

8.4.3.2. Technological Overview

An examination of the complete assemblage highlights the existence of one-hundred and ten technological blades (including cortical blades), technological cores, or technological blade tools (Table 8.33). This number is slightly higher than the inventory undertaken by Jean de Heinzelin following excavations from 1977 onwards, and differs primarily by the number of artefacts identified as blade fragments, and the inclusion of *lames débordants*. All cores were confidently identified with only a small number of Laminar products (5.71%) classified as other than 'definite' products (Table 8.34).

Artefact	n	Percentage
Laminar blade (unretouched)	41	37.27%
Laminar blade (retouched)	6	5.45%
Laminar blade fragment (unretouched)	43	39.09%
Laminar blade fragment (retouched)	4	3.64%
Laminar crested blade (unretouched)	10	9.09%
Laminar crested blade (retouched)	0	0.00%
Laminar crested blade fragment (unretouched)	1	0.91%
Laminar crested blade fragment (retouched)	0	0.00%
Laminar blade core	5	4.55%
Levallois blade (unretouched)	0	0.00%
Levallois blade (retouched)	0	0.00%
Levallois blade fragment (unretouched)	0	0.00%
Levallois blade fragment (retouched)	0	0.00%
Levallois *éclat débordant* (unretouched)	0	0.00%
Levallois *éclat débordant* (retouched)	0	0.00%
Levallois *éclat débordant* fragment (unretouched)	0	0.00%
Levallois *éclat débordant* fragment (retouched)	0	0.00%
Levallois recurrent blade core	0	0.00%
Total:	110	100.00%

Table 8.33. Technological overview of the artefacts studied

Confidence	Laminar core	Levallois core	Laminar product	Levallois product
A (definite)	5 (100.00%)	-	99 (94.29%)	-
B (probable)	0	-	6 (5.71%)	-
C (possible)	0	-	0 (0.00%)	-

Table 8.34. Confidence categories for the artefacts studied

8.4.3.3. Taphonomic History

Analyses of the taphonomic history support many ideas already established about the local geological processes, in addition to providing a more detailed description about behaviours within the blade component of Rocourt (Table 8.35).

Given its position within a plateau environment, distant from the local hydrological network and thus the distinct lack of a fluvial environment, it would be possible to suggest that there would be little chemical alteration. This hypothesis is supported through examination of the chemical alteration, with only fourteen examples (12.73% of the examined assemblage) featuring light patination or chemical alteration and a further two examples featuring moderate patination. Observed cortex retained on artefacts (for specifics see below) appears worn, uniform, unstained and relatively unaltered in appearance.

Rocourt (la Sablière Gritten): artefact condition (n=110)									
	Levallois (0)		Laminar (110)			Levallois (0)		Laminar (110)	
Whole/broken:					Degree of patination:				
Whole	0	0.00%	63	57.27%	Unpatinated	0	0.00%	94	85.45%
Broken	0	0.00%	47	42.73%	Lightly patinated	0	0.00%	14	12.73%
					Moderately patinated	0	0.00%	2	1.82%
					Heavily patinated	0	0.00%	0	0.00%
Degree of edge damage:					Degree of burning:				
No edge damage	0	0.00%	103	93.64%	Unburned	0	0.00%	99	90.00%
Lightly damaged	0	0.00%	7	6.36%	Lightly burned	0	0.00%	11	10.00%
Moderately damaged	0	0.00%	0	0.00%	Moderately burned	0	0.00%	0	0.00%
Heavily damaged	0	0.00%		0.00%	Heavily burned	0	0.00%	0	0.00%
Degree of rolling:					Portion/break:				
Unrolled	0	0.00%	106	96.36%	Complete	0	0.00%	62	56.36%
Lightly rolled	0	0.00%	4	3.64%	Proximal fragment	0	0.00%	19	17.27%
Moderately rolled	0	0.00%	0	0.00%	Medial fragment	0	0.00%	7	6.36%
Heavily rolled	0	0.00%	0	0.00%	Distal fragment	0	0.00%	22	20.00%
					Siret	0	0.00%	0	0.00%
Observations: Minimal scratching and abrasion documented.									

Table 8.35. Detailed taphonomic characteristics of material analysed at Rocourt (la Sablière Gritten)

Despite the cryogenic nature of the assemblage a low energy environment is known within the immediate landscape (Haesaerts et al., 2011a), with minimal disturbance to the condition of the artefacts examined. This is supported through a low occurrence of mechanical damage with only seven examples (6.36% of the examined assemblage) documenting edge damage, all light in nature, and four accounts (3.64% of the examined assemblage) of rolling damage on the ridges and profiles – this is also light in nature. Minimal scratching and abrasion is noted on a small number of examples. Despite the high breakage rate (42.73% of the examined assemblage), it is hypothesised that breakages result from blade extraction, given the high rate of distal and proximal breakages present. Anthropogenic signatures of breaking (impact marks and mechanical differences in the break) are also lacking.

Only a small number of artefacts were observed to feature burning, in contrast to general comments on the assemblage (Otte et al., 1990). This is however expected, as only the blade component is being considered within this analysis, blades which would have been exploited deeper in the raw material, and less susceptible to signatures of preparatory firing. Of the one hundred and ten artefacts examined, only eleven featured evidence for fire and heat treatment, representing 10.00% of the overall blade component.

8.4.3.4. Raw Material

An examination of the overall assemblage highlights the use of a single type of high-quality flint, with fine-grained homogeneous composition. Given the surrounded cretaceous outcrops within the immediate landscape the material is assumed to be from a semi-autochthonous (*sensu* Turq, 2005) context within the immediate landscape.

In their morphology, cortical elongated nodules are known to be exploited (Otte et al., 1990; Haesaerts et al., 2011a); this is supported through elongation indices recorded for both the blades produced, core morphologies (see below), and refit analyses. In addition to the use of elongated cortical nodules, larger blocks of material are known to have been recorded within the assemblage (Otte et al., 1990).

8.4.3.5. Technology: Extended Analysis

Given the presence of extensive refit analyses and a high number of blades and blade fragments, a high resolution of technological behaviour can be interpreted.

In the preparation of blade cores, various flaking strategies of varying degrees of preparation are undertaken on the core's platforms, with bidirectional and multiple lineal platform preparation strategies noted alongside commonly noted single lineal removal (Table 8.36). Core platforms are typically flat and concave in morphology, and feature some edge preparation, as noted through scarring on the core-edges, and in the presence of facetting on blade *débitage* (see below). Following this, both natural and anthropogenic ridges of varying size are exploited. Analyses of the complete crested blades (Table 8.37) highlight the investment of time and energy in the careful initiation of blade sequence with six examples (60.00%) featuring ridging over greater than 50% of the blade's ridge, all featuring removals on both dorsal faces of the ridge. In this, these six examples can be defined as *lames á crêtes sensu stricto*. A variety of different average scar widths and sizes are evident, with scars less than ten millimetres, and scars greater than twenty-five millimetres documented. And as Remontage F exemplifies, they can be exploited to varying success in their exploitation (see below). All ten whole crested blades feature no retouch or modification following exploitation. In addition to anthropogenic ridges, examples exist for the natural exploitation of ridges and the raw material's natural geometry e.g. RO-P6/P25.25m.

Rocourt (la Sablière Gritten): technological core observations (n=5)							
Core strategy:			Number of scars/core:				
Laminar	5	100.00%	Laminar: Min: 7, Max: 11, Mean: 8.4 (CV: 19.92)				
Levallois	0	0.00%	Levallois: N/A				
			Number of elongated (L/W = 1.75>) scars/core:				
			Laminar: Min: 2, Max: 5, Mean: 3.8 (CV: 43.24)				
			Levallois: N/A				
Levallois strategy:			Laminar core shape:				
Recurrent unidirectional	0	0.00%	Orthogonal/prismatic			0	0.00%
Recurrent bidirectional	0	0.00%	Semi-orthogonal/semi-prismatic			5	100.00%
			Pyramidal			0	0.00%
Laminar strategy:			Laminar platform preparation strategy:				
Semi-tournant/semi-rotating	4	80.00%	Single Lineal			1	20.00%
Tournant/rotating	0	0.00%	Multiple Lineal			1	20.00%
Facial	0	0.00%	Bidirectional			3	60.00%
Frontal	1	20.00%	3-way centripetal			0	0.00%
Multiple (combination)	0	0.00%	Centripetal			0	0.00%
			Lateral (left/right)			0	0.00%
			Perpendicular (left/right)			0	0.00%
Laminar core volume utilised:			Distal end-types:	Levallois (0)		Laminar (5)	
1-25%	1	20.00%	Feathered	0	0.00%	3	42.86%
26-50%	1	20.00%	Stepped	0	0.00%	0	0.00%
51-75%	3	60.00%	Hinged	0	0.00%	1	14.29%
76-100%	0	0.00%	Reverse Hinged	0	0.00%	0	0.00%
			Overshot	0	0.00%	3	42.86%
Levallois core preparation strategy:			Number of platforms:				
Unidirectional	0	0.00%	1	0	0.00%	5	100.00%
Bidirectional	0	0.00%	2	0	0.00%	0	0.00%
Convergent unidirectional	0	0.00%	Cortex percentage:				
Centripetal	0	0.00%	Absent	0	0.00%	1	20.00%
Unidirectional left	0	0.00%	1-25%	0	0.00%	2	40.00%
Unidirectional right	0	0.00%	26-50%	0	0.00%	2	40.00%
Bidirectional lateral	0	0.00%	51-75%	0	0.00%	0	0.00%
Unidirectional distal	0	0.00%	76-100%	0	0.00%	0	0.00%

Table 8.36. Technological observations from Rocourt (la Sablière Gritten) (core attributes)

In their morphology, cores are of varying size, feature a high mean elongation index over double the core's width (Table 8.38), and a regular core shape typically semi-prismatic in their final form. Through an analysis of the blank profile, the core convexities, and core surface dimensions can be further understood. Analyses suggest that the cores are slightly convex, with 21% (21.27%) of all whole blades featuring a curved profile, and three-quarters (74.46%) of blade material feature a straight profile. The convexities observed agree with the cores observed, and in addition to their similar morphology it can be hypothesised that the blades were produced locally and on-site within the immediate landscape.

Despite the incomplete nature of many of the refits a general sequence of the blade production strategy can be determined, highlighting the use of a frontal technique, in isolation as a core (e.g. Remontage K), and as part of initiating the blade production sequence before the adoption of a *semi-tournant* reduction strategy (e.g. Remontage L). Analyses of isolated examples of cores also highlight the use of both management strategies with varying volumes of core edge circumference are observed. The cores feature a variety of feathered, hinged, and overshot distal end-types, with the overshot examples observed in both isolation and through refits, possibly representing a convexity maintenance technique. Despite the use of a bidirectional strategy as observed through the refit analyses all isolated cores highlight a unidirectional technique. This is also exemplified through analysis of the blank's dorsal scar pattern (see below).

Rocourt (la Sablière Gritten) technological data: crested blades (n=10)		
Crested blade scar percentage:		
<50% (*lame à crête partielle*)	4	40.00%
>50% (*lame à crête*)	6	60.00%
Crested blade scar regularity:		
Regular	9	90.00%
Irregular	1	10.00%
Number of crested sides knapped:		
One (*lame à demi-crête*)	4	40.00%
Two (*lame à crête*)	6	60.00%
Average width of scars:		
> 25 mm	1	10.00%
25-20 mm	2	20.00%
20-15 mm	3	30.00%
15-10 mm	2	20.00%
< 10 mm	2	20.00%
Presence of retouch:		
Yes	0	0.00%
No	10	100.00%
Retouch information: No retouch or modification following crested blade production		

Table 8.37. Technological observations from Rocourt (la Sablière Gritten)

The blanks produced exemplify the use of a hard hammer percussion strategy, however the greatest number of blades (n=37, 39.36%) are characterised by diffused bulbar scar features (Table 8.39), contrasting analyses of previous contexts. It would be difficult, given the indeterminable nature of some blades (see Chapter 2), and the large number of diffused scar features, to determine whether hard and/or soft hammer percussion technology was employed.

Weight (g)	Min.	Max.	Mean	S.D.	Med.	CV
Levallois	-	-	-	-	-	-
Laminar	25.30	184.50	116.33	82.02	139.20	70.51
Length (mm)	Min.	Max.	Mean	S.D.	Med.	CV
Levallois	-	-	-	-	-	-
Laminar	64.31	161.40	97.88	39.14	83.10	39.99
Width (mm)	Min.	Max.	Mean	S.D.	Med.	CV
Levallois	-	-	-	-	-	-
Laminar	22.52	152.50	62.66	52.86	50.10	84.36
Elongation index (L/W)	Min.	Max.	Mean	S.D.	Med.	CV
Levallois	-	-	-	-	-	-
Laminar	0.71	2.86	2.12	0.92	2.60	43.54
Thickness (mm)	Min.	Max.	Mean	S.D.	Med.	CV
Levallois	-	-	-	-	-	-
Laminar	10.20	36.20	24.78	9.55	27.10	38.51
Core flattening index (Thickness/Width)	Min.	Max.	Mean	S.D.	Med.	CV
Levallois	-	-	-	-	-	-
Laminar	0.12	0.44	0.27	0.13	0.31	46.58

Table 8.38. Metric data for complete cores analysed (n=5)

With respect to the morphology of the blades identified, blades are of varying size, partially due to the inclusion of *lames débordants* and overshot examples. Despite these, blades feature a relatively low standard deviation and CV values, and can be viewed as somewhat standardised (Table 8.40). The blades feature an elongation index far-exceeding the typical 2:1 morphological convention with a mean elongation index of 3:1 (2.98) recorded, and feature a flattening index parallel to Laminar blades produced through the experimental and archaeological datasets. In their cross-section, most blades are triangular, with low counts of trapezoidal or polyhedral forms (Figure 8.19).

In terms of their technological characteristics blades retain little cortex with over half of examples (56.38%) retaining no cortex. Examples of blades retaining a high percentage of cortex are, however, also evident. The blades typically feature 1-2 dorsal scars on average, 1-2 elongated scars on average, and typically feature one ridge with sixty-four examples (68.09%) documenting one individual ridge. In their shape, ridges are typically singular and central. All these above characteristics of technological shape and the high degree of technological standardisation highlight the stereotyped proceduralised nature of blades produced and the successful extension of the blade sequence. As noted previously, most technological blade strategies are unidirectional in their dorsal scar pattern with a total of sixty-eight (72.34%) unidirectional (convergent and non-convergent) scar patterns documented. This contrasts previous narrative-based analyses of the refits, which emphasise the bidirectional aspect of the Rocourt sequences (Otte et al., 1990). Similarly, only sixteen examples (whole/broken) feature facetting with the majority (n=19, 20.21%) of platforms flat/plain in nature.

Rocourt (la Sablière Gritten): technological analysis (n=94)									
Percussion strategy:	Levallois (0)		Laminar (94)		Bulbar scar features:	Levallois (0)		Laminar (94)	
Hard	0	0.00%	59	62.77%	Well defined	0	0.00%	26	27.66%
Soft	0	0.00%	0	0.00%	Diffused	0	0.00%	59	62.77%
Mixed/Indeterminable	0	0.00%	35	37.23%	Absent/missing	0	0.00%	7	7.45%
Absent	0	0.00%	0	0.00%	Removed	0	0.00%	2	2.13%
Cortex percentage:					Number of dorsal scars:				
Absent	0	0.00%	53	56.38%	Absent	0	0.00%	3	3.19%
1-24%	0	0.00%	30	31.91%	1-2	0	0.00%	48	51.06%
25-49%	0	0.00%	3	3.19%	3-4	0	0.00%	37	39.36%
50-74%	0	0.00%	0	0.00%	5-6	0	0.00%	2	2.13%
75-99%	0	0.00%	5	5.32%	7+	0	0.00%	4	4.26%
Complete	0	0.00%	3	3.19%					
Number of elongated scars:					Number of ridges/arrises:				
Absent	0	0.00%	3	3.19%	Absent	0	0.00%	3	3.19%
1-2	0	0.00%	59	62.77%	1	0	0.00%	64	68.09%
3-4	0	0.00%	28	29.79%	2	0	0.00%	22	23.40%
5-6	0	0.00%	4	4.26%	3	0	0.00%	3	3.19%
7+	0	0.00%	0	0.00%	4	0	0.00%	2	2.13%
					5+	0	0.00%	0	0.00%
Dorsal ridge/arise shape:					Flake scar pattern:				
Singular	0	0.00%	51	54.26%	Unidirectional	0	0.00%	60	63.83%
Parallel	0	0.00%	14	14.89%	Centripetal	0	0.00%	1	1.06%
Irregular	0	0.00%	9	9.57%	3-way centripetal	0	0.00%	0	0.00%
Regular converging	0	0.00%	4	4.26%	Bidirectional	0	0.00%	12	12.77%
Regular diverging	0	0.00%	3	3.19%	Lateral left	0	0.00%	0	0.00%
Y-shape	0	0.00%	2	2.13%	Lateral right	0	0.00%	0	0.00%
Inverted Y-shape	0	0.00%	3	3.19%	Convergent unidirectional	0	0.00%	8	8.51%
Offset left/right	0	0.00%	2	2.13%	Convergent bidirectional	0	0.00%	3	3.19%
Partial	0	0.00%	2	2.13%	Convergent and perpendicular	0	0.00%	1	1.06%
Central converging	0	0.00%	1	1.06%	Double perpendicular	0	0.00%	1	1.06%
Absent	0	0.00%	3	3.19%	Straight and perpendicular	0	0.00%	4	4.26%
					Cortical	0	0.00%	3	3.19%
					Indeterminable	0	0.00%	1	1.06%
Distal end-type:					Butt type:				
Feathered	0	0.00%	37	39.36%	Plain/flat	0	0.00%	19	20.21%
Stepped	0	0.00%	17	18.09%	Dihedral	0	0.00%	5	5.32%
Hinged	0	0.00%	13	13.83%	Cortical	0	0.00%	2	2.13%
Overshot	0	0.00%	0	0.00%	Natural (but non-cortical)	0	0.00%	0	0.00%
Present but indeterminable	0	0.00%	1	1.06%	Marginal	0	0.00%	8	8.51%
Missing	0	0.00%	26	27.66%	Mixed	0	0.00%	19	20.21%
					Facetted	0	0.00%	8	8.51%
					Missing	0	0.00%	29	30.85%
					Trimmed	0	0.00%	3	3.19%
					Chapeau de Gendarme	0	0.00%	0	0.00%
					Damaged/unidentifiable	0	0.00%	1	1.06%

Table 8.39. Technological observations from Rocourt (la Sablière Gritten) (blade attributes)

Weight (g)	Min.	Max.	Mean	S.D.	Med.	CV
Complete Laminar blade	2.01	76.43	15.04	16.73	10.28	111.23
Complete Levallois blade	-	-	-	-	-	-
Broken Laminar blade	0.53	27.40	5.99	5.70	4.50	95.07
Broken Levallois blade	-	-	-	-	-	-
Length (mm)	Min.	Max.	Mean	S.D.	Med.	CV
Complete Laminar blade	33.55	115.25	60.37	20.16	52.79	33.39
Complete Levallois blade	-	-	-	-	-	-
Broken Laminar blade	13.76	81.30	40.24	17.08	39.57	42.44
Broken Levallois blade	-	-	-	-	-	-
Width (mm)	Min.	Max.	Mean	S.D.	Med.	CV
Complete Laminar blade	8.90	44.88	24.25	9.40	22.86	38.76
Complete Levallois blade	-	-	-	-	-	-
Broken Laminar blade	11.04	61.20	22.52	10.15	19.25	45.09
Broken Levallois blade	-	-	-	-	-	-
Elongation Index (L/W)	Min.	Max.	Mean	S.D.	Med.	CV
Complete Laminar blade	1.84	5.62	2.98	0.95	2.72	31.86
Complete Levallois blade	-	-	-	-	-	-
Broken Laminar blade	0.80	3.84	1.87	0.64	1.78	34.43
Broken Levallois blade	-	-	-	-	-	-
Thickness (mm)	Min.	Max.	Mean	S.D.	Med.	CV
Complete Laminar blade	3.04	22.02	7.98	4.18	6.71	52.39
Complete Levallois blade	-	-	-	-	-	-
Broken Laminar blade	1.98	19.29	8.21	3.72	7.92	45.31
Broken Levallois blade	-	-	-	-	-	-
Working edge/edge circum. (mm)	Min.	Max.	Mean	S.D.	Med.	CV
Complete Laminar blade	89.08	302.57	163.13	53.07	148.81	32.53
Complete Levallois blade	-	-	-	-	-	-
Broken Laminar blade	49.25	230.54	113.96	43.93	104.29	38.55
Broken Levallois blade	-	-	-	-	-	-
Cutting edge per weight (mm/g)	Min.	Max.	Mean	S.D.	Med.	CV
Complete Laminar blade	3.89	48.88	17.97	10.74	16.02	59.74
Complete Levallois blade	-	-	-	-	-	-
Broken Laminar blade	5.06	128.22	35.14	29.42	22.27	83.73
Broken Levallois blade	-	-	-	-	-	-
Flattening index (mT/mW)	Min.	Max.	Mean	S.D.	Med.	CV
Complete Laminar blade	0.18	1.20	0.52	0.23	0.48	44.20
Complete Levallois blade	-	-	-	-	-	-

Table 8.40. Metric data for broken and complete Laminar blades analysed (n=94)

One final aspect of the blank's technological characteristics to note is their condition following their removal, with just under half (44.12%) of all complete blades exemplifying non-feathered distal end-types. Complimented with the high degree of breakages present, it is evident that despite the amount of preparation invested (facetting, heat treatment, cresting, etc.) several flintknapping accidents still occurred.

Discussions on blank retouch have already noted the presence of several retouch tools typical of the Upper Palaeolithic period (Cahen, 1987; Otte et al., 1990; Haesaerts et al., 2011a) with less emphasis on the specific technological characteristics of the tools in question. In total, ten blades were recorded as featuring retouch, representing 10.64% of all blades recorded. Of these, retouch is positioned and located over various parts of the tool blank with no examples of continuous or complete retouch documented (Table 8.41). The retouch is a mix of direct, inverse and proximal (burinated) in direction, and of minimal coverage. Scraper retouch is typically scaled, with examples of parallel retouch also recorded, and is of varying form with rectilinear and concave retouched edges present. Tools, as noted by Otte et al. (1990) were identified including backed-knives, burins, scraper-types and microlithic forms. In one example, following retouch one scraper tool has broken: reasons for this break are currently unclear. For examples of blade *débitage* and retouched tools discussed see Figure 8.20.

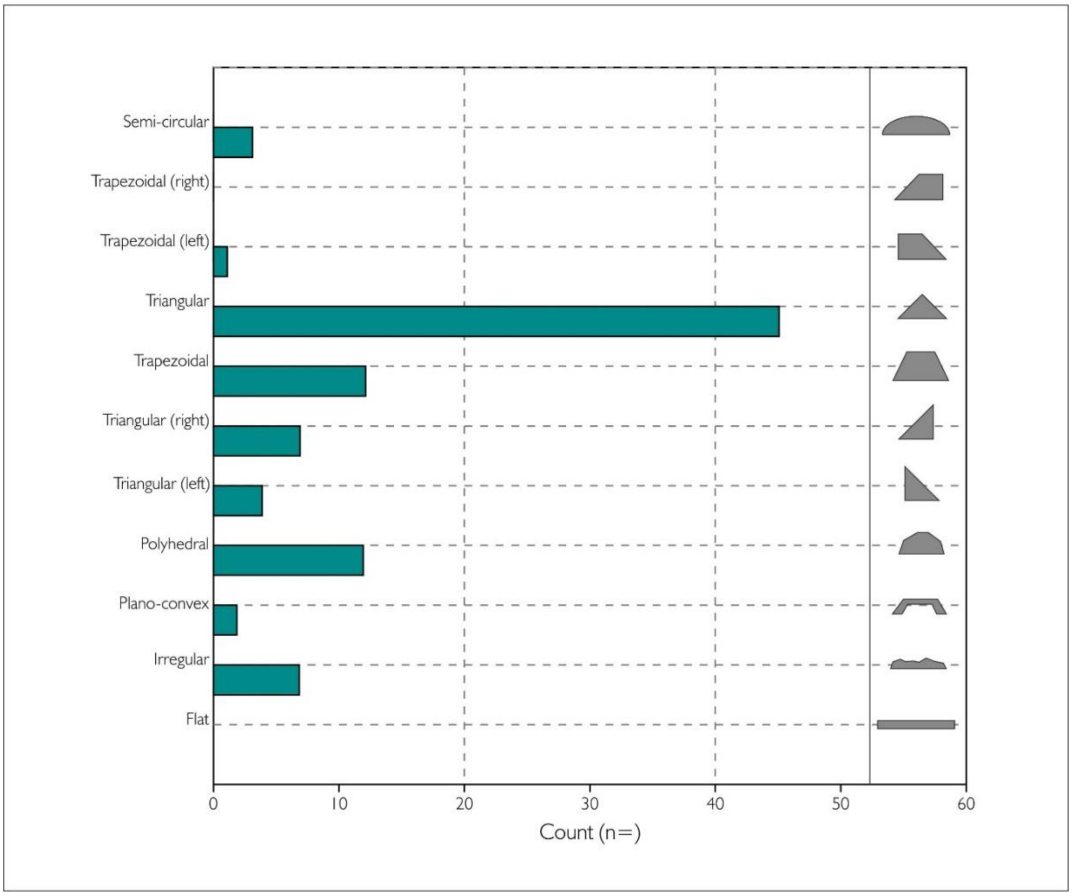


Figure 8.19. A bar-chart of the different cross-sections documented throughout Rocourt (la Sablière Gritten) (Dark Cyan: Laminar)

Rocourt (la Sablière Gritten): retouch analysis (n=94)									
Presence of retouch:	Levallois (0)		Laminar (94)		Location of retouch:	Levallois (0)		Laminar (94)	
Yes	0	0.00%	10	10.64%	Proximal left	0	0.00%	4	20.00%
No	0	0.00%	84	89.36%	Proximal right	0	0.00%	4	20.00%
					Medial left	0	0.00%	4	20.00%
					Medial right	0	0.00%	2	10.00%
					Distal left	0	0.00%	5	25.00%
					Distal right	0	0.00%	1	5.00%
					Complete/continuous	0	0.00%	0	0.00%
Position of retouch:					Retouch coverage (%):				
Direct	0	0.00%	3	30.00%	No retouch	0	0.00%	84	89.36%
Inverse	0	0.00%	3	30.00%	1-25%	0	0.00%	7	7.45%
Alternate	0	0.00%	0	0.00%	26-50%	0	0.00%	1	1.06%
Bifacial	0	0.00%	0	0.00%	51-75%	0	0.00%	2	2.13%
Crossed	0	0.00%	0	0.00%	76-99%	0	0.00%	0	0.00%
Proximal (i.e. burin)	0	0.00%	4	40.00%	Complete retouch	0	0.00%	0	0.00%
Presence of burination:					Distribution of retouch:				
Yes	0	0.00%	4	40.00%	Continuous	0	0.00%	5	50.00%
No	0	0.00%	6	60.00%	Discontinuous	0	0.00%	4	40.00%
					Partial	0	0.00%	1	10.00%
Form of retouched edge:					Morphology of retouch:				
Rectilinear	0	0.00%	4	40.00%	Scaled	0	0.00%	4	40.00%
Concave	0	0.00%	2	20.00%	Stepped	0	0.00%	0	0.00%
Convex	0	0.00%	0	0.00%	Sub-parallel	0	0.00%	0	0.00%
Single removal (notch/burin)	0	0.00%	4	40.00%	Parallel	0	0.00%	2	20.00%
Denticulate	0	0.00%	0	0.00%	Notch/Denticulate	0	0.00%	0	0.00%
Multiple	0	0.00%	0	0.00%	Burin	0	0.00%	4	20.00%

Table 8.41. Technological observations from Rocourt (la Sablière Gritten) (retouch attributes)

8.4.3.6. Refit Analysis

Of the eighteen refits reconstructed, seven sequences over six refits pertain to behaviours associated with Laminar blade production. These are summarised in detail below with examples displayed in Figure 8.21.

Remontage C: Remontage C is a refit of four artefacts comprising of two cortical core fragments, and two blade fragments. Cortex is retained on all artefacts recorded, and exemplifies the exploitation of raw material with a globular morphology Facetting is documented on one blade fragment.

Remontage E: Remontage E is an elongated cortical nodule comprised of seven artefacts: one crested blade, one flake (featuring a medial break), and a series of four blades around a core (exhausted?). Cresting is observed on artefact #ID RO-F E11 through a series of parallel flake removals to accentuate a natural ridge prior to blade exploitation. Blades are then carefully prepared through facetting before being exploited through a *semi-tournant* unidirectional strategy. The presence of cortex exemplifies the dimensions of the original cortical nodule, and highlight a nodule with a high elongation index. A series of blades are incomplete from the series and are absent from the refit assemblage and excavation. No artefacts observed within Remontage E feature retouch.

Figure 8.20. Examples of blades (unretouched and retouched) and cores from Rocourt (la Sablière Gritten). Arrows indicate retouch

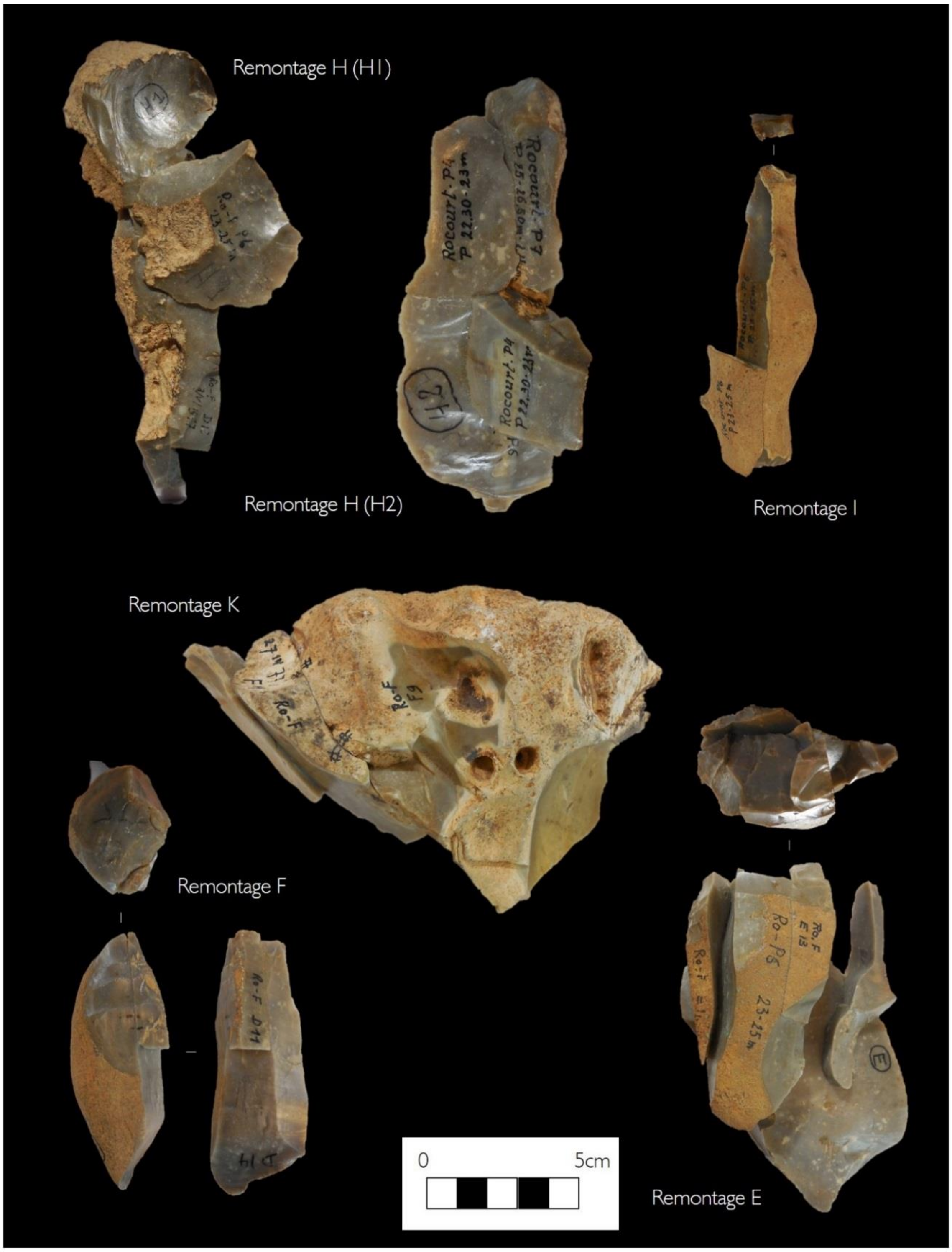


Figure 8.21. Examples of refits present within the Rocourt (la Sablière Gritten) assemblage (for descriptions see text)

Remontage F: Remontage F is a series of three artefacts comprising of a crested blade fragment, a blade, and a core. A series of four flakes are removed from one cortical face of the ridge before exploitation to create a crested blade. During exploitation, the crested blade breaks, with only the proximal section retained. A series of removals are then undertaken, some overshot, with one blade in the sequence retained. The series follows a *semi-tournant* exploitation strategy. Evidence for facetting and platform preparation is also observed.

Remontage H: Remontage H comprises of two sets refits (H1 and H2) totalling nine artefacts. H1 is represented by five artefacts (a series of three flakes, one blade and one fragment) and H2 is comprised of four artefacts (two blades and two blade fragments). The series exemplifies a series of cortical flake removals in a lateral direction before a series of blade removals. Blades are removed through a unidirectional system. The series is incomplete, and only represents the exploitation of blades from a narrow edge of a large nodule (frontal strategy). Facetting is also observed on many examples of blades recorded.

Remontage I: Remontage I consists of two artefacts of a much larger block piece of raw material, both retaining a high percentage of cortex coverage. Dorsal scars exemplify the removal of further cortical blades, with facetting also observed.

Remontage K: Remontage K comprises of a series of three artefacts (two blades and a core) exemplifying the use of a unipolar frontal technique. The core is narrow and cortical in morphology and represents a large flake from a much larger block. The blades are produced on the narrow edge on the raw material with the series incomplete in nature. Negative scars demonstrate overshot blades, despite their absence within the refit.

Remontage L: Remontage L is a series of eleven artefacts, demonstrating an elongated cortical nodule featuring varying stages of a bidirectional frontal and *semi-tournant* Laminar core reduction strategy. The strategy exemplifies the adoption of a frontal reduction strategy to initiate the sequence, with the narrow edge exploited through a bidirectional strategy before the broadest edge was exploited and maintained around the nodule. Throughout, preparation is noted through the presence facetting, and removals are feathered. Many blades are absent from the different phases of blade production.

8.4.4. Hominin Behaviour at Rocourt (la Sablière Gritten)

The extensive refitted material at Rocourt highlights clear Neanderthal technological proficiency in the production of blades through all stages of preparation, reduction, maintenance and modification. The evidence highlights a variety of decision-making behaviours, from the exploitation of local high-quality raw material, the anthropogenic modification of blade cores through preparation and treatment, cresting and core flaking, and an extended sequence of blade production through the fusion of various Laminar core volume management strategies. The use of various tool-types highlight parallel behaviours to Upper Palaeolithic populations humans, and similarities in their technological response to raw material. Furthermore, the clear presence of refits exemplifies not just the immediate production on blades on-site, but also through the incomplete sequences, the possible off-site transport of many blades and possibly cores. The different strategies employed echo contemporary evidence at Séclin and St-Germain-des-Vaux in Northern France, and in their sophistication mirror, to a large degree, contexts studied within this thesis. These commonalities, in addition to a number of notable differences (morphologies and artefact transformation) are discussed in more detail in Chapter 10.

Chapter Nine
Technological Blade Strategies in the UK: Selected Contexts

9.1. Introduction

This chapter concludes the regional analyses, outlining the archaeological data for technological blade strategies at two sites in the UK. It will first investigate the various collections from the site of Baker's Hole at Northfleet, Kent, and its evidence for Levalloisian blade technology. The chapter will then discuss the Levalloisian evidence in the various pits and exposures within the Crayford/Erith area, also in Kent. In both instances, emphasis here is placed on the wider use of the landscapes through the various collections at both contexts over the last century. While these collections are heavily biased in their origins, they still provide an insight into Neanderthal technological behaviour throughout the Early Middle Palaeolithic, and their behavioural capabilities.

9.2. Baker's Hole (various collections)

9.2.1. Introduction and Overview of Investigations

The material referring to Baker's Hole pertains to a collection of material from a region in a chalk debris deposit ('coombe rock') in the north-west region of Southfleet Pit (Smith, 1911), situated on a tributary of the Thames in south-east England. (Figure 9.1). As Scott (2011) notes, the locality has since been classified as Baker's Hole although the pit name refers to an archaeologically sterile quarry north of the region.

Baker's Hole and the surrounding region features a rich history of archaeological investigations, with the first artefacts recorded within the Northfleet area towards the end of the nineteenth century, with the discovery of Levallois *débitage* recovered in association with faunal remains near Northfleet Church (Spurrell, 1883, 1884). Collections from the coombe rock were first described with Abbott and Smith's descriptions of archaeological material recovered (Abbott, 1911; Smith, 1911). However, in both instances, neither Abbott or Smith excavated at the site, with Abbott describing material from a local collector from the pit's opening from 1907 onwards, and Smith publishing a description of artefacts held in a collection by the Associated Portland Cement Company, APCC henceforth (Scott, 2011). As Scott (2011) notes, the very nature of these initial investigations resulted in the size of the assemblage to be unknown with the quantity of the number of artefacts estimated to be in the hundreds of thousands despite only approximately seven hundred and fifty artefacts being donated from the APCC in the British Museum in addition to a number of smaller collections distributed to other regional museums (Scott, 2011). Given the issue of selectivity, fragmentation, and problems including the specific position of the material recovered from the coombe rock (Scott, 2011), the integrity of the collection, separate other material from systematic investigations, as described below, has been called into question (Scott, 2010, 2011). Despite this, given the local geology, their designation as originating from Early Middle Palaeolithic is credible.

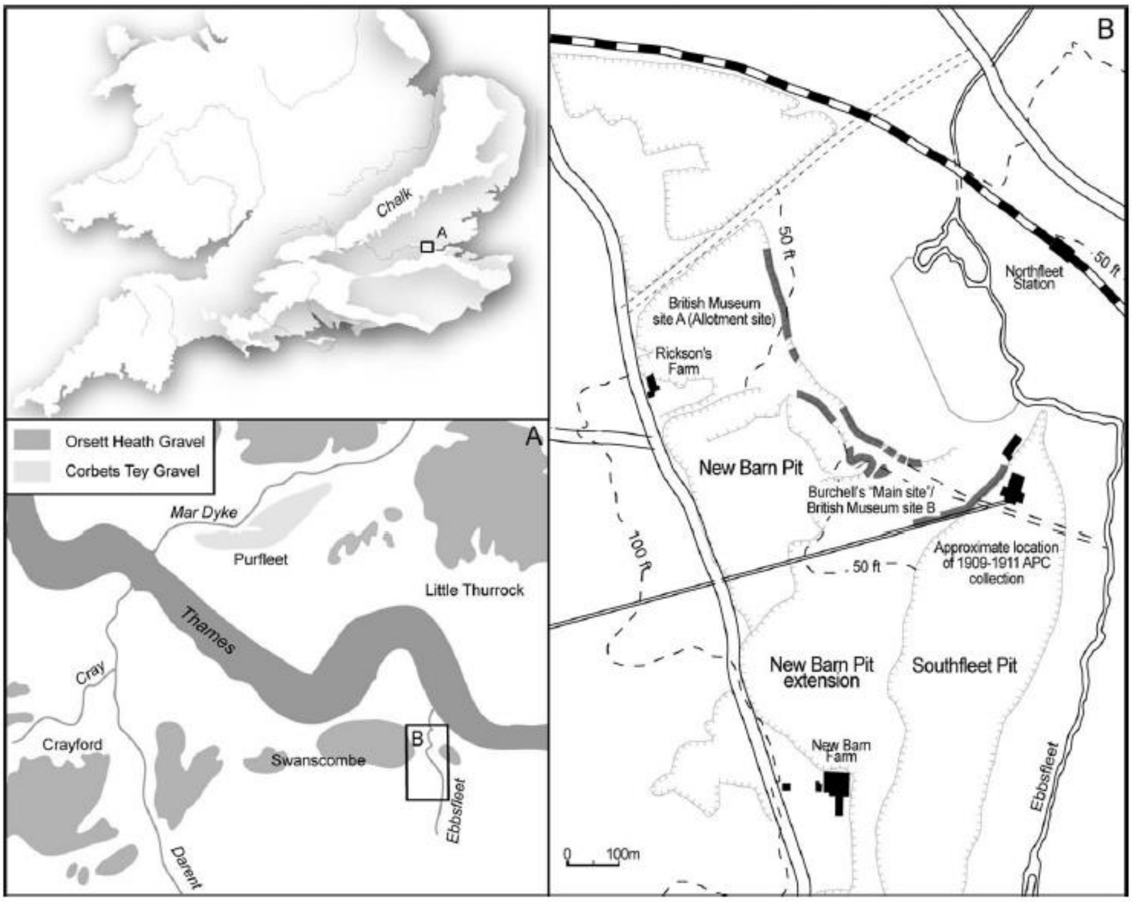


Figure 9.1. Location of the various collections and excavations within the Baker's Hole landscape, and its position in relation to other Palaeolithic contexts (Scott, 2010)

Following these descriptions at the beginning of the twentieth century, the archaeology-bearing deposits in the Ebbsfleet Valley were systematically investigated through controlled excavations by Burchell from 1933 onwards, who wished to understand the stratigraphic relationship between the Ebbsfleet channel fills and the coombe rock (Burchell, 1933, 1935, 1936a, 1936b, 1936c, 1938, 1954, 1957). Burchell's sections are suggested to have been located several hundred metres west of the main deposit described above (Wenban-Smith, 1995), and in his descriptions, Burchell highlights the persistence of Levallois within the Ebbsfleet Valley sequence. Coulson (1990: 241), however, later refines Burchell's location of the material to the lower fluvial units.

A series of smaller excavations including the investigations by the British Museum (1965-1969) into the 'Temperate Bed' and allotment sites (Kerney and Sieveking, 1977), in addition to the more recent investigations by Wenban-Smith (1995, ongoing), have since extended our understanding of the Baker's Hole landscape by confirming the sequences first hypothesised by Burchell, in addition to producing further archaeological and faunal material. Throughout all excavations described above, two different contemporary contexts exist: 1) the chalk rubble material from the earliest initial investigations, and 2) the lower fluvial material of Burchell and the British Museum investigations. Both were deposited in a cool and open environment with a date towards the end of MOIS 8 and early MOIS 7 hypothesised (Bridgland, 1994). For a more explorative account of the landscape's history see Scott (2010, 2011).

With respect to the lithic material, under de Mortillet's classificatory framework (see Chapter 4), Smith (1911) classified the Baker's Hole assemblage as pertaining to the Mousterian period given its evidence for Levallois technology and flake producing technologies. Half a century later, Wymer (1968) produced the first in-depth lithic analysis of Smith's material, in addition to the various local museum collections noted above. In this he noted the blade-like flakes pertaining from simple prismatic cores and more evolved opposing-platform cores (Wymer, 1968), while Roe (1981) and Robinson (1986) emphasise the more classic elements of the Levallois technique.

Over the last twenty-five years, Wenban-Smith (1992) has highlighted the existence for Levalloisian blade technology in addition to some elements which can be classified as originating from a Laminar technological blade strategy. More recently, the collections have been reassessed for their integrity, in terms of their composition and their technological attributes through the work of Scott (2006, 2010, 2011). In these, aspects of the Laminar component, discussed in Roe (1981) and Wenban-Smith (1992) have been queried given the mixed taphonomic characteristics and relatively freshness of the assemblage. This is discussed in more detail through the technological analysis.

9.2.2. Geological and Chronostratigraphic Background

Through the work of Burchell from 1933 onwards (Burchell, 1933, 1935, 1936a, 1936b, 1936c, 1938, 1954, 1957), workers observations (Boswell, 1940; Zeuner, 1945, 1946, 1954; Kerney and Sieveking, 1977), and subsequent reconsiderations and revisions (Bridgland, 1994), the Ebbsfleet valley sequence can be summarised in great detail. In total, twelve units are identified. Modified from Scott (2011) and Bridgland (1994), the twelve units are described in Table 9.1 and exemplified in Figure 9.2.

Unit number (Burchell's classification)	Description
Unit 12	Trail; gravelly loam with rafts of coombe rock (cryoturbated?).
Unit 11 ('Uppermost Loam')	Sandy 'fluvial brickearth'.
Unit 10	Gravel.
Unit 9	Trail; gravelley loam with rafts of coombe rock (cryoturbated?).
Unit 8	Silt; aeolian/colluvial brickearth; ferruginous staining (upper Unit 8). Produced *Pupilla muscorum*.
Unit 7	Upper coombe rock; produced derived artefacts.
Unit 6 ('Temperate Bed')	Fossiliferous temperate silt.
Unit 5a	Soil developed on top of bed 5.
Unit 5 ('Lower Loam')	Silt; numerous minor lobes of coombe rock and/or gravel (colluvial?). Produced *Pupilla muscorum, Vallonia costata* and *Limax sp*.
Unit 4	Gravel; artefact and faunal layer; Palaeogene shells and flint pebbles noted within this unit (Canreck 1972, in Bridgland, 1994).
Unit 3 ('Lowermost Loam')	Fossiliferous sand. Produced *Bithynia tentaculata*.
Unit 2	Coarse gravel, cryoturbated.
Unit 1	Main coombe rock (equivalent to that at Baker's Hole).
Unit 0	Frost shattered chalk

Table 9.1. The twelve units within the Ebbsfleet Valley sequence
(modified from Bridgland 1994 and Scott 2011)

The archaeological deposits represent a basal infilling of the Ebbsfleet channel, to a channel of 7.5 O.D. (Burchell, 1933). Bridgland (1994: 272) suggests, through its altitude, and altitude with other contexts (see below), that the deposits correlate with the Taplow/Mucking formation dating to the Early Middle Palaeolithic (MOIS 8/7). The suggested chronostratigraphic date is supported through amino acid data of *Lymnea peregra* in the allotment vicinity (Bowen and Sykes, in Wenban-Smith, 1995), and mineralogical analyses (Catt and Weir, in Bridgland, 1994), both proposing a date of MOIS 7. More recently, zooarchaeological analyses of the mammalian assemblage throughout the deposits, re-evaluated by Schreve (1997, 2001, 2004), have also suggests a date of MOIS 7 (early MOIS 7). The nature and deposition of the coombe rock, following the downcutting of the channel, and the presence of *Coelodonta antiquitatis,* also indicates an open cold environment, indicative of late MOIS 8 and early MOIS 8 (Bridgland, 1994; Schreve, 1997).

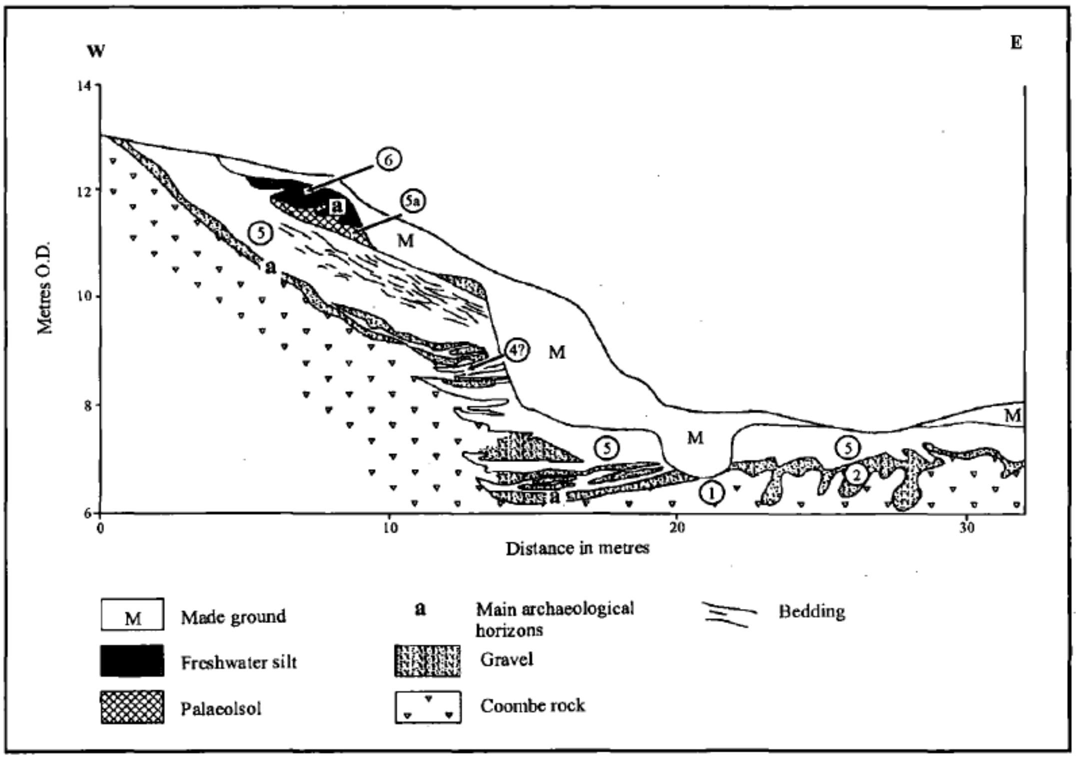


Figure 9.2. Deposits exposed from the British Museum excavations
(unit numbers described in detail in Table 9.1; modified from Bridgland 1994)

9.2.3. Artefact Analysis

9.2.3.1. Treatment and Selection of the Collection

As described above, the material described by Smith which was later donated to the British Museum and local museums represents collections and donations by the Associated Portland Cement Company and not material from controlled excavations. A high degree of selectivity, with artefact-types preferred, is therefore assumed. Despite this, as the material is believed to originate from within the coombe rock (Abbott, 1911; Smith, 1911). Scott (2010, 2011), however, notes that material within the assemblage is also technologically comparable with the Early Neolithic with artefacts including endscrapers, and important to this thesis, blade cores from a Laminar technological blade strategy present. Given that the material was collected by the quarry company, material from the overlying gravels and silts, may have become merged with the material from the exposed sequence, as Scott (2010, 2011) notes. This is supported through her taphonomic analysis of the material suggested to be Neolithic in date (Scott, 2010: 80). Evidence for Laminar technological blade cores should therefore be excluded from the analysis undertaken below. Material pertaining from a Levallois technological strategy, known to originate from a cold deposit, can be assumed to originate from an Early Middle Palaeolithic, however the "interpretive limits of the material" (Scott, 2010: 82) should be noted.

In analysing technological blade strategies throughout the Early Middle Palaeolithic, emphasis here is therefore placed on the wider Baker's Hole landscape, and as such a number of collections were analysed. The sample analysed therefore comprises of material housed at the British Museum (Frank's House) and includes material recovered by Smith, and later excavations and smaller collections including the Institute of Archaeology, and the Wellcome collections. Undertaking a number of collections allow not just a greater appreciation of the wider landscape, despite the interpretive limits, but provides a credible dataset for testing and analysing aspects of artefact morphology and behavioural potential.

9.2.3.2. Technological Overview

The sample comprises of forty artefacts all originating from a Levallois technological blade strategy. The blades produced are large and carefully prepared before being heavily retouched through notch and scaled retouching strategies. While the assemblage features a higher percentage of retouch in comparison to other Early Middle Palaeolithic Levallois blade contexts, it is important to stress the selectivity with which the collections were amassed. In this, retouched Levallois blades may be over-represented within the material produced within the Baker's Hole landscape. Similarly, the actual amount of blade technology produced is just a small percentage of the overall amount of material present within the collections at Frank's House and the wider collections. Irrespective of these factors, the archaeological evidence does highlight the functionality and desirability of Levallois blades, in their retouch potential, and highlights technological behaviours of preparation and reduction associated with blade production within the landscape of south-east England.

Confidence	Laminar core	Levallois core	Laminar product	Levallois product
A (definite)	0 (0.00%)	4 (80.00%)	0 (0.00%)	25 (71.42%)
B (probable)	0 (0.00%)	1 (20.00%)	0 (0.00%)	9 (25.71%)
C (possible)	0 (0.00%)	0 (0.00%)	0 (0.00%)	1 (2.86%)

Table 9.2. Confidence categories for the artefacts studied

Artefact	n	Percentage
Laminar blade (unretouched)	0	0.00%
Laminar blade (retouched)	0	0.00%
Laminar blade fragment (unretouched)	0	0.00%
Laminar blade fragment (retouched)	0	0.00%
Laminar crested blade (unretouched)	0	0.00%
Laminar crested blade (retouched)	0	0.00%
Laminar crested blade fragment (unretouched)	0	0.00%
Laminar crested blade fragment (retouched)	0	0.00%
Laminar blade core	0	0.00%
Levallois blade (unretouched)	5	12.50%
Levallois blade (retouched)	27	67.50%
Levallois blade fragment (unretouched)	1	2.50%
Levallois blade fragment (retouched)	2	5.00%
Levallois *éclat débordant* (unretouched)	0	0.00%
Levallois *éclat débordant* (retouched)	0	0.00%
Levallois *éclat débordant* fragment (unretouched)	0	0.00%
Levallois *éclat débordant* fragment (retouched)	0	0.00%
Levallois recurrent blade core	5	12.50%
Total:	40	100.00%

Table 9.3. Technological overview of the artefacts studied

All material was identified with a high degree of confidence (Table 9.2) as pertaining to Levallois blade production. For a breakdown of the artefacts analysed see Table 9.3.

9.2.3.3. Taphonomic History

As Scott (2010, 2011) notes, given the processes which have concluded in the accumulation of material at the British Museum, and the nature of the context, the material will feature varying levels of edge damage, chemical alteration and staining. Analyses of the collection's taphonomic history further support this view, with the forty artefacts featuring varying levels of edge damage and chemical alteration and patination (Table 9.4). Taphonomic analyses of each individual collection also highlight the varying taphonomic histories (see Appendix for more information).

Baker's Hole (various): artefact condition (n=40)									
	Levallois (40)		Laminar (0)			Levallois (40)		Laminar (0)	
Whole/broken:					Degree of patination:				
Whole	37	92.50%	0	0.00%	Unpatinated	17	42.50%	0	0.00%
Broken	3	7.50%	0	0.00%	Lightly patinated	19	47.50%	0	0.00%
					Moderately patinated	4	10.00%	0	0.00%
					Heavily patinated	0	0.00%	0	0.00%
Degree of edge damage:					Degree of burning:				
No edge damage	15	37.50%	0	0.00%	Unburned	40	100.00%	0	0.00%
Lightly damaged	23	57.50%	0	0.00%	Lightly burned	0	0.00%	0	0.00%
Moderately damaged	2	5.00%	0	0.00%	Moderately burned	0	0.00%	0	0.00%
Heavily damaged	0	0.00%	0	0.00%	Heavily burned	0	0.00%	0	0.00%
Degree of rolling:					Portion/break:				
Unrolled	37	92.50%	0	0.00%	Complete	37	92.50%	0	0.00%
Lightly rolled	3	7.50%	0	0.00%	Proximal fragment	0	0.00%	0	0.00%
Moderately rolled	0	0.00%	0	0.00%	Medial fragment	0	0.00%	0	0.00%
Heavily rolled	0	0.00%	0	0.00%	Distal fragment	3	7.50%	0	0.00%
					Siret	0	0.00%	0	0.00%
Observations: Minor abrasion and scratching documented; little surface damage.									

Table 9.4. Detailed taphonomic characteristics of material analysed at Baker's Hole

In their totality, over half of examples feature some degree of edge damage (n = 25, 62.50%), with a small amount (n=2, 0.05%) featuring moderate edge damage. Despite this, there is little evidence for surface damage, ridge and flake scar abrasion. Whereas the mechanical damage and its variation may be resulting from the incorporation and discard into the aggrading deposit, the lack of surface damage and abrasion observed highlights that, despite these factors, the material analysed has undergone minimal reworking. Scott (2011) notes through the refits present in smaller museum collections (Wenban-Smith, 1995), that while the assemblage may not be *in-situ* the material is still in a primary context, highlighting the exploitation of the local active slope. Varying levels of patination and chemical alteration are also recorded, with just under half (n = 19, 47.50%) featuring light patination, in addition to a number of examples (n=4, 10.00%) featuring moderate patination.

Most blades are complete in nature with only three broken examples documented, all distal fragments in nature. These appear to result from the knapping sequence and are not thought to be caused through taphonomic means.

No traces of burning were recorded on the assemblage.

9.2.3.4. Raw Material

It is assumed, given its location and association, that the assemblage is produced on flint available from the ongoing erosion of the chalk slope (Scott, 2011). No examples of bullhead flint from the Thanet beds were observed, despite their presence within the overall assemblage known (Scott, 2011). The Levallois cores analysed vary as much as eight hundred grams in weight, are vary in their dimensions (see below). Despite this, all examples are large and support statements by (Scott, 2011) that large nodules of flint were exploited.

Of the five cores examined, only one example retains evidence for cortex. In this example (P1989 1-4 656), a small amount (less than 25%) of worn and stained cortex is retained on the core's preparation surface. Minor mechanical damage is also evident on the retained cortex, with light battering present. Of the blades, two examples were also recorded as retaining any cortex. In both examples the cortex retained is of a low percentage (1-24%), shows no evidence for mechanical damage, is slightly worn, and is unstained.

9.2.3.5. Technology: Extended Analysis

The evidence for technological blade strategies within the Baker's Hole locality stem from a Levalloisian strategy concentrated on the production of large stereotyped elongated blades. Within the collection, a high percentage of these (higher than other sites studied herein) are retouched, however this percentage needs to be interpreted alongside the precaution that the assemblage is heavily curated and represents select finds from quarry workers as detailed above.

In the preparation of cores, a centripetal core preparation strategy with large invasive radial scars is exemplified on the majority of Levallois recurrent elongated cores analysed. This centripetal strategy is widely documented throughout the rest of the Baker's Hole assemblage on other material Levalloisian in nature (see Scott 2011). Other preparation strategies, in addition to a centripetal strategy are undertaken, with evidence for both unidirectional and unidirectional right preparation strategies exemplified (Table 9.5). Further preparation is documented in the presence for facetting, core edge trimming, and complex Levallois platforms, on all five cores documented. This is supported further through analyses of blade platform types (see below).

Baker's Hole (various): technological core observations (n=5)							
Core strategy:			Number of scars/core:				
Laminar	0	0.00%	Laminar: Min: N/A, Max: N/A, Mean: N/A (CV: 0.00)				
Levallois	5	100.00%	Levallois: Min: 11, Max: 14, Mean: 12.2 (CV: 10.69)				
			Number of elongated (L/W = 1.75>) scars/core:				
			Laminar: Min: N/A, Max: N/A, Mean: N/A (CV: 0.00)				
			Levallois: Min: 2, Max: 5, Mean: 3.0 (CV: 47.14)				
Levallois strategy:			Laminar core shape:				
Recurrent unidirectional	3	60.00%	Orthogonal/prismatic			0	0.00%
Recurrent bidirectional	2	40.00%	Semi-orthogonal/semi-prismatic			0	0.00%
			Pyramidal			0	0.00%
Laminar strategy:			Laminar platform preparation strategy:				
Semi-tournant/semi-rotating	0	0.00%	Single Lineal			0	0.00%
Tournant/rotating	0	0.00%	Multiple Lineal			0	0.00%
Facial	0	0.00%	Bidirectional			0	0.00%
Frontal	0	0.00%	3-way centripetal			0	0.00%
Multiple (combination)	0	0.00%	Centripetal			0	0.00%
			Lateral (left/right)			0	0.00%
			Perpendicular (left/right)			0	0.00%
Laminar core volume utilised:			Distal end-types:	Levallois (5)		Laminar (0)	
1-25%	0	0.00%	Feathered	5	62.50%	0	0.00%
26-50%	0	0.00%	Stepped	1	12.50%	0	0.00%
51-75%	0	0.00%	Hinged	2	25.00%	0	0.00%
76-100%	0	0.00%	Reverse Hinged	0	0.00%	0	0.00%
			Overshot	0	0.00%	0	0.00%
Levallois core preparation strategy:			Number of platforms:				
Unidirectional	1	20.00%	1	3	60.00%	0	0.00%
Bidirectional	0	0.00%	2	2	40.00%	0	0.00%
Convergent unidirectional	0	0.00%	Cortex percentage:				
Centripetal	3	60.00%	Absent	4	80.00%	0	0.00%
Unidirectional left	0	0.00%	1-25%	1	20.00%	0	0.00%
Unidirectional right	1	20.00%	26-50%	0	0.00%	0	0.00%
Bidirectional lateral	0	0.00%	51-75%	0	0.00%	0	0.00%
Unidirectional distal	0	0.00%	76-100%	0	0.00%	0	0.00%

Table 9.5. Technological observations from Baker's Hole (core attributes)

With respect to their shape, Levallois cores are typically circular in planar view, and are relatively flat in all examples as demonstrated by the low flattening index and its associated low coefficient of variation values including length, width, and thickness (Table 9.6), pertaining to the classic tortoise shape.

In their exploitation, both the creation of opposed and single Levallois recurrent blade platforms are documented, in addition to negative scarring that is both bidirectional and unidirectional in nature; this is further exemplified through the dorsal scar patterns of both flake and blade *débitage* (see below). All cores highlight the varying sizes of blades produced, all with a high elongation index, and exemplify successful blade removals, with feathered end-type negative scars documented throughout. Examples of stepped and hinged examples are also present, albeit in small quantities. Cortex is only retained on one core, with less than 25% coverage on the core's preparation surface.

Weight (g)	Min.	Max.	Mean	S.D.	Med.	CV
Levallois	115.40	947.25	579.97	354.46	709.40	25.03
Laminar	-	-	-	-	-	-
Length (mm)	Min.	Max.	Mean	S.D.	Med.	CV
Levallois	119.86	142.60	128.99	10.55	122.56	8.18
Laminar	-	-	-	-	-	-
Width (mm)	Min.	Max.	Mean	S.D.	Med.	CV
Levallois	47.96	126.57	97.39	32.45	110.93	33.32
Laminar	-	-	-	-	-	-
Elongation index (L/W)	Min.	Max.	Mean	S.D.	Med.	CV
Levallois	1.10	2.56	1.48	0.62	1.15	41.85
Laminar	-	-	-	-	-	-
Thickness (mm)	Min.	Max.	Mean	S.D.	Med.	CV
Levallois	30.22	54.90	42.97	10.85	38.82	25.26
Laminar	-	-	-	-	-	-
Core flattening index (Thickness/Width)	Min.	Max.	Mean	S.D.	Med.	CV
Levallois	0.31	0.63	0.47	0.11	0.47	24.53
Laminar	-	-	-	-	-	-

Table 9.6. Metric data for complete cores analysed (n = 5)

All whole blades were produced through a hard hammer percussion strategy, with pronounced and well-defined bulbar scars (Table 9.7). In only three examples, a percussion strategy was indeterminable as these are broken (distal fragments). Like Levallois cores recorded, the blades produced retain little if any cortex. In only two instances was cortex retained with, coverage less than 25%. In their dorsal profile, the blades feature between three-to-four scars (accounting for 57.14% of the assemblage) typically elongated in form, and commonly feature one arrise, with twenty-one blades documenting an individual arrise down the technological axis of the blade. In their directionality, similarly to the evidence for Levallois cores, both unidirectional and bidirectional flaking can be observed, with just over half of all artefacts (n = 9, 54.29%) documenting a unidirectional scar pattern.

Interestingly, elongated dorsal scar patterns associated with the presence of blade-based behaviours can be observed on Levallois preferential flakes too. This includes artefact ID# 1915-1-112, a plunged preferential flake with radial trimming, opposed faceted platforms, and a large number of directional elongated scars (n=7). It is possible that this instance may represent core rejuvenation, following a series of blade removals.

Baker's Hole (various): technological analysis (n=35)									
Percussion strategy:	Levallois (35)		Laminar (0)		Bulbar scar features:	Levallois (35)		Laminar (0)	
Hard	32	91.43%	0	0.00%	Well defined	27	77.14%	0	0.00%
Soft	0	0.00%	0	0.00%	Diffused	5	14.29%	0	0.00%
Mixed/Indeterminable	3	8.57%	0	0.00%	Absent/missing	3	8.57%	0	0.00%
Absent	0	0.00%	0	0.00%	Removed	0	0.00%	0	0.00%
Cortex percentage:					Number of dorsal scars:				
Absent	33	94.29%	0	0.00%	Absent	0	0.00%	0	0.00%
1-24%	2	5.71%	0	0.00%	1-2	5	14.29%	0	0.00%
25-49%	0	0.00%	0	0.00%	3-4	20	57.14%	0	0.00%
50-74%	0	0.00%	0	0.00%	5-6	8	22.86%	0	0.00%
75-99%	0	0.00%	0	0.00%	7+	2	5.71%	0	0.00%
Complete	0	0.00%	0	0.00%					
Number of elongated scars:					Number of ridges/arrises:				
Absent	0	0.00%	0	0.00%	Absent	0	0.00%	0	0.00%
1-2	12	34.29%	0	0.00%	1	21	60.00%	0	0.00%
3-4	23	65.71%	0	0.00%	2	14	40.00%	0	0.00%
5-6	0	0.00%	0	0.00%	3	0	0.00%	0	0.00%
7+	0	0.00%	0	0.00%	4	0	0.00%	0	0.00%
					5+	0	0.00%	0	0.00%
Dorsal ridge/arise shape:					Flake scar pattern:				
Singular	12	34.29%	0	0.00%	Unidirectional	19	54.29%	0	0.00%
Parallel	4	11.43%	0	0.00%	Centripetal	0	0.00%	0	0.00%
Irregular	1	2.86%	0	0.00%	3-way centripetal	0	0.00%	0	0.00%
Regular converging	6	17.14%	0	0.00%	Bidirectional	8	22.86%	0	0.00%
Regular diverging	1	2.86%	0	0.00%	Lateral left	0	0.00%	0	0.00%
Y-shape	7	20.00%	0	0.00%	Lateral right	0	0.00%	0	0.00%
Inverted Y-shape	1	2.86%	0	0.00%	Convergent unidirectional	5	14.29%	0	0.00%
Offset left/right	3	8.57%	0	0.00%	Convergent bidirectional	2	5.71%	0	0.00%
Partial	0	0.00%	0	0.00%	Convergent and perpendicular	1	2.86%	0	0.00%
Central converging	0	0.00%	0	0.00%	Double perpendicular	0	0.00%	0	0.00%
Absent	0	0.00%	0	0.00%	Straight and perpendicular	0	0.00%	0	0.00%
					Cortical	0	0.00%	0	0.00%
					Indeterminable	0	0.00%	0	0.00%
Distal end-type:					Butt type:				
Feathered	31	88.57%	0	0.00%	Plain/flat	1	2.86%	0	0.00%
Stepped	2	5.71%	0	0.00%	Dihedral	2	5.71%	0	0.00%
Hinged	2	5.71%	0	0.00%	Cortical	0	0.00%	0	0.00%
Overshot	0	0.00%	0	0.00%	Natural (but non-cortical)	0	0.00%	0	0.00%
Present but indeterminable	0	0.00%	0	0.00%	Marginal	0	0.00%	0	0.00%
Missing	0	0.00%	0	0.00%	Mixed	3	8.57%	0	0.00%
					Facetted	23	65.71%	0	0.00%
					Missing (proximal missing)	3	8.57%	0	0.00%
					Trimmed	2	5.71%	0	0.00%
					Chapeau de Gendarme	0	0.00%	0	0.00%
					Damaged/unidentifiable	1	2.86%	0	0.00%

Table 9.7. Technological observations from Baker's Hole (blade attributes)

As noted above through the analysis of cores, evidence for the careful preparation of blades can be documented, with twenty-three examples (accounting for 65.71% of the assemblage) documenting facetted butt types. This may partially explain the success of blade removals with thirty-one blades (88.57% of all blades) documenting a feathered end-type.

In their morphology, Levallois blades are typically straight in profile (see Chapter 10) and triangular in cross-section, with few examples featuring a plano-convex shape (Figure 9.3). The blades produced, while featuring a relatively standardised elongation index, feature a mean elongation index slightly higher than the conventional 2:1 ratio (2.34). A flattening index comparable to other Levallois blades analysed through the experimental and archaeological framework is also documented (0.37).

Weight (g)	Min.	Max.	Mean	S.D.	Med.	CV
Complete Laminar blade	-	-	-	-	-	-
Complete Levallois blade	11.10	235.40	80.72	55.47	76.45	68.71
Broken Laminar blade	-	-	-	-	-	-
Broken Levallois blade	13.40	25.40	18.67	6.13	17.20	32.86
Length (mm)	Min.	Max.	Mean	S.D.	Med.	CV
Complete Laminar blade	-	-	-	-	-	-
Complete Levallois blade	57.49	173.63	112.52	29.51	124.08	26.23
Broken Laminar blade	-	-	-	-	-	-
Broken Levallois blade	59.32	86.15	70.77	13.84	66.85	19.55
Width (mm)	Min.	Max.	Mean	S.D.	Med.	CV
Complete Laminar blade	-	-	-	-	-	-
Complete Levallois blade	26.82	72.45	49.21	14.15	52.75	28.76
Broken Laminar blade	-	-	-	-	-	-
Broken Levallois blade	31.49	36.41	34.37	2.55	35.11	7.43
Elongation Index (L/W)	Min.	Max.	Mean	S.D.	Med.	CV
Complete Laminar blade	-	-	-	-	-	-
Complete Levallois blade	1.81	3.76	2.34	0.43	2.22	18.28
Broken Laminar blade	-	-	-	-	-	-
Broken Levallois blade	1.84	2.45	2.06	0.34	1.88	16.70
Thickness (mm)	Min.	Max.	Mean	S.D.	Med.	CV
Complete Laminar blade	-	-	-	-	-	-
Complete Levallois blade	3.99	17.36	9.98	3.39	10.29	33.97
Broken Laminar blade	-	-	-	-	-	-
Broken Levallois blade	6.14	9.89	7.71	1.94	7.12	25.20
Working edge/edge circum. (mm)	Min.	Max.	Mean	S.D.	Med.	CV
Complete Laminar blade	-	-	-	-	-	-
Complete Levallois blade	155.55	459.17	298.15	79.72	325.93	26.74
Broken Laminar blade	-	-	-	-	-	-
Broken Levallois blade	168.20	226.89	196.55	29.39	194.58	14.95
Cutting edge per weight (mm/g)	Min.	Max.	Mean	S.D.	Med.	CV
Complete Laminar blade	-	-	-	-	-	-
Complete Levallois blade	1.95	16.42	5.86	3.98	4.02	67.87
Broken Laminar blade	-	-	-	-	-	-
Broken Levallois blade	8.93	12.55	10.93	1.84	11.31	16.83
Flattening index (mT/mW)	Min.	Max.	Mean	S.D.	Med.	CV
Complete Laminar blade	-	-	-	-	-	-
Complete Levallois blade	0.21	0.76	0.37	0.11	0.33	29.51

Table 9.8. Metric data for complete and broken Levallois blades analysed (n=35)

Over four-fifths of all blades analysed feature retouch, and as noted previously, this may be over-represented by the selection process undertaken by the quarry workers. In their characteristics, twenty-two examples document continuous or complete retouch around the whole blade (Table 9.9). This retouch is most often direct, with several examples (n = 9) also featuring bifacial retouch. Like a number of Early Middle Palaeolithic contexts studied within this thesis (e.g. the Rissori complex), the retouch is typically notch or denticulate-based with large invasive removals apparent on a large number of blades examined.

See Figure 9.4 for examples of Levallois blade *débitage*.

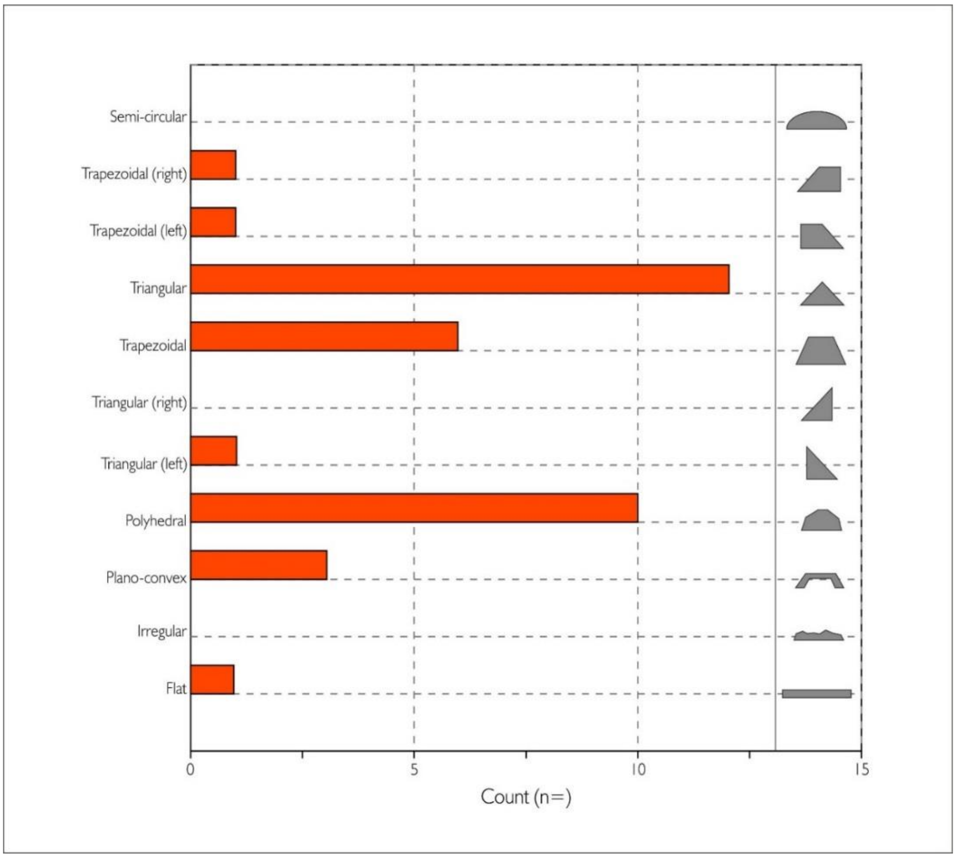


Figure 9.3. A bar-chart of the different cross-sections documented throughout Baker's Hole (Orangered: Levallois)

9.2.4. Hominin Behaviour at Baker's Hole

The archaeological material analysed above highlights the clear use of a Levalloisian core volume management strategy in order to produce elongated stereotyped material for possible immediate use, and for further transformation. While the collection's history is complex and multifaceted, the material does highlight the degree of time invested in the successful exploitation of technological blades, the use of local raw material close to the River Thames, and their possible abandonment, given the abundance of raw material within the immediate landscape, or following use. Irrespective of their quantity and percentage, the transformation of the blades produced parallel many Belgian examples discussed in the previous chapter, with a high-coverage notch-denticulate transformation dominating, and scaled scraper-retouch in the minority, in addition to being a stark contrast to other possible contemporary contexts utilising a Laminar technological strategy including Saint-Valery-sur-Somme.

Baker's Hole (various): retouch analysis (n=35)									
Presence of retouch:	Levallois (35)		Laminar (0)		Location of retouch:	Levallois (35)		Laminar (0)	
Yes	29	82.86%	0	0.00%	Proximal left	3	7.69%	0	0.00%
No	6	17.14%	0	0.00%	Proximal right	1	2.56%	0	0.00%
					Medial left	4	10.26%	0	0.00%
					Medial right	3	7.69%	0	0.00%
					Distal left	4	10.26%	0	0.00%
					Distal right	2	5.13%	0	0.00%
					Complete/continuous	22	56.41%	0	0.00%
Position of retouch:					Retouch coverage (%):				
Direct	18	62.07%	0	0.00%	No retouch	6	17.14%	0	0.00%
Inverse	1	3.45%	0	0.00%	1-25%	2	5.71%	0	0.00%
Alternate	1	3.45%	0	0.00%	26-50%	1	2.86%	0	0.00%
Bifacial	9	31.03%	0	0.00%	51-75%	2	5.71%	0	0.00%
Crossed	0	0.00%	0	0.00%	76-99%	2	5.71%	0	0.00%
Proximal (i.e. burin)	0	0.00%	0	0.00%	Complete retouch	22	62.86%	0	0.00%
Presence of burination					Distribution of retouch:				
Yes	0	0.00%	0	0.00%	Continuous	28	96.55%	0	0.00%
No	35	100.00%	0	0.00%	Discontinuous	1	3.45%	0	0.00%
					Partial	0	0.00%	0	0.00%
Form of retouched edge:					Morphology of retouch:				
Rectilinear	4	13.79%	0	0.00%	Scaled	24	57.14%	0	0.00%
Concave	9	31.03%	0	0.00%	Stepped	0	0.00%	0	0.00%
Convex	0	0.00%	0	0.00%	Sub-parallel	1	2.38%	0	0.00%
Single removal (notch/burin)	2	6.90%	0	0.00%	Parallel	0	0.00%	0	0.00%
Denticulate	2	6.90%	0	0.00%	Notch/Denticulate	17	40.48%	0	0.00%
Multiple	12	41.38%	0	0.00%	Burin	0	0.00%	0	0.00%

Table 9.9. Technological observations from Baker's Hole (retouch attributes)

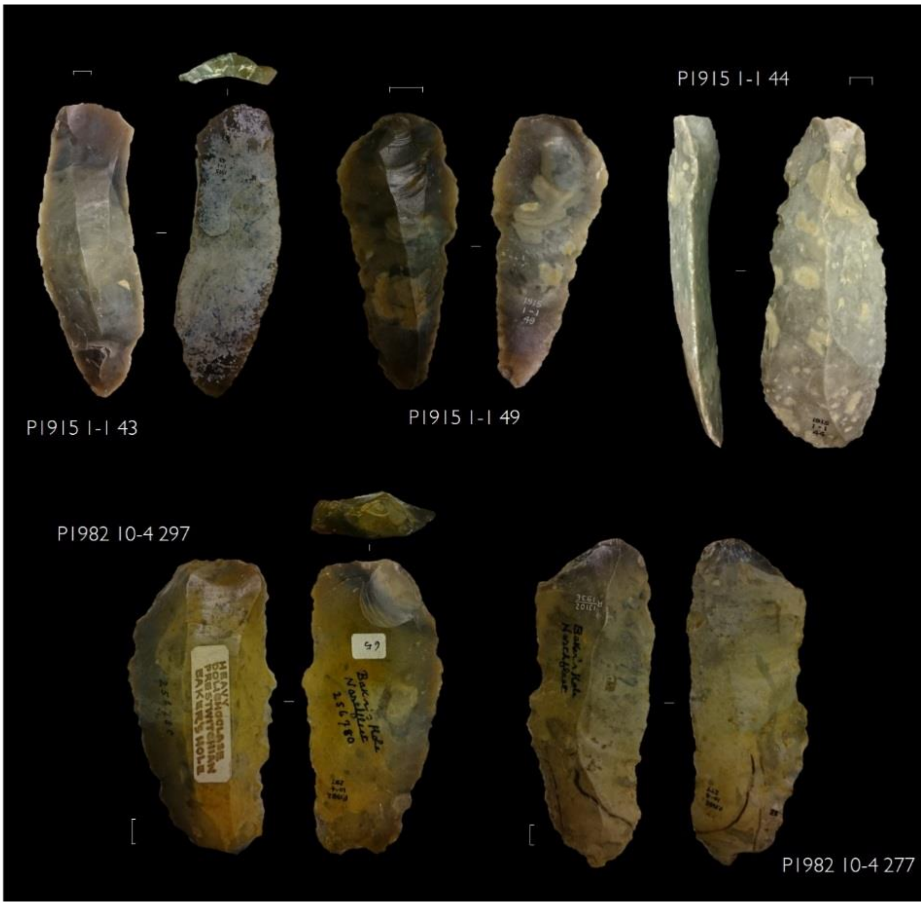


Figure 9.4. Examples from Baker's Hole (various): unretouched and retouched Levallois blades

9.3. Crayford (various collections)

9.3.1. Introduction and Overview of Investigations

Located on the south bank of the River Thames, a number of pits and exposures in the Crayford area, to the west of Baker's Hole, have produced a significant amount of archaeological and faunal deposits attributed to the Early Middle Palaeolithic. Due to issues of ownership and nomenclature over the region's long period of investigation, only eight of the numerous pits and exposures can be accurately positioned. These are the pits of: 1) Furner's/Murray's Old Pit, 2) Furner's New Pit, 3) Norris' Brickyard Pit, 4) Norris' Brickearth Pit, 5) Rutter's New East Pit, 6) Rutter's New West Pit, 7) Stoneham's Pit, and 8) Talbot's Pit (see Figure 9.5).

Like Baker's Hole, the region has a rich history of archaeological investigations stretching as far back as the 1830s (Morris, 1838). The main impetus of research occurred towards the end of the nineteenth century (Spurrell, 1884, 1886, 1898; Leach, 1905; Chandler and Leach, 1912, 1916; Chandler, 1915, 1916), following the discovery of the 'working floor', an *in-situ* refitting sequence, in association with faunal remains, gently buried in the lower section of the Crayford Brickearths in Stoneham's Pit (Spurrell, 1884, 1886, 1898; Kennard, 1944). In its nature, the extent of the refits and its freshness, the archaeological material is unique for the British Middle Palaeolithic. Given this, Stoneham's Pit has become the most intensively investigated and discussed region of the Crayford locality (Mellars, 1974; Roe, 1981; Cook, 1986; Révillion, 1995; Scott, 2006, 2011). Following its discovery, further material was collected from the Lower Brickearths unit of Stoneham's Pit by Kennard (Kennard, 1944), in addition to two further pits, the Rutter's New East and West pits, between 1905 and 1913. A number of much smaller pits and exposures were also excavated (discussed below), in addition to collections by antiquarians.

The main corpus of investigations into Crayford have focused on the archaeological material within Stoneham's Pit, and the behavioural implications associated with producing elongated Levallois material. The material has been long-debated in its technological classification, with Mellars (1974) noting the Upper Palaeolithic characteristics of the blades (with little explanation) produced, and Roe (1981) emphasising the Levalloisian characteristics of the material in terms of its scar directionality and convexities. A series of studies then followed, characterising the material as originating from a Laminar system of core volume management through extended refit analyses. Cook (1986), in her refit analysis of the material from Stoneham's Pit (the most extensive refit analysis up until that point) noted a distinct absence of core preparation and predetermination, citing the material as stemming from a non-Levallois strategy. This view was furthered by Révillion's (1995) study into Cook's refits, through an assessment of the material with respect to Böeda's (1986, 1994) volumetric concept of Levallois technology (see Chapter 2).

Révillion (1995: 428) notes that "*Le concept régissant ce type de schéma opératoire est non-Levallois*", with the material representing an opportunistic form of a convergent direct non-Levallois technique conditioned by the raw material's elongated morphology. More recently, this has been challenged by Scott (2006, 2011) who noted the use of the core's volume, not to produce stereotyped blades, but to prepare a Levallois flaking strategy, with a clear non-interchangeable hierarchy of raw material observed. In addition, Scott (2006, 2011) notes through dorsal scar analyses the production of Levallois points not observed within the refit sequence.

9.3.2. Geological and Chronostratigraphic Background

The Crayford landscape is characterised by a cliff-edge from erosion processes on the Thanet Sands and chalk bedrock eroding below 0m O.D. (Bridgland, 1994). It is against this cliff edge which many of the archaeological deposits have accumulated. Through the various investigations within the region's extensive history (Morris, 1838; Dawkins, 1869; Spurrell, 1899; Leach, 1905; Chandler and Leach 1912a, 1912b, 1916; Chandler, 1914, 1916; Kennard, 1944; Bridgland, 1994; Scott, 2006, 2011) a consistent stratigraphic and geological picture is now known. Six horizons have been noted:

1. Trail: a clay-rich sandy gravel with large flints (< 2.1m thickness)
2. Upper Brickearth: colluvial in origin and clay rich; thinly bedded (< 6.0m thickness)
3. *Corbicula* bed: small mammalian and molluscan remains; sandy (0.25-1.5m thickness)
4. Lower Brickearth: fine sands with occasional pebble lenses; fluvial (< 9.0m thickness)
5. Crayford gravels: coarse gravels with some faunal remains; fluvial (< 4.5m thickness)
6. Chalk/Thanet Sands: some solifluction

A stratigraphic cross-section of the Crayford landscape can be seen in Figure 9.6.

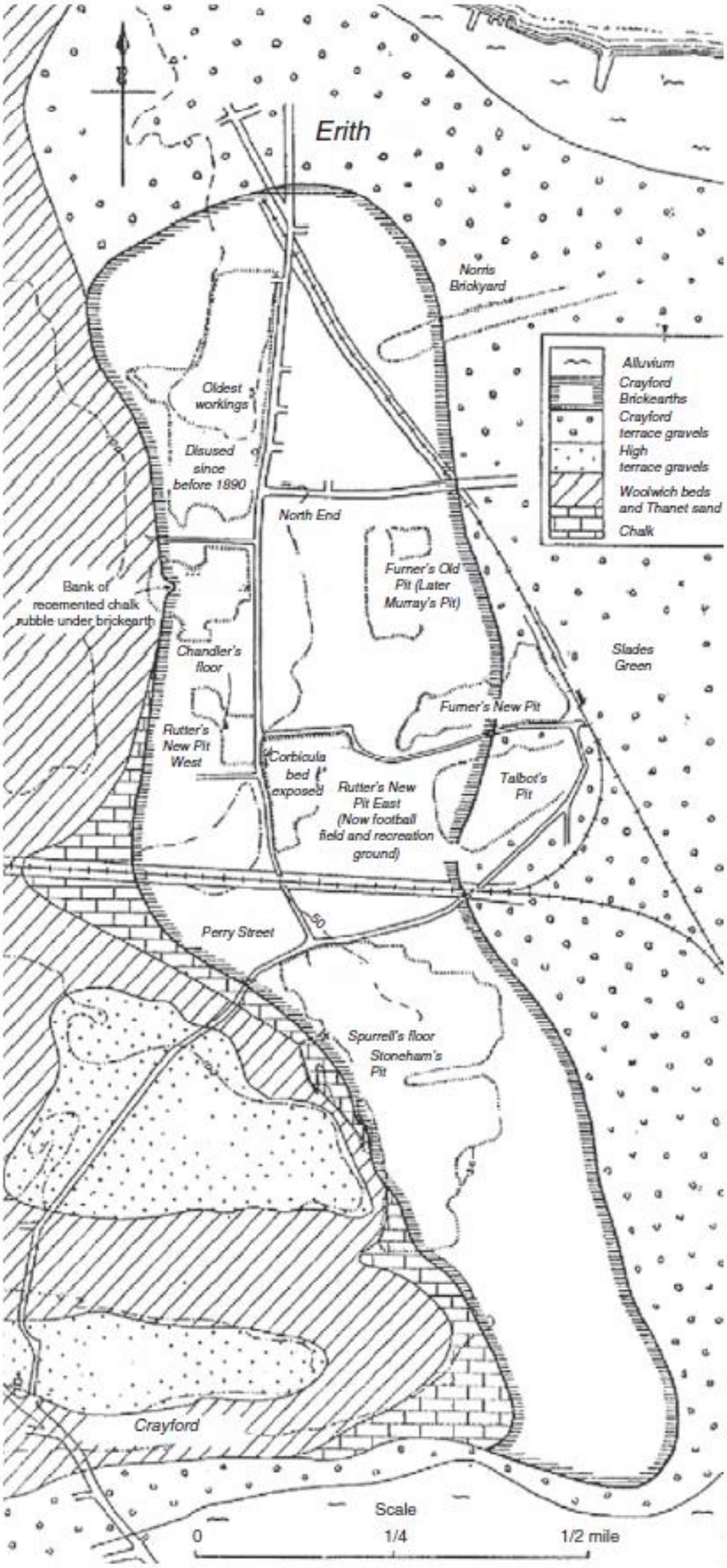


Figure 9.5. Kennard's (1944) plan of the Crayford and Erith area, with the various pits and exposures detailed (sourced from and modified in Scott 2011)

The Crayford Gravel is a coarse and sandy horizon composed of flints in addition to granites, quartzites and sandstones (Dawkins, 1867; Spurrell, 1886). As the overlying deposits decrease to the east, the Crayford Gravels become exposed in the Slades Green region. This horizon has yielded abraded and derived artefacts, many of the artefacts analysed herein in addition to a number of unworked mammalian remains (Spurrell, 1886), which Schreve (1997) suggests to be unworked in nature. This overlies the chalk and Thanet Sands.

Overlying the Crayford Gravels is the Lower Brickearth layer, a fluvially deposited horizon containing sands and occasional pebble lenses. It is within this horizon which many of the pits documented above and throughout originate from, including Spurrell's 'working floor' in Stoneham's Pit, which was discovered at its base. Kennard (1944) suggested that the Lower Brickearths represents a dry and open grassland environment given the absence of aquatic vegetation.

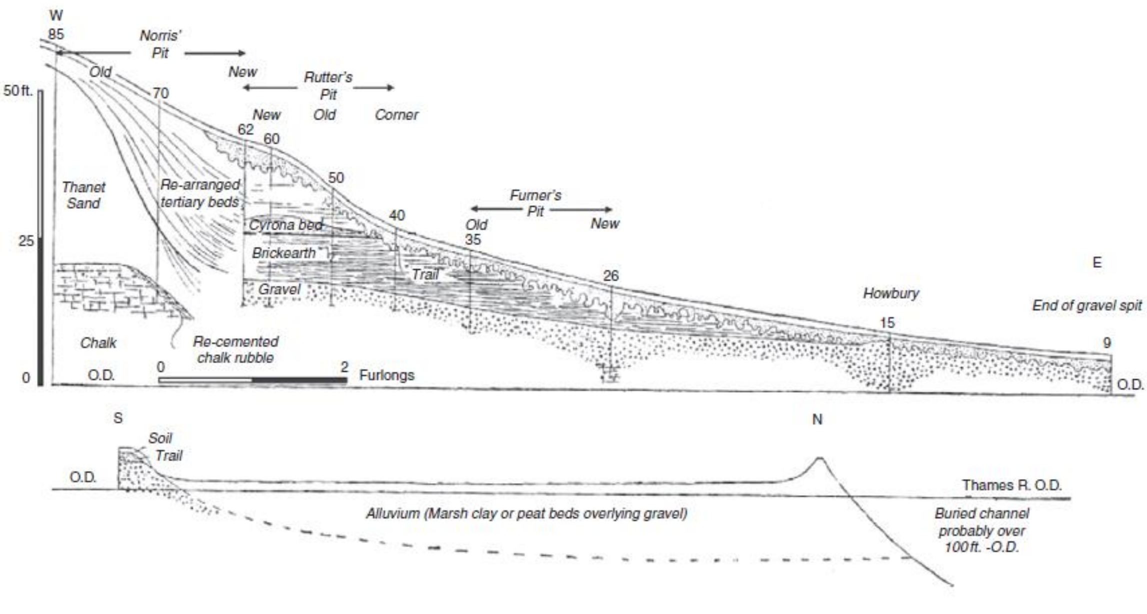


Figure 9.6. Chandler's (1914) composite section of the horizons exposed in the Crayford/Erith area (sourced from and modified in Scott 2011)

Overlying the Lower Brickearth is the *Corbicula* Bed. This varies in thickness throughout the Crayford region, and is characterised by pebbles and a yellow fine sand.

Above the *Corbicula* Bed lies the clay-rich and often laminated Upper Brickearth horizon (Leach, 1905). First noted to be distinguishable from the Lower Brickearths by Tylor (1869), the Upper Brickearth horizon is a colluvial deposit produced through heavy rainfall from overlying deposits, and features few if any fossils. Both the Upper and Lower Brickearth horizons extend from Crayford to the Erith region.

This sequence is finished by a solifluction deposit (trail), consisting of gravels, large flints, and tertiary deposits derived from neighbouring deposits, reflecting a cold environment (Dawkins, 1867; Chandler, 1914; Kennard, 1944).

In dating the Crayford material, the general sequence is attributed to the Taplow/Mucking formation of the Lower Thames, given similarities in its altitude to that of other sites, with a date of MOIS 8-6 hypothesised (Bridgland, 1994). A date of the Early Middle Palaeolithic is further supported through amino-acid racemisation (Bowen et al., 1989), in addition to biostratigraphical evidence, with the latter concluding in a late MOIS 7/early MOIS 6 date (Currant, 1986; Schreve, 1997; Candy and Schreve, 2007). However, as Scott (2011) notes, given difficulties in assigning particular fossils to specific points of the sequence, and determining the specific environmental circumstances within each horizon (with exception to the trail and *Corbicula* beds), a date of MOIS 8-6 should be preferred. Aspects of the single gravel body underlying the Crayford Brickearths can suggest a date of late MOIS 8/early MOIS 7 for the Slades Green material, however as the direct connection between the gravels at Slade Green and Stoneham's Pit has never been observed, a more precise date cannot be concluded at present.

9.3.3. Artefact Analysis

9.3.3.1. Treatment and Selection of the Collection(s)

While the material discovered throughout the Brickearths and Crayford Gravels may not source from direct *in-situ* deposits similarly to Stoneham's pit, their identification within the Crayford sequence is known, and their importance should not be underemphasised. The artefacts can still provide information on the technological behaviours undertaken within the Crayford landscape, irrespective of their contemporaneity with other pits, and provide important morphometric and technological data for the Early Middle Palaeolithic. In addition, as the material at Stoneham's Pit is refitted and glued, extensive morphometric and technological analyses are difficult, and can be erroneous. This explains why narrative-based approaches have been preferred previously (Cook, 1986; Révillion, 1995, Scott, 2006, 2011). In order to understand the behavioural potential and technological behaviours within the

British Early Middle Palaeolithic, it was decided that analyses of the numerous collections and pits were preferred. Undertaking this compliments and contextualises the material at Stoneham's Pit within the greater landscape, providing a more holistic picture of Neanderthal technological behaviour. This includes material collected by Brice-Higgins, Chandler, Garraway Rice, Marston among others. Some of these pieces e.g. P1971 6-1 312 are thought to originate from Stoneham's Pit, whereas others originate from other exposures and pits including Talbot's Pit and Slades Green, for example. As they are documented and pictured (Higgins, 1914; Chandler, 1916), and feature original labels they can be assumed to derive from their personal collections. It is also assumed that, through an analysis of these collections, analyses will highlight a varied taphonomic history, and, similarly to Baker's Hole, selectivity biases will be prevalent. As such, they must be interpreted with a degree of caution.

All material was studied in the British Museum (Franks House) in London.

9.3.3.2. Technological Overview

The material analysed comprises of sixty-seven artefacts known to originate from a technological blade strategy, and a further three examples of *éclats débordants*, which may originate from Levallois recurrent elongated strategies. However, as no Levallois cores were recorded it is difficult to determine whether these originate from preferential, recurrent, or recurrent (elongated) strategies, and given their known existence within the Crayford locale (Scott, 2011), should be interpreted with caution. Despite this, all other products were confidently defined as originating from a Levallois technology blade strategy (Table 9.10), given their overall laminarity, and technological characteristics.

Confidence	Laminar core	Levallois core	Laminar product	Levallois product
A (definite)	0 (0.00%)	0 (0.00%)	0 (0.00%)	59 (85.51%)
B (probable)	1 (100.00%)	0 (0.00%)	0 (0.00%)	9 (13.04%)
C (possible)	0 (0.00%)	0 (0.00%)	0 (0.00%)	1 (1.45%)

Table 9.10. Confidence categories for the artefacts studied

Like other contexts, a large number of broken and complete artefacts feature retouch, with notched/denticulated and scraper-based forms apparent. Again, selectivity biases and issues of interpretation mean that their quantities cannot be treated at face value.

One core recorded from Marlston's Slades Green collection features technological characteristics typical of Laminar blade production. Besides this, no evidence for Laminar technological blade strategies are apparent.

For a technological breakdown see Table 9.11.

Artefact	n	Percentage
Laminar blade (unretouched)	0	0.00%
Laminar blade (retouched)	0	0.00%
Laminar blade fragment (unretouched)	0	0.00%
Laminar blade fragment (retouched)	0	0.00%
Laminar crested blade (unretouched)	0	0.00%
Laminar crested blade (retouched)	0	0.00%
Laminar crested blade fragment (unretouched)	0	0.00%
Laminar crested blade fragment (retouched)	0	0.00%
Laminar blade core	1	1.43%
Levallois blade (unretouched)	33	47.14%
Levallois blade (retouched)	24	34.29%
Levallois blade fragment (unretouched)	7	10.00%
Levallois blade fragment (retouched)	2	2.86%
Levallois *éclat débordant* (unretouched)	2	2.86%
Levallois *éclat débordant* (retouched)	1	1.43%
Levallois *éclat débordant* fragment (unretouched)	0	0.00%
Levallois *éclat débordant* fragment (retouched)	0	0.00%
Levallois recurrent blade core	0	0.00%
Total:	70	100.00%

Table 9.11. Technological overview of the artefacts studied

9.3.3.3. Taphonomic History

It was assumed that a mixed taphonomic history was to be expected as artefacts are derived from a number of different pits and exposures throughout the Crayford Gravels and Brickearths. This is demonstrated through the varying levels of mechanical damage and rolling documented throughout the assemblage (see Table 9.12). Of the seventy artefacts analysed, just over half of all artefacts (n = 37, 52.86%) feature no observable edge damage, with a further twenty-seven examples (38.57%) exemplifying light edge damage, and six examples (8.57%) of moderate edge damage. Very few examples also demonstrate evidence for rolling with only eight artefacts demonstrating rolling. The ten broken artefacts also do not appear to have been broken through their taphonomic history, but rather reflect breakages during the knapping sequence. So, while the artefacts may have been subject to some mechanical damage, the artefacts represented are not from reworked contexts. It is also possible that edge damage originates following their recovery within personal collections, however this cannot be demonstrated or elaborated on further at this point.

A large amount of artefacts appear to demonstrate evidence for patination or chemical alteration with over three quarters of all examples (78.57%) featuring some patination, reflecting the mixed non-fluvial/fluvial settings for the artefacts studied. A small number of artefacts, noted as deriving from Stoneham's Pit appear to feature minor patination, supporting Scott's (2012) view that the material uncovered after Spurrell was not an extension of the 'working floor'. In addition, manyartefacts feature smooth and worn dorsal scar arrises, further exemplifying the fluvial context following deposition.

Crayford (various): artefact condition (n=70)									
	Levallois (69)		Laminar (1)			Levallois (69)		Laminar (1)	
Whole/broken:					Degree of patination:				
Whole	59	85.51%	1	100.00%	Unpatinated	14	20.29%	1	100.00%
Broken	10	14.49%	0	0.00%	Lightly patinated	30	43.48%	0	0.00%
					Moderately patinated	18	26.09%	0	0.00%
					Heavily patinated	7	10.14%	0	0.00%
Degree of edge damage:					Degree of burning:				
No edge damage	36	52.17%	1	100.00%	Unburned	69	100.00%	1	100.00%
Lightly damaged	27	39.13%	0	0.00%	Lightly burned	0	0.00%	0	0.00%
Moderately damaged	6	8.70%	0	0.00%	Moderately burned	0	0.00%	0	0.00%
Heavily damaged	0	0.00%	0	0.00%	Heavily burned	0	0.00%	0	0.00%
Degree of rolling:					Portion/break:				
Unrolled	61	88.41%	1	100.00%	Complete	61	88.41%	1	100.00%
Lightly rolled	8	11.59%	0	0.00%	Proximal fragment	3	4.35%	0	0.00%
Moderately rolled	0	0.00%	0	0.00%	Medial fragment	1	1.45%	0	0.00%
Heavily rolled	0	0.00%	0	0.00%	Distal fragment	4	5.80%	0	0.00%
					Siret	0	0.00%	0	0.00%
Observations: Light scratching; some ridge/arrise damage.									

Table 9.12. Detailed taphonomic characteristics of material analysed at Crayford

With respect to cortex, a small number of examples retain evidence for cortex. On artefacts examined, the cortex appears to be mixed generally, with worn and lightly stained examples, and fresher more chalky examples, again reflecting the mixture of contexts the artefacts were recovered from.

No examples analysed feature evidence of alteration from fire.

For a full breakdown of the different taphonomic histories for each collection see the Appendix.

9.3.3.4. Raw Material

Within the Crayford landscape, it is known through the refitting at Stoneham's Pit that flint freshly eroded from the immediate chalk cliff was utilised, and while the nodule form could not be determined, Scott (2011) states that large cores of indeterminate, amorphous, and cylindrical shape were exploited in addition to spherical, oval and lenticular nodules. With respect to other examples throughout the Brickearths and the Crayford Gravels it is assumed that the immediate chalk cliff was also exploited.

In terms of raw material quality, Cook (1986) notes that the material from Stoneham's Pit is local in nature features coarse inclusions with regular thermal fractures, resulting from frost-action damage. Throughout the pieces examined, raw material appears fairly homogenous with large coarse inclusions and microfossils in small quantities when present, agreeing with analyses by Cook (1986).

In determining the morphology of the raw material used throughout the landscape, difficulties arrise as no examples of Levallois cores were recorded. Aspects of the raw material shape can be identified through an analysis of the blades dimensions, and the convexities of the blade profiles analysed. Over four-fifths of all products feature a relatively straight profile, with slight curvature documented (see Chapter 10), exemplifying the relative convexity of the Levallois cores used. Analyses of the blades dimensions highlight that relatively large nodules were also exploited, with a maximum length of 163.09mm, and a mean length of 106.60mm. More information on blade morphologies can be seen below.

Only one Laminar core was recorded. This retains no cortex, is heavily worked and features a low elongation index. More information about this core is also described below.

9.3.3.5. Technology: Extended Analysis

The various pits and exposures around Stoneham's Pit attest to the production of elongated material through a Levallois recurrent elongated system of core volume management. Despite there being an absence of Levallois recurrent elongated cores (or Levallois cores generally), the blade *débitage* in its technological characteristics highlight the Levallois concept of blade production. Among the various collections only one artefact suggests the production of elongated stereotyped material through a Laminar technological blade strategy, however due to issues of context it is unknown whether other material was retained with the blade core, or its specific placement within the Early Middle Palaeolithic.

Weight (g)	Min.	Max.	Mean	S.D.	Med.	CV
Complete Laminar blade	-	-	-	-	-	-
Complete Levallois blade	3.40	176.30	57.48	35.55	49.70	61.85
Broken Laminar blade	-	-	-	-	-	-
Broken Levallois blade	8.50	112.60	39.57	28.72	36.95	72.58
Length (mm)	Min.	Max.	Mean	S.D.	Med.	CV
Complete Laminar blade	-	-	-	-	-	-
Complete Levallois blade	60.78	163.09	106.60	26.01	107.59	24.40
Broken Laminar blade	-	-	-	-	-	-
Broken Levallois blade	48.47	158.26	94.31	34.61	85.96	36.70
Width (mm)	Min.	Max.	Mean	S.D.	Med.	CV
Complete Laminar blade	-	-	-	-	-	-
Complete Levallois blade	13.60	72.10	44.94	12.92	45.28	28.75
Broken Laminar blade	-	-	-	-	-	-
Broken Levallois blade	23.71	68.94	45.14	13.15	44.87	29.12
Elongation Index (L/W)	Min.	Max.	Mean	S.D.	Med.	CV
Complete Laminar blade	-	-	-	-	-	-
Complete Levallois blade	1.77	4.47	2.48	0.61	2.26	24.75
Broken Laminar blade	-	-	-	-	-	-
Broken Levallois blade	1.42	2.87	2.09	0.40	1.99	19.16
Thickness (mm)	Min.	Max.	Mean	S.D.	Med.	CV
Complete Laminar blade	-	-	-	-	-	-
Complete Levallois blade	3.28	16.86	8.83	2.56	8.60	28.97
Broken Laminar blade	-	-	-	-	-	-
Broken Levallois blade	5.53	16.57	11.56	3.40	11.43	29.44
Working edge/edge circum. (mm)	Min.	Max.	Mean	S.D.	Med.	CV
Complete Laminar blade	-	-	-	-	-	-
Complete Levallois blade	147.15	427.34	277.61	62.20	280.77	23.49
Broken Laminar blade	-	-	-	-	-	-
Broken Levallois blade	134.27	450.15	259.35	96.02	238.35	37.02
Cutting edge per weight (mm/g)	Min.	Max.	Mean	S.D.	Med.	CV
Complete Laminar blade	-	-	-	-	-	-
Complete Levallois blade	2.42	49.63	7.54	7.72	5.83	102.45
Broken Laminar blade	-	-	-	-	-	-
Broken Levallois blade	3.54	15.80	8.56	4.30	6.64	50.30
Flattening index (mT/mW)	Min.	Max.	Mean	S.D.	Med.	CV
Complete Laminar blade	-	-	-	-	-	-
Complete Levallois blade	0.25	0.63	0.38	0.09	0.36	24.57

Table 9.13. Metric data for complete and broken Levallois blades analysed (n=66)

The Laminar core analysed features a plain platform, resulting from one large flake removal, and features no evidence for facetting or edge preparation on its edges. Up to three-quarters of the core's circumference is exploited in a *semi-tournant* technique with a predominantly unidirectional flaking system. At least six elongated scars are identified, with stepped, hinged, and feathered end-type negatives all present. Despite only one platform being recorded, bidirectional flaking is evident, and it is hypothesised that the second platform was removed through a series of overshot removals, given the convex nature of the remaining artefacts remaining platform. The resulting morphology is semi-pyramidal/semi-orthogonal and narrow, with a low elongation index (1.04). As noted above, no blades were identified as originating from the blade core, or a Laminar technological blade strategy.

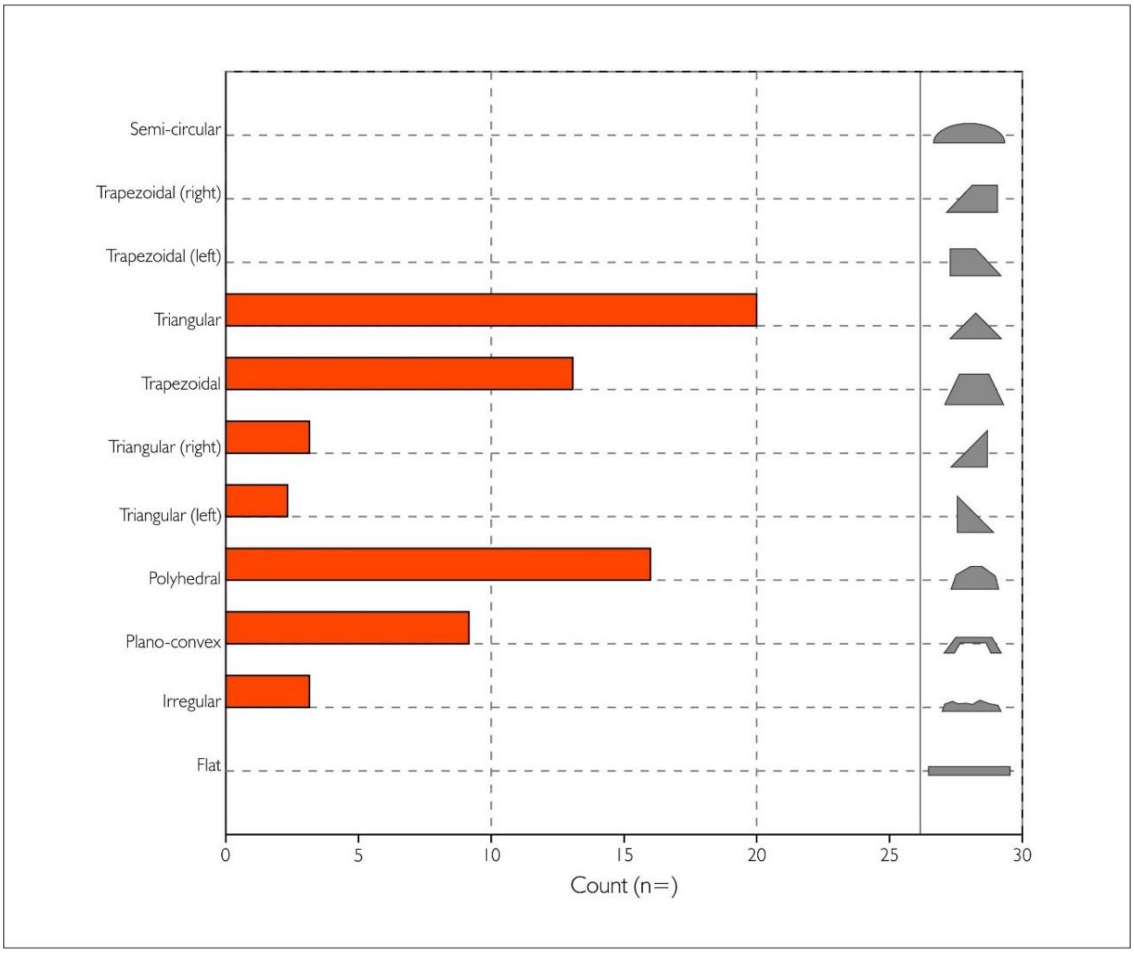


Figure 9.7. A bar-chart of the different cross-sections documented throughout Crayford (Orangered: Levallois)

With the exception of the Laminar core, all other artefacts identified originate from a Levalloisian technological strategy. In their dimensions and morphology, the blades produced are typically triangular, trapezoidal and polyhedral in cross-section (see Figure 9.7), feature an elongation index significantly higher than the conventional 2:1 ratio, with a mean index of 2.48, and are relatively standardised in their elongation as suggested by the relatively low coefficient of variation value (Table 9.13). The blades vary considerably in their weight (with a range of 102.31g) and in their dimensions, however despite this, relatively low standard deviations and coefficient of variation values for their length, width, and thickness calculated.

A flattening index comparable to other Levallois blade contexts, and experimental Levallois material, is also observed (mean flattening index: 0.38).

Crayford (various collections): technological analysis (n=66)									
Percussion strategy:	Levallois (66)		Laminar (0)		Bulbar scar features:	Levallois (66)		Laminar (0)	
Hard	58	87.88%	0	0.00%	Well defined	40	60.61%	0	0.00%
Soft	0	0.00%	0	0.00%	Diffused	21	31.82%	0	0.00%
Mixed/Indeterminable	3	4.55%	0	0.00%	Absent/missing	5	7.58%	0	0.00%
Absent	5	7.58%	0	0.00%	Removed	0	0.00%	0	0.00%
Cortex percentage:					Number of dorsal scars:				
Absent	54	81.82%	0	0.00%	Absent	0	0.00%	0	0.00%
1-24%	8	12.12%	0	0.00%	1-2	9	13.64%	0	0.00%
25-49%	3	4.55%	0	0.00%	3-4	36	54.55%	0	0.00%
50-74%	0	0.00%	0	0.00%	5-6	18	27.27%	0	0.00%
75-99%	1	1.52%	0	0.00%	7+	3	4.55%	0	0.00%
Complete	0	0.00%	0	0.00%					
Number of elongated scars:					Number of ridges/arrises:				
Absent	0	0.00%	0	0.00%	Absent	0	0.00%	0	0.00%
1-2	28	42.42%	0	0.00%	1	32	48.48%	0	0.00%
3-4	36	54.55%	0	0.00%	2	33	50.00%	0	0.00%
5-6	2	3.03%	0	0.00%	3	1	1.52%	0	0.00%
7+	0	0.00%	0	0.00%	4	0	0.00%	0	0.00%
					5+	0	0.00%	0	0.00%
Dorsal ridge/arise shape:					Flake scar pattern:				
Singular	25	37.88%	0	0.00%	Unidirectional	30	45.45%	0	0.00%
Parallel	12	18.18%	0	0.00%	Centripetal	1	1.52%	0	0.00%
Irregular	6	9.09%	0	0.00%	3-way centripetal	1	1.52%	0	0.00%
Regular converging	10	15.15%	0	0.00%	Bidirectional	10	15.15%	0	0.00%
Regular diverging	0	0.00%	0	0.00%	Lateral left	0	0.00%	0	0.00%
Y-shape	7	10.61%	0	0.00%	Lateral right	0	0.00%	0	0.00%
Inverted Y-shape	1	1.52%	0	0.00%	Convergent unidirectional	18	27.27%	0	0.00%
Offset left/right	2	3.03%	0	0.00%	Convergent bidirectional	3	4.55%	0	0.00%
Partial	2	3.03%	0	0.00%	Convergent and perpendicular	1	1.52%	0	0.00%
Central converging	1	1.52%	0	0.00%	Double perpendicular	0	0.00%	0	0.00%
Absent	0	0.00%	0	0.00%	Straight and perpendicular	2	3.03%	0	0.00%
					Cortical	0	0.00%	0	0.00%
					Indeterminable	0	0.00%	0	0.00%
Distal end-type:					Butt type:				
Feathered	49	74.24%	0	0.00%	Plain/flat	9	13.64%	0	0.00%
Stepped	5	7.58%	0	0.00%	Dihedral	3	4.55%	0	0.00%
Hinged	7	10.61%	0	0.00%	Cortical	0	0.00%	0	0.00%
Overshot	1	1.52%	0	0.00%	Natural (but non-cortical)	0	0.00%	0	0.00%
Present but indeterminable	0	0.00%	0	0.00%	Marginal	1	1.52%	0	0.00%
Missing	4	6.06%	0	0.00%	Mixed	12	18.18%	0	0.00%
					Facetted	29	43.94%	0	0.00%
					Missing (proximal missing)	5	7.58%	0	0.00%
					Trimmed	0	0.00%	0	0.00%
					Chapeau de Gendarme	1	1.52%	0	0.00%
					Damaged/unidentifiable	6	9.09%	0	0.00%

Table 9.14. Technological observations from Crayford (blade attributes)

The blades produced all retain characteristics of hard hammer production, with most artefacts (n = 40, 60.61%) featuring pronounced and well-defined bulbar scar features (Table 9.14). In their dorsal profiles, less than a fifth of all examples retain cortex (18.18%), with low coverage documented in all but one example. The blades most often feature three-to-four dorsal scars (n = 36, 54.55%), and one-to-two longitudinal arrises (n = 65, 98.48%). Analyses of dorsal scar pattern document a unidirectional strategy (n = 48, 73.15%), however again it must be stressed that these result from highly-selected collections, and may not be representative of the pits and exposures they originate from. In addition, it is clearly exemplified that facetting was undergone within the Neanderthal Crayford landscape, with thirty examples (45.45%) of facetting documented, one with a *chapeau de gendarme* morphology.

Crayford (various): retouch analysis (n=66)									
Presence of retouch:	Levallois (66)		Laminar (0)		Location of retouch:	Levallois (66)		Laminar (0)	
Yes	26	39.39%	0	0.00%	Proximal left	0	0.00%	0	0.00%
No	40	60.61%	0	0.00%	Proximal right	1	3.57%	0	0.00%
					Medial left	3	10.71%	0	0.00%
					Medial right	2	7.14%	0	0.00%
					Distal left	1	3.57%	0	0.00%
					Distal right	1	3.57%	0	0.00%
					Complete/continuous	20	71.43%	0	0.00%
Position of retouch:					Retouch coverage (%):				
Direct	17	65.38%	0	0.00%	No retouch	66	71.74%	0	0.00%
Inverse	4	15.38%	0	0.00%	1-25%	1	1.09%	0	0.00%
Alternate	0	0.00%	0	0.00%	26-50%	4	4.35%	0	0.00%
Bifacial	4	15.38%	0	0.00%	51-75%	2	2.17%	0	0.00%
Crossed	1	3.85%	0	0.00%	76-99%	5	5.43%	0	0.00%
Proximal (i.e. burin)	0	0.00%	0	0.00%	Complete retouch	14	15.22%	0	0.00%
Presence of burination:					Distribution of retouch:				
Yes	0	0.00%	0	0.00%	Continuous	20	76.92%	0	0.00%
No	66	100.00%	0	0.00%	Discontinuous	4	15.38%	0	0.00%
					Partial	2	7.69%	0	0.00%
Form of retouched edge:					Morphology of retouch:				
Rectilinear	5	19.23%	0	0.00%	Scaled	21	72.41%	0	0.00%
Concave	2	7.69%	0	0.00%	Stepped	0	0.00%	0	0.00%
Convex	6	23.08%	0	0.00%	Sub-parallel	0	0.00%	0	0.00%
Single removal (notch/burin)	2	7.69%	0	0.00%	Parallel	0	0.00%	0	0.00%
Denticulate	2	7.69%	0	0.00%	Notch/Denticulate	8	27.59%	0	0.00%
Multiple	9	34.62%	0	0.00%	Burin	0	0.00%	0	0.00%

Table 9.15. Technological observations from Crayford (retouch attributes)

Of the sixty-six blades analysed, twenty-six (39.39%) feature retouch (Table 9.15). The retouch is typically continuous and complete in coverage, and is predominantly direct in its position. Bifacial, inverse, and crossed retouch positions are however also documented. In its nature, most examples feature scaled retouch of various forms, with eight examples of notched and denticulated forms also noted.

Three *éclats débordants* were also recorded, one of which features complete direct retouch, with both convex and concave forms strategies apparent, further exemplifying the use of core-edge material as a desirable and functional artefact. Again, it is unsure, given the fragmentary nature of the assemblage as to whether these pertain from recurrent elongated strategies or other Levalloisian technologies.

For examples of blade *débitage* documented see Figure 9.8.

Figure 9.8. Examples from Crayford (various). Top left: Levallois blade; Top right: retouched Levallois blade; Centre left: Laminar blade core; Centre right: Levallois blade; Bottom left: Levallois blade; Bottom right: Levallois blade

9.3.4. Hominin Behaviour at Crayford

While a large corpus of research has investigated the *in-situ* deposits of the 'working floor' scatter within Stoneham's Pit and provided a valuable insight into technological behaviour close to the cliff-edge, little work has been undertaken with respect to the wider Crayford landscape. Despite issues of context, their provenance within the Early Middle Palaeolithic can be assumed, given the regions geological context and the horizons noted above. The evidence highlights the careful preparation of blade material in order to produce retouched and unworked forms, some of considerable size, using local high-quality raw material. and. The absence of cores within these collections provides speculation as to their possible provenance within the immediate or extended landscape, however the presence of large overshot flakes provide a hint of the blade core morphologies undertaken. Further work is needed in uncovering more detail about the individual collections, particularly the origins of the material recovered, and their exact context, through further archival and museum-based research.

Chapter Ten
Comparative Analyses of the Archaeological Evidence: A Consideration of Morphometric and Technological Variability

10.1. Introduction

In assessing the behavioural potential of the different technological blade strategies, and the extent with which the functional properties of technological blade strategies can account for the changes in their quantity throughout the European Middle Palaeolithic and their concurrent use, a comparative synthesis of material analysed is essential. This chapter therefore integrates the two main sources of investigation throughout this thesis, and provides more detail on the morphometric elements of the archaeological data discussed.

It will first detail aspects of artefact design for the archaeological contexts discussed through aspects of performance, efficiency and standardisation, and assess alongside the experimental framework from Chapter 5. This will provide a thorough basis of understanding aspects of artefact design through a consideration of the experimental and archaeological datasets.

This chapter will then analyse the diachronic relationship between the different technological blade contexts documented throughout, and assess the 'true' nature of technological variability through the four main aspects of behaviour described in Chapter 5. Other archaeological contexts are discussed where appropriate.

The commonalities and differences between the technological blade strategies throughout the Middle Palaeolithic will then be assessed through a goodness-of-fit with the conclusions drawn from a consideration of artefact design to assess the role aspects of artefact design and behavioural potential influence: 1) the change from a Levallois-high/Laminar-low Early Middle Palaeolithic to a Levallois-low/Laminar high Late Middle Palaeolithic, 2) the concurrency of strategies on individual contexts, and 3) the use of blades within individual contexts. This is discussed in Chapter 11.

10.2. An Archaeological Assessment of Artefact Design Strategy

To compare both the archaeological and experimental datasets in terms of their morphological characteristics, the same three aspects of artefact design strategy used in Chapter Six are discussed in detail here. Only unretouched whole blades are analysed here, with three hundred and forty-seven unretouched whole blades analysed through a traditional lineal framework, and three hundred and fifteen whole blades analysed in terms of their two-dimensional planform shape. The discrepancy is due to the nature of the archaeological evidence, i.e. the use of adhesives in refitted examples and the nature of the breaks observed. Where appropriate, the credibility of blade strategies and issues of identification, touched upon in the last three chapters, are then discussed. The observations from the archaeological examples are then cross-validated with the experimental dataset, providing a measure of how 'alike' the datasets are. Due to possible issues of edge damage, only the flattening index is used as a measure of archaeological edge angle, as highlighted in Chapter Six. And where caution was urged in previous chapters on the identification of certain blade strategies, these are discussed.

10.2.1. Artefact Design Strategy #1: Properties Regarding the Shape and Nature of the Cutting-edge

With respect to the two-dimensional planform shape of the archaeological blades analysed, geometric morphometric analyses highlight differences in the two different *débitage* techniques, similarly to the experimental data analysis.

Through Elliptical Fourier Analysis of the first twenty-one harmonics (as determined in Chapter Five), the first two axes account for 67% (67.103%) cumulative shape variance, the first eleven axes account for 95% (95.209%) of cumulative shape variance, and the first twenty-five axes account for 99% (99.012%) cumulative shape variance. A Principal Component Analysis of the first two main axes of shape variance highlight morphological changes documented throughout the experimental dataset, with the first axis (52.999% shape variance) extending from wider and concave shapes to thinner, flatter, more elongated shapes. The second main source of shape variation, accounting for 14.104% shape variance, extends from distal-heavy to proximal-heavy morphologies (Figure 10.1). Laminar technological blades feature more negative PC1 values, attesting to more elongated narrower forms, whereas Levallois technological blades feature more positive PC1 values, attesting to more concave and wider morphologies.

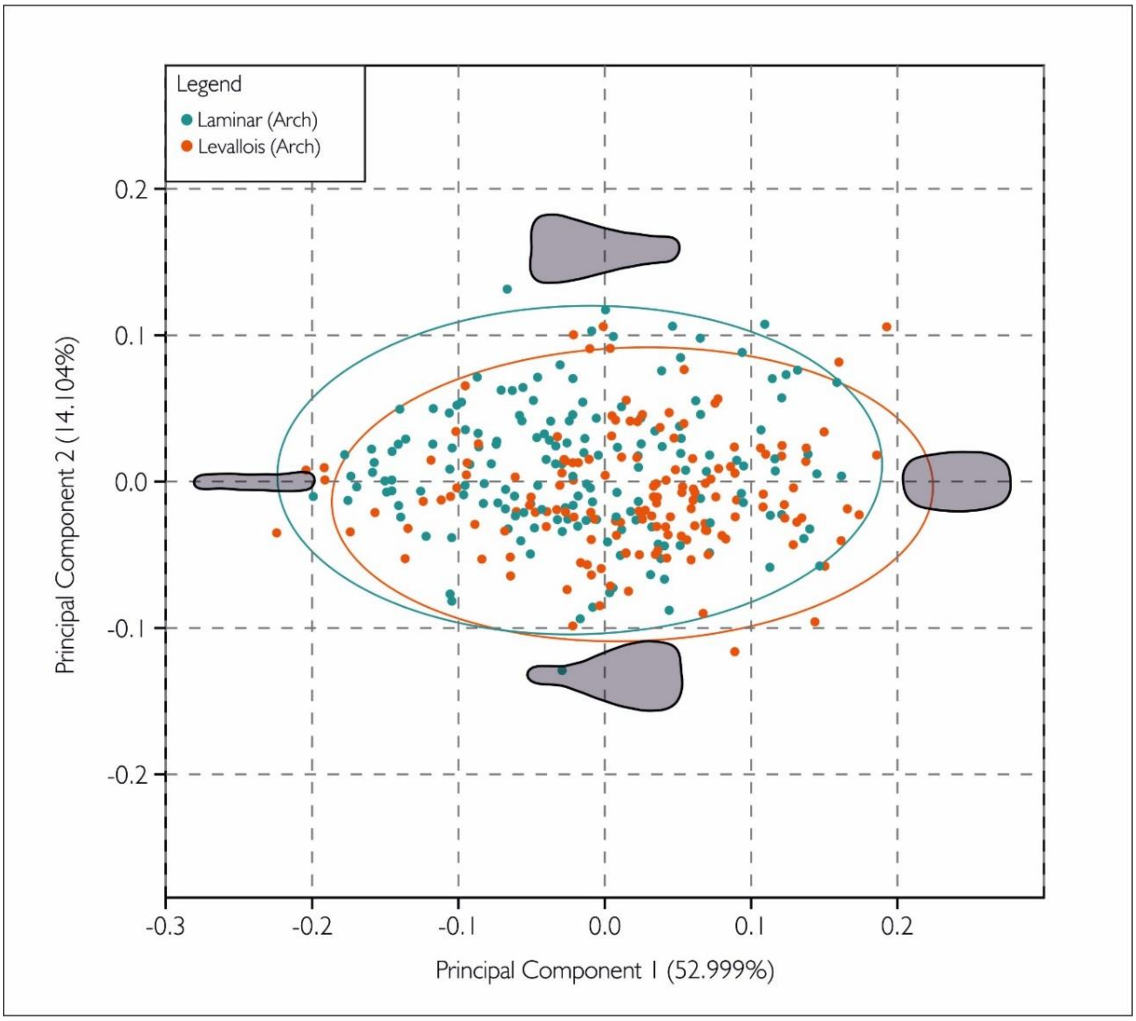


Figure 10.1. Principal Component Analysis (PCA) of the first twenty-one Fourier harmonics (attributable to 99.99% harmonic power) for archaeological examples of blade production

While the PCA demonstrates that there is some distinction between the groups, in their first two main axes, this method does not test for discrimination or statistical significance, in addition to not taking into consideration the individual blade strategies as groups. The first fifty-two axes (accounting for 99.9% shape variance) were therefore subject to a MANOVA and a LDA with the axis scores tested for statistical significance (similarly to Chapter Six). MANOVA of the first fifty-two axes highlight that there is statistical difference to 99% confidence (*Wilks' lambda*: 0.734, *F*: 1.825, *p*: 0.0012; *Pillai trace*: 0.266, *F*: 1.825, *p*: 0.0012) with LDA (Figure 10.2) and confusion matrices (see Appendix) further highlighting that the two groups can be discriminated with 73.33% success, with a jackknifed value (using leave-one-out cross-validation) of just over half (59.68%). Therefore, while the groups can be discriminated with respect to their maximum differences, it is problematic to assign random shapes to either of two groups, however this is to be assumed given the nature of lithic variability and blade technology. A t-test of the Canonical Variate axis further exemplifies this discrimination between the two technological strategies (*t*: 10.649, *permutated p*: 0.0001).

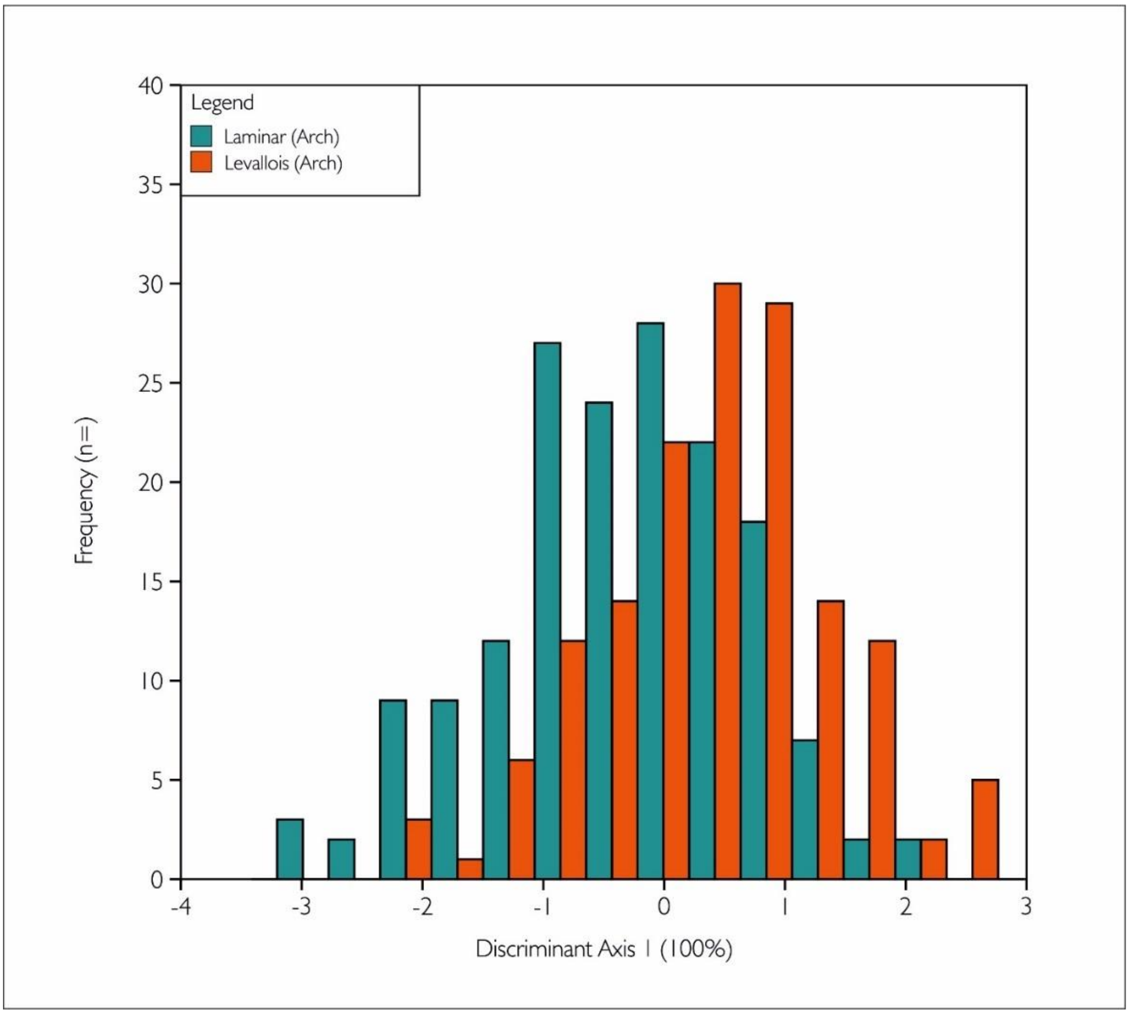


Figure 10.2. Lineal Discriminant Analysis (LDA) of two-dimensional planform shape (99.99% shape variation) for archaeological blade strategies

These analyses however mask the changes between the Early Middle Palaeolithic and how the strategies differ in shape between the two different periods. Despite unequal sample sizes, the analyses do highlight a differing change between Levallois and Laminar technological blade strategies throughout the Middle Palaeolithic (Figure 10.3). For the Early Middle Palaeolithic, a Principal Component Analysis of the first two major axes (accounting for

68.096% cumulative shape variance) highlights that there is no difference in clustering between the two technological blade strategies, with Laminar technological blades (primarily from Saint-Valery-sur-Somme centred in the middle of the Levallois range. Despite a larger Levallois sample providing a higher resolution of shape variance the Laminar technological blades do not appear to be clustered towards the narrower, more elongated forms, as exemplified in previous analyses. The analyses highlight again the Levallois nature of the blades produced from Saint-Valery-sur-Somme (as noted in Chapter 7), the more Laminar nature of Early Middle Palaeolithic blade strategies in a number of examples, e.g. Le Rissori (IIIA/IIIB), and the degree to which both strategies are stereotyped. MANOVA of 99.99% cumulative shape variance further highlights that there is no statistical significance in shape variance between the two groups (*Wilks' lambda*: 0.8301, *F*: 0.5935, *p*: 0.9693; *Pillai trace*: 0.1699, *F*: 0.5935, *p*: 0.9693). Both Levallois and Laminar technological blade strategies can therefore not be distinguished by their blade products.

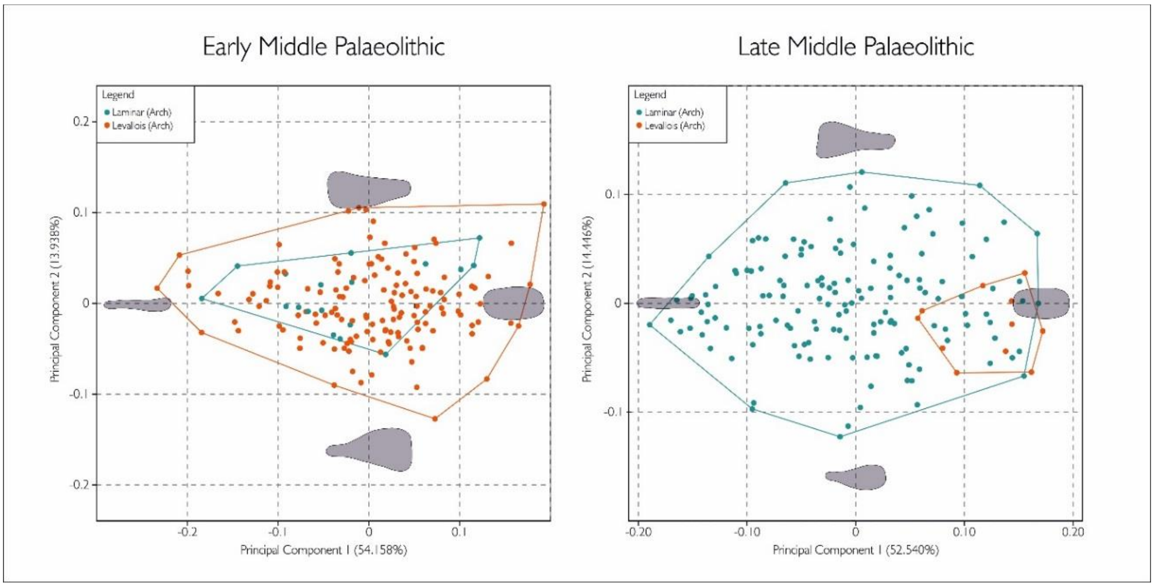


Figure 10.3. Principal Component Analysis (PCA) of Early and Late Middle Palaeolithic technological blade strategies (as analysed through the first two axes of shape variance)

For the Late Middle Palaeolithic, despite a small Levallois sample clear differences can be documented between the two technological blade strategies with a tight Levallois clustering and more positive PC1 values. Again, the two main sources of shape variation account for 66.986% accumulative shape variance, and are parallel to both the previous archaeological and experimental analyses. The results highlight Levallois blades are much wider and less elongated with convex lateral edges, and Laminar technological blades, while more tightly clustered towards more negative PC1 scores (elongated, narrower morphologies) also feature examples of two-dimensional morphologies akin to Levallois examples. MANOVA of 99.99% cumulative shape variance highlights that for the two groups in the Late Middle Palaeolithic, blade industries can be distinguished up to 95% confidence (*Wilks' lambda*: 0.6625, *F*: 1.49, *p*: 0.0521; *Pillai trace*: 0.3375, *F*: 1.49, *p*: 0.0521). More information on both analyses can be seen in the appendix.

Context (MOIS)	Levallois (mean)	SD	Laminar (mean)	SD	Difference
SVSS (8)	-	-	**0.38**	0.10	-
MSV (8)	**0.41**	0.27	0.55	0.27	+ 0.14
RIV (8)	**0.39**	0.08	-	-	-
CRY (8/7/6)	**0.38**	0.09	-	-	-
BKH (8/7)	**0.37**	0.11	-	-	-
RIIIB (7)	**0.41**	0.01	-	-	-
RIIIA (7)	**0.38**	0.10	0.48	0.03	+ 0.10
THR (7/6)	0.38	-	**0.49**	0.12	+ 0.11
ROC (5)	-	-	**0.52**	0.23	-
FAV (5)	0.32	0.07	**0.47**	0.15	+ 0.15
BSO (5)	0.36	0.09	**0.46**	0.14	+0.10
Experimental	0.29	0.10	0.36	0.12	+ 0.07
Key: Saint-Valery-sur-Somme (SVSS); Le Rissori IV (RIV); Mesvin IV (MSV); Crayford (CRY); Baker's Hole (BKH); Le Rissori IIIB (RIIIB); Le Rissori IIIA (RIIIA); Therdonne (THR); Rocourt (ROC); Fresnoy-au-Val S1 (FAV); Bettencourt-Saint-Ouen (BSO)					

Table 10.1. Flattening Index for the different archaeological and experimental contexts with the predominant blade strategy in bold

Throughout the lithic analyses, it was observed that there is a distinct difference in the flattening index of both technological blade strategies with Levallois blades producing a lower and more standardised flattening index, and by proxy a sharper edge angle (Figure 10.4). Clear differences can be documented through the mean flattening index of both technological blade strategies, with distinct differences in the strategies on an inter-context level. Even when artefacts which are harder to identify and assign to a specific strategy are discounted, distinct differences can be seen (Table 10.1), mirroring analyses of the experimental assemblage. The lower experimental values may represent the distinct decision to exhaust the cores, whereas many archaeological examples documented throughout do not appear exhausted.

A non-parametric test for statistical significance further demonstrates that the two technological blade strategies (unretouched and whole) can be distinguished in terms of their flattening index (Mann-Whitney U: 8601, z: -5.5305, permutated p: 0.0001), with Levallois blades featuring a more acute angle.

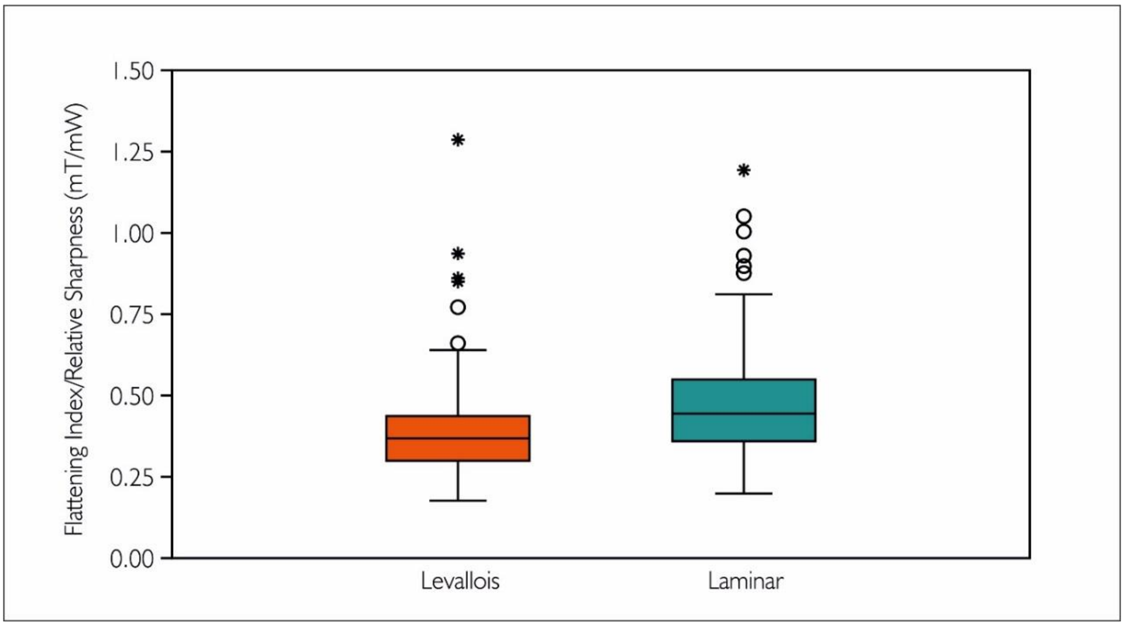


Figure 10.4. A box-plot of recorded Flattening Index/Relative Sharpness for archaeological examples of both Levallois (n = 154) and Laminar (n = 173) technological blade strategies

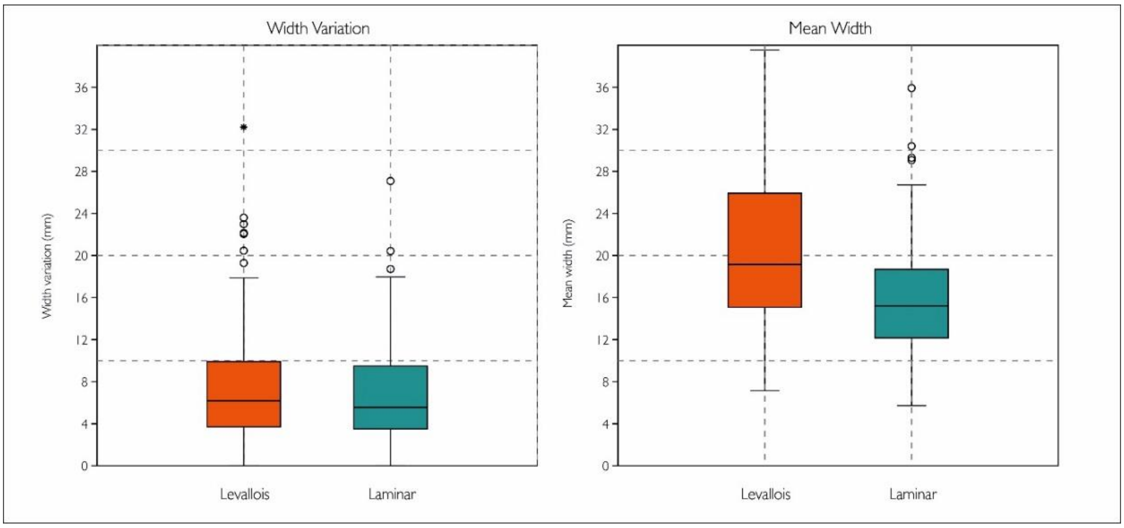


Figure 10.5. Two box-plots of width variation and mean widths for both Levallois (n = 154) and Laminar (n = 173) technological blade strategies

When examining edge regularity, as recorded through width variation, little width variation is documented with blades producing similar medians, ranges, and outliers (Figure 10.5), highlighting that despite differences in the shape both strategies provide a consistent width and cutting edge. This can be further demonstrated through similar PC2 values documented throughout the GM analyses, and through non-parametric analyses of the two strategies (*Mann-Whitney U*: 12300, *z*: -1.5625, *permutated p*: 0.1147). When mean width is considered, it is evident that Levallois blades produce a higher mean width, with larger blades documented throughout the archaeological evidence, and is echoed through experimental analyses (Chapter 6). This is further demonstrated through the geometric morphometric analyses with the first principal component representing elongation and width blade morphologies.

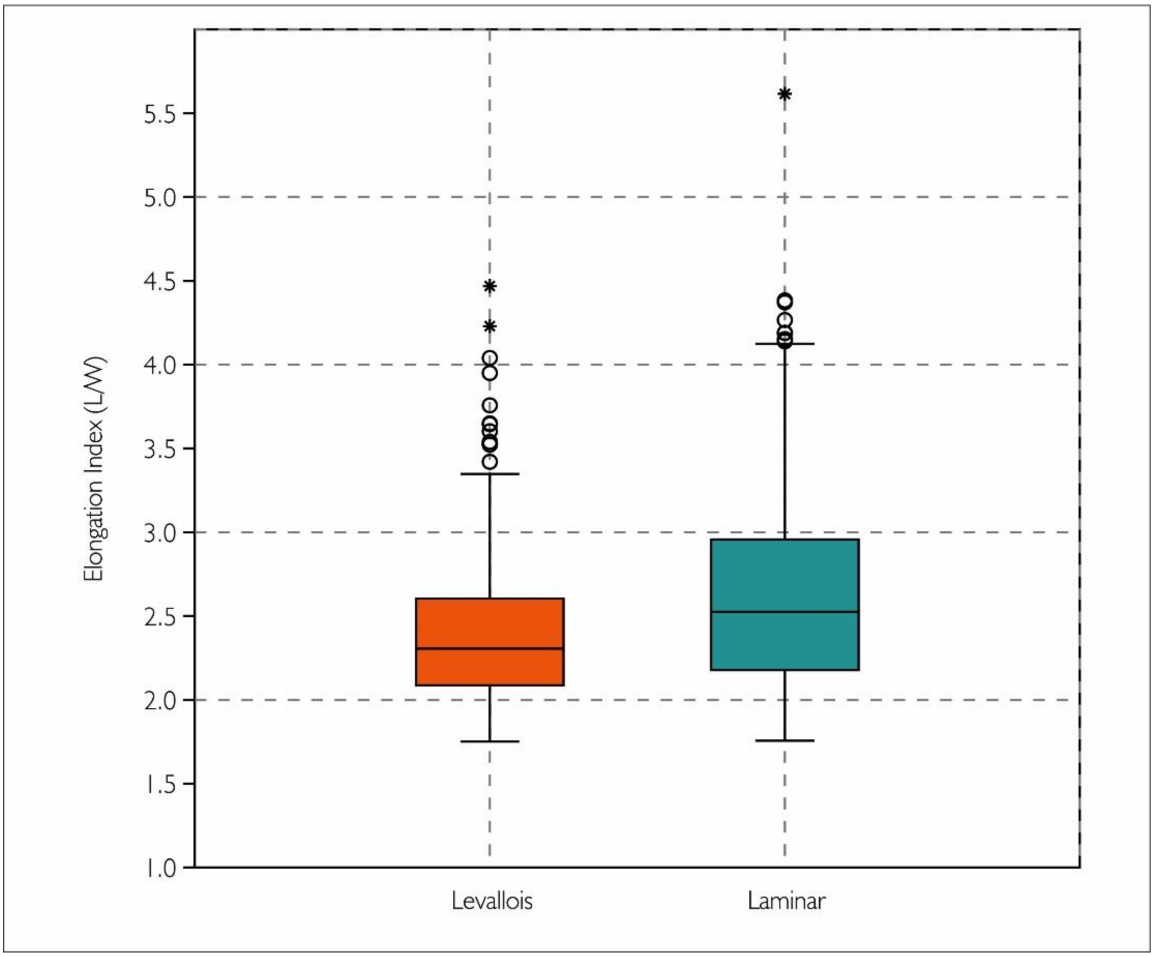


Figure 10.6. A box-plot of elongation index for both Levallois (n = 154) and Laminar (n = 173) archaeological technological blade strategies

Finally, elongation index was considered, both in the analyses of different technological strategies and their diachronic relationship (elongation over time). Analyses of the different strategies' elongation index highlights that Laminar technological blade strategies produce more elongated morphologies, with a higher mean, median, and outlier range (Figure 10.6). It also highlights that examples of Levallois blade strategies are relatively more standardised with a tighter box-plot distribution. Interesting the archaeological dataset produced close to the same main elongation indices as the experimental data, with mean elongation indices of 2.7 and 2.4 for Laminar and Levallois blades respectively (Experimental Lam: 2.8, Experimental Lev: 2.4). Non-parametric analyses further highlight that the elongation index for both technological strategies is statistically significant (*Mann-Whitney U:* 11411, *z*: -3.6975, *permutated p*: 0.0003).

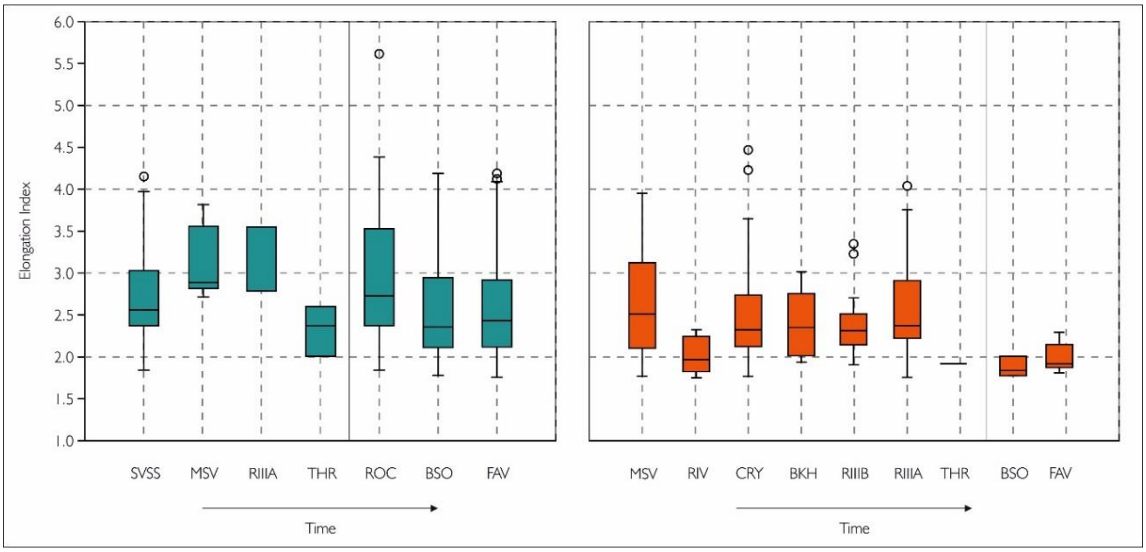


Figure 10.7. Box-plot ranges for both Levallois and Laminar technological blades within each archaeological context

When elongation is considered (Figure 10.7), it appears that there is no temporal relationship between the elongation index of Laminar blades. In contexts where large datasets of Laminar technological blades are available, it is evident that large ranges of elongated material is observed, with elongation indices up to 4:1. Furthermore in the Late Middle Palaeolithic examples, similar medians and ranges are apparent, particularly for the sites of Bettencourt-Saint-Ouen (N2B) and Fresnoy-au-Val (S1), two commonly cited in the Northwest Technocomplex. For Levallois blades, there appears to be a general trend with elongation indices increasing throughout the Early Middle Palaeolithic, with the exception of Mesvin (IV), before an abrupt change in the Therdonne (N3) and two Late Middle Palaeolithic examples analysed, where the extent for Levallois blades is far less. Additionally, despite appearing technologically similar, differences can be noted in the range of elongation indices recorded at Le Rissori (IIIA/IIIB), despite shared characteristics throughout.

10.2.2. Artefact Design Strategy #2: Aspects of Raw Material Economisation

Analyses of edge circumference highlight that in the one-hundred and fifty-four examples of unretouched whole Levallois blades analysed the average blade featured 214.69mm of cutting edge, producing a total of 33062.31mm cutting edge. In the one-hundred and seventy-one examples of unretouched Laminar blades analysed the average blade produced 183.68mm of cutting edge, and a total of 31408.47mm. The average Levallois blade features just over thirty millimetres (31.01mm) more cutting edge, with non-parametric analyses highlighting their difference (*Mann-Whitney U*: 9795, *z*: -3.9861, *permutated p*: 0.0002). As experimental analyses highlighted that Laminar cores could be further exhausted, producing smaller blades, it is assumed that the allometric relationship of these technologies influences the descriptive statistics above.

In terms of economic properties, through an examination of cutting edge per weight of stone, means of both Levallois and Laminar technological blade strategies highlight that Laminar technological blades are more economical in producing at least one-and-a-half more cutting edge per weight of stone (mm/g) in comparison to Levallois blades. Analyses of whole unretouched archaeological examples reveal that Laminar technological blades produce 1.58 times more cutting edge with the average Laminar blade producing 16.988 mm/g, and the average Levallois blade producing 10.753 mm/g (Table 10.2). Non-parametric analyses that these are statistically significant (*Mann-Whitney U*: 5417, *z*: -5.5713, *permutated p*: 0.0001), but the allometric relationship must be considered, given the existence of smaller Laminar blades, and an observed increase in cutting edge per weight of stone as the blade decreases (Chapter 6).

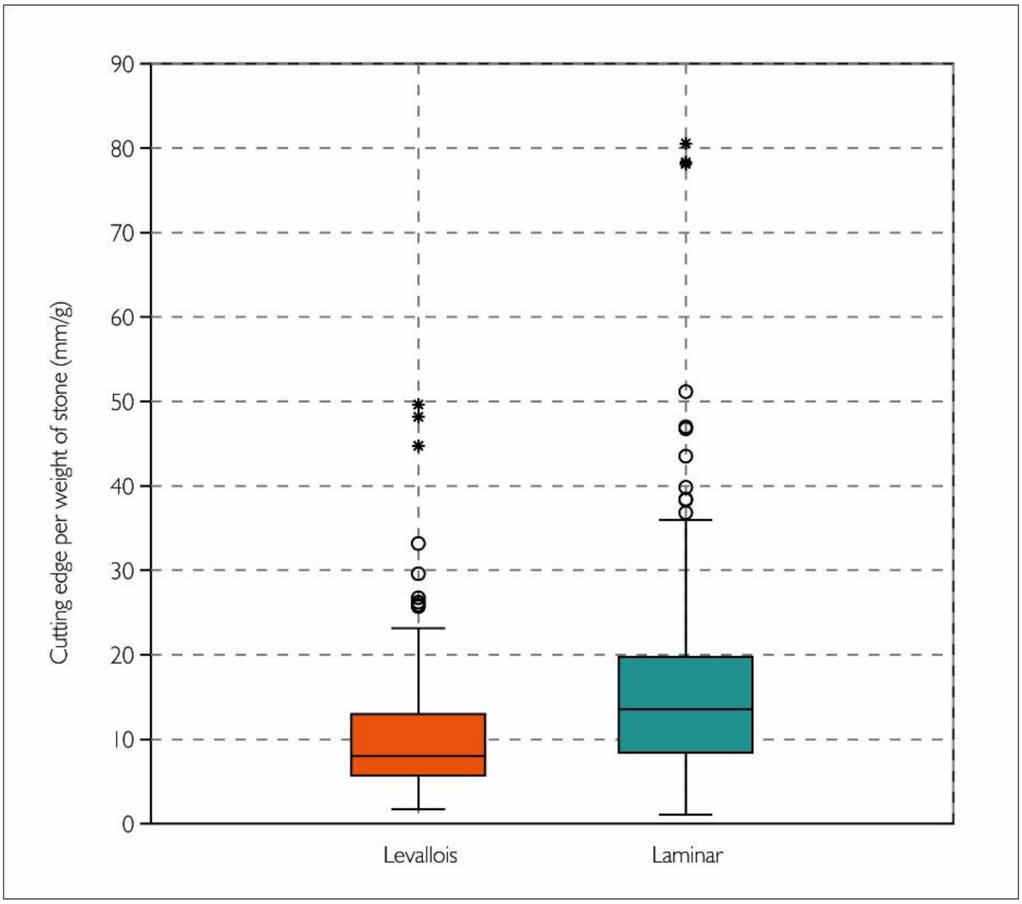


Figure 10.8. A box-plot displaying the cutting edge per weight of stone for both Levallois (n = 154) and Laminar (n = 173) technological blade strategies

Context (MOIS)	Laminar (mean mm/g)	Levallois (mean mm/g)	Difference
SVSS (8)	13.85	-	-
MSV (8)	10.90	5.48	x 1.99
RIV (8)	-	9.30	-
CRY (8/7/6)	-	7.54	-
BKH (8/7)	-	5.86	-
RIIIB (7)	-	9.09	-
RIIIA (7)	14.96	9.84	x 1.52
THR (7/6)	18.15	10.09	x 1.80
ROC (5)	17.97	-	-
FAV (5)	13.56	6.57	x 2.06
BSO (5)	18.22	7.53	x 2.42
Experimental	28.90	16.34	x 1.77
Key: Saint-Valery-sur-Somme (SVSS); Le Rissori IV (RIV); Mesvin IV (MSV); Crayford (CRY); Baker’s Hole (BKH); Le Rissori IIIB (RIIIB); Le Rissori IIIA (RIIIA); Therdonne (THR); Rocourt (ROC); Fresnoy-au-Val S1 (FAV); Bettencourt-Saint-Ouen (BSO)			

Table 10.2. Mean cutting edge per weight (mm/g) for each of the archaeological contexts discussed

When the individual archaeological contexts are examined, differences in economisation between the technological blade strategies can be better understood. Analyses highlight that in every instance Laminar technological blade strategies provide greater cutting edge per weight of stone, with almost double the amount of cutting edge per weight of stone documented in many instances. Throughout the Early Middle Palaeolithic, there is a general increase in the amount of cutting edge per weight of stone, exemplifying again the proficiency with which Levallois technological blade strategies are being produced, before a general decrease in the Late Middle Palaeolithic, perhaps exemplifying the lack of stereotyping and more fortuitous Levallois blade techniques in the contexts analysed. Analyses also highlight that the experimental and archaeological datasets agree in concluding that Laminar technological blades produce more cutting edge per weight of stone. Again, issues of sample size need to be addressed for a more robust interpretation however the evidence highlights that blade strategies appear to shift, throughout the Middle Palaeolithic to an increased amount of cutting edge per weight of stone, and thus a more economic method of producing usable edge.

10.2.3. Artefact Design Strategy #3: Standardisation and Blank Regularity

So far, traditional and geometric morphometric analyses have outlined important morphological characteristics with respect to the shape and nature of the archaeological blades examined, in isolation, with respect to the experimental dataset, and throughout the Middle Palaeolithic. Through this, commonalities and differences between the two methods of production have been outlined, in their shape, and their economisation of raw material. However, an important aspect to consider in artefact design strategy is product regularity and standardisation.

Through the geometric morphometric methodology undertaken, the key differences in shape were outlined. In this it was observed that, in terms of technology, irrespective of period, neither strategy appeared to be more standardised in terms of the two main sources of shape variation. 95% ellipses were not of varying size, with each strategy producing similar ranges, albeit with differences in spatial clustering, both positioned away from the mean shape (i.e. 0,0). This, however, contrasts the experimental evidence which suggested that Laminar technological blade strategies were more standardised as they converged to the overall mean shape, more so than with Levallois technological strategies. As the archaeological dataset features a more equal amount of both strategies (in contrast to the experimental dataset) irrespective of periodisation, not one strategy appears more standardised in two-dimensional shape.

In terms of the blade's dimensions, similar standard deviations were calculated for the blade's flattening index, with Levallois blades featuring a tight clustering in terms of its quartile ranges (Figure 10.4). For edge regularity, similar ranges were recorded in terms of width variation, with Laminar producing a more standardised (albeit smaller) mean width. And despite Laminar technological blades producing more elongated morphologies, Levallois blades produced a more standardised elongation index as exemplified through box-plots of the technologies, and their diachronic relationship. However, in each of these properties core exhaustion is important to consider. As Laminar technological blade strategies can be exhausted to a smaller volume of raw material, variations in the dimensions are going to be greater, and skew analyses of standard deviations and coefficient of variation values.

Context (MOIS)	Levallois breakage rate	Laminar breakage rate
SVSS (8)	-	48.12%
MSV (8)	28.21%	0.00%
RIV (8)	11.11%	-
CRY (8/7/6)	13.64%	-
BKH (8/7)	8.57%	-
RIIIB (7)	2.86%	-
RIIIA (7)	20.25%	0.00%
THR (7/6)	0.00%	20.00%
ROC (5)	-	50.00%
FAV (5)	6.67%	32.05%
BSO (5)	0.00%	18.69%
Key: Saint-Valery-sur-Somme (SVSS); Le Rissori IV (RIV); Mesvin IV (MSV); Crayford (CRY); Baker's Hole (BKH); Le Rissori IIIB (RIIIB); Le Rissori IIIA (RIIIA); Therdonne (THR); Rocourt (ROC); Fresnoy-au-Val S1 (FAV); Bettencourt-Saint-Ouen (BSO)		

Table 10.3. Breakage rates for blade *débitage* in each archaeological context

One important aspect to consider in product regularity is the success with which blades can be produced. Experimental analyses have already highlighted that when the two strategies are compared, similar breakage percentages occur with Levallois appearing to feature fewer breakages. This was advantageous for Laminar strategies given the large number of blades produced in contrast to Levallois technology (Chapter 6). When the individual contexts are analysed (Table 10.3) Laminar technological blade strategies feature a higher breakage rate, when the predominant technological blade strategy is analysed, or analysed alongside the other technological strategy. Examination of the previous chapters highlight that Levallois typically features a greater degree of facetting (see appendix for an overview of facetting indices), and this is expected given the differing availabilities of ridge, and thus control, associated with each technique. This, in conjunction with the degree of predetermination through surface hierarchy, may explain the higher success rate in whole blades through the Levallois technique. There are, however, a number of caveats which need to be appreciated. These include site recovery practice and the nature of the collections (e.g. controlled INRAP excavations at Fresnoy-au-Val and Bettencourt-Saint-Ouen vs. parts of collections in the IRSNB vs. selective material housed in the Baker's Hole and Crayford collections), the area excavated and site extent, and 3) aspects of raw material properties.

10.2.4. Discussion: An Assessment of Artefact Design Strategy

This analysis has provided a valuable insight into the morphology of blades produced and their behavioural potential, supporting conclusions from the experimental analysis. Levallois technological blade strategies are flatter (and sharper) and, with more convex lateral edges, producing larger blanks with more cutting edge per blank. Laminar technological blade strategies produce more cutting edge per weight of stone, are more elongated, and can be produced in greater number.

Analyses have highlighted chronological changes including increased proficiency in Levallois blade production until the Late Middle Palaeolithic with more standardised and elongated forms being produced throughout the Early Middle Palaeolithic, and similarities among contexts typically seen to be contemporary e.g. Northwest Technocomplex contexts.

10.3. Commonalities and Differences in Blade Behaviour: An Inter-Context Approach

In order to assess the extent behavioural potential can explain the changes in the relationship between Levallois and Laminar technological blade strategies, the true nature of technological variability among contexts featuring both periods need to be documented, in order to assess a goodness-of-fit. It is already observed that Late Middle Palaeolithic contexts exemplify a more Laminar-based approach, with the Early Middle Palaeolithic documenting a greater use of Levallois blades, but just how similar are the contexts of each period to each other? What technological differences are there? And how do sites in the Northwest Technocomplex compare?

Each strategy is discussed below regarding the four main comparative themes, as highlighted in Chapter Five. These are: 1) intensity of core and tool reduction, 2) core management strategy and core exploitation, 3) core surface dimensions and convexities, and 4) tool-kit morphology. These will then be synthesised and compared alongside other known archaeological contexts to discuss changing behaviours throughout the Middle Palaeolithic, providing a platform for an investigation of behavioural potential and the relevance of artefact design.

10.3.1. Inter-regional Comparisons of Middle Palaeolithic Levallois Blade Strategies

10.3.1.1. Inter-regional Comparisons #1: Intensity of Core and Tool Reduction

In examining intensity of core and tool reduction (Table 10.4), it is observed that, as assumed Early Middle Palaeolithic technological blade strategies feature greater retouch percentages, with examples in the Early Middle Palaeolithic featuring typically 40% retouch (Table 10.4). Two exceptions are evident: the contexts of Baker's Hole and Therdonne (N3). Baker's Hole features an atypically high retouch percentage, however as this is not from a controlled excavation and represents the selective recovery of artefacts from various pits and exposures the retouch ratio cannot be assumed to be credible. And at Therdonne (N3), a small count for Levallois blades is noted, with greater evidence for cores than products observed (Chapter 7). A similar observation is made when the cortical ratio of each assemblage is made, with lower ratios documented in the Late Middle Palaeolithic and the Therdonne (N3) context, with higher values throughout most contexts noted. All cores appear to feature the same degree of exhaustion, with no examples documented what could be classified as the total exhaustion of cores; however, as this is a subjective category, the cores may be considered exhausted to past populations. Examination of all contexts show that similar mean scar counts are noted throughout both periods of the Middle Palaeolithic. The data also highlights the stark similarities previously documented in Chapter Eight with respect to the Le Rissori (IIIA) and Le Rissori (IIIB) assemblages, with parallel retouch ratios and similar cortical ratios. While both are just parts of a much bigger collection the data here suggests at the similar behaviours apparent within both assemblages.

10.3.1.2. Inter-regional Comparisons #2: Core Management Strategy and Core Exploitation

Concerning the core management strategies utilised, comparative analyses suggest varying levels of preparation were undertaken in the exploitation of blades, with relatively low percentages of facetting documented for Early Middle Palaeolithic contexts including Mesvin (IV) and Le Rissori (IIIA) and Le Rissori (IIIB) and higher ratios for historic collections and mixed assemblages in the Middle Palaeolithic including Baker's Hole and Crayford (Table 10.5). It is assumed that archaeological biases and collection selectivity are again to account for these increased percentages. For the Late Middle Palaeolithic, extremes are again exemplified, with varying percentages noted in Therdonne (N3), Fresnoy-au-Val (S1) and Bettencourt-Saint-Ouen (N2B). This may reflect a lack of standardisation with a more Laminar-centric strategy, however as these represent much smaller collections, only limited interpretations are permitted.

With respect to the Levallois preparation strategies utilised, a convergent unidirectional is common, with centripetal-dominant examples observed within the Baker's Hole collection and Late Middle Palaeolithic contexts. Like previously noted observations, both Le Rissori (IIIA) and Le Rissori (IIIB) feature a common Levallois preparation strategy, both favouring a convergent unidirectional technique. In the examination of exploitation strategies, no common preferred method is observed throughout the assemblages, or within the individual periods of the Middle Palaeolithic.

10.3.1.3. Inter-regional Comparisons #3: Core Surface Dimensions and Convexity

Comparative analyses of Levallois core surface dimension and convexities (Table 10.6) highlight characteristics associated with Levallois technological blade strategies, challenges other previously assumed characteristics, in addition to highlighting the diversity of different morphologies utilised.

Comparative analyses of blank profile convexities highlight that, with the exception of Therdonne (N3), blanks are relatively straight with high percentages documented. However, as the categorical data homogenises a variety of different curvature degrees, slight curvature is not highlighted. Observational analyses throughout highlight that Levallois blades feature minor curvature, demonstrating the 'peeling off' of Levallois blades, producing core morphologies with a convex exploitation surface. Again, similarities between the two Rissori III contexts are documented, with similar convexities complimenting similar elongation and flattening indices, demonstrating similar core morphologies.

Interestingly, most blades produced throughout are triangular or trapezoidal, perhaps emphasising the importance of ridge centrality and ridge accentuation in the exploitation of blade production. Despite viewed as a typical characteristic of Levallois blade production (Bar-Yosef and Kuhn, 1999), plano-convex cross-sections only feature a small percentage of blades documented throughout.

10.3.1.4. Inter-regional Comparisons #4: Tool-kit Morphology

Analyses of tool-kit morphology have been detailed extensively throughout the traditional and geometric morphometric frameworks, with differences in two-dimensional planform shape noted, breakage rates, and contrasting elongation and flattening indices between the blade strategies throughout the Palaeolithic.

Further inter-regional analyses, specifically on the dorsal scar pattern highlight the dominant use of a unidirectional Levallois technique in almost all Early Middle Palaeolithic contexts, with the exception of Therdonne (N3) (note the incredibly low sample size). This unidirectional scar pattern contrasts the diversity of dominant exploitation strategies documented in section 10.3.1.2. This is discussed more in Chapter 11.

In all examples of contexts featuring retouch on Levallois blades, continuous scraper-edge retouch, in association with high quantities of denticulate and notch-based morphologies of retouch dominate, highlighting their transformable nature.

10.3.2. Inter-regional Comparisons of Middle Palaeolithic Laminar Blade Strategies

10.3.2.1. Inter-regional Comparisons #1: Intensity of Core and Tool Reduction

Analyses of core and tool reduction/intensity demonstrate that throughout the Middle Palaeolithic Laminar technological blade strategies feature low retouch percentages, lower than a fifth of all blades examined (Table 10.8). Comparative analyses also highlight the relatively high percentages of cortical blades in the Early Middle Palaeolithic, and lower quantities in the Late Middle Palaeolithic. These values, however, may reflect the hypothetical transportation of desired blades (and cores) following their production at contexts such as Saint-Valery-sur-Somme, and potentially Le Rissori in the Early Middle Palaeolithic, and examples including Rocourt during the Late Middle Palaeolithic.

With respect to core exhaustion, it was documented throughout that the cores could have been exploited further if needed. Examples of raw material being tested appears to have been observed at contexts including Rissori and Fresnoy-au-Val (S1), whereas in other examples such as Saint-Valery-sur-Somme and Therdonne (N3), it appears that the cores were reduced to much greater intensity. One thing worth nothing is the similar composition of variables for sites categorised within the Northwest Technocomplex i.e. Rocourt, Fresnoy-au-Val (S1), and Bettencourt-Saint-Ouen (N2B), and particularly contexts within the same landscape i.e. Fresnoy-au-Val (S1) and Bettencourt-Saint-Ouen (N2B).

10.3.2.2. Inter-regional Comparisons #2: Core Management Strategy and Core Exploitation

Comparative analyses of Laminar core volume management strategies (Table 10.9) demonstrate the graduality of anthropogenic cresting documented throughout the assemblages, from the natural exploitation of ridges at Saint-Valery-sur-Somme, and possible hints of semi-cresting at Mesvin (IV), to increased evidence within Le Rissori (IIIA), Le Rissori (IIIB) and Therdonne (N3) assemblages before the more formal cresting (as initial preparation and as rejuvenation), utilising both faces in the Late Middle Palaeolithic. Only Bettencourt-Saint-Ouen (N2B) was here documented to demonstrate the transformation of crested blades following their exploitation.

Analyses also highlight the increased use of facetting and platform preparation in the Late Middle Palaeolithic, with Saint-Valery-sur-Somme representing the only contexts to document platform facetting. It is possible that increased platform preparation documented at Saint-Valery-sur-Somme further represents the fusion of Levallois behaviours within a Laminar technique, as discussed in Chapter 7.

While there is no marked change in the dominant exploitation strategy, analyses suggest that in the Late Middle Palaeolithic examples, and Therdonne (N3) demonstrate increased core circumference exploitation in comparison to earlier contexts through semi-rotating and rotating techniques, with certain contexts e.g. Rocourt demonstrating the use of multiple core volume management strategies on the same raw material. Again, interpretative caution is needed given the lack of evidence for the 'core' at Saint-Valery-sur-Somme, the extent of evidence within refits for later examples, and issues of samples and representation for some of the sites discussed. The evidence does, however, suggest that while the Early Middle Palaeolithic features hallmarks associated with Laminar technology, it is only during the Late Middle Palaeolithic when these techniques become more proceduralised and flexible within the Neanderthal toolkit.

10.3.2.3. Inter-regional Comparisons #3: Core Surface Dimensions and Convexity

Comparative analyses highlight a contrast between more elongated Laminar cores in the Late Middle Palaeolithic MOIS 5 examples, and the shorter examples documented throughout the Early Middle Palaeolithic (Table 10.10). Again, analyses highlight that Therdonne (N3) represents more of a Late Middle Palaeolithic 'style' of Laminar blade production system, and almost identical core elongation indices for the two commonly cited Northwest Technocomplex examples of Fresnoy-au-Val (S1) and Bettencourt-Saint-Ouen (N2B). Interestingly, Rocourt features a higher elongation index for both cores and blades (see below), perhaps suggestive of the preference for on-site elongated nodules. Similar lateral and curvature convexities for both Fresnoy-au-Val (S1) and Bettencourt-Saint-Ouen (N2B) are also documented with similar proportions of cross-section types and blank profiles. Analyses of blank profiles highlight that, while straight profiles are typical, there is an increased amount of curved convexities, typically associated with unidirectional pyramidal blade cores, and overshot blades as a form of rejuvenation.

10.3.2.4. Inter-regional Comparisons #4: Tool-kit Morphology

Comparative analyses (Table 10.11) highlight many of the morphological characteristics noted in previous sections, including the relatively high elongation index proceeding through the Middle Palaeolithic, and the relatively high flattening index in comparison to Levallois technological blade strategies. Analyses further highlight technological attributes also prescribed above, particularly the relatively high breakage rates in comparison to the Levallois technique.

One of the more striking differences as observed through the lithic analyses are examples of 'Upper Palaeolithic' retouch types documented in the MOIS 5 contexts, specifically the use of burins and end-scrapers. With the exception of Saint-Valery-sur-Somme, all other Early Middle Palaeolithic examples feature no retouch. Even then, the retouch at Saint-Valery is non-invasive, with little coverage, matching many of the later MOIS 5 contexts, despite the lack of Upper Palaeolithic retouch types.

Context (see legend)	MSV	RIV*	BKH	CRY**	RIIIB**	RIIIA**	THR*	FAV*/**	BSO*/**
MOIS	8	8	8/7	8/7/6	7	7	7/6	5	5
Retouch Ratio (whole)	0.39	0.44	0.84	0.42	0.46	0.46	0.00	0.07	0.00
Cortical Ratio (whole)	0.29	0.22	0.06	0.18	0.27	0.30	0.00	0.07	0.18
Core Exhaustion (Henry's Dimensional)	Slight core exhaustion	N/A	Slight core exhaustion	N/A	Slight core exhaustion	Slight core exhaustion	Slight core exhaustion	Slight core exhaustion	N/A
Core Scar Count (mean)	13.33 (n = 6)	N/A	12.2 (n = 5)	N/A	13.00 (n = 9)	13.25 (n = 4)	13.83 (n = 6)	13.93 (n = 5)	N/A

*sample size = n < 30 ; **part collection analysed
Key: Saint-Valery-sur-Somme (SVSS); Le Rissori IV (RIV); Mesvin IV (MSV); Crayford (CRY); Baker's Hole (BKH); Le Rissori IIIB (RIIIB); Le Rissori IIIA (RIIIA); Therdonne (THR); Rocourt (ROC); Fresnoy-au-Val S1 (FAV); Bettencourt-Saint-Ouen (BSO)

Table 10.4. Measures of core and tool reduction/intensity for archaeological contexts featuring Levallois technological blade strategies

Context (see legend)	MSV	RIV*	BKH	CRY**	RIIIB**	RIIIA**	THR*	FAV*/**	BSO*/**
MOIS	8	8	8/7	8/7/6	7	7	7/6	5	5
Platform Preparation Ratio	0.29	0.00	0.66	0.46	0.11	0.16	1.00	0.60	0.18
Dominant Levallois Preparation Strategy	Convergent Unidirectional	N/A	Centripetal	N/A	Convergent Unidirectional	Convergent Unidirectional	Centripetal	Centripetal	N/A
Dominant Levallois Exploitation Strategy	Bidirectional	N/A	Unidirectional	N/A	Unidirectional	Mixed	Unidirectional	Bidirectional	N/A

*sample size = n < 30 ; **part collection analysed
Key: Saint-Valery-sur-Somme (SVSS); Le Rissori IV (RIV); Mesvin IV (MSV); Crayford (CRY); Baker's Hole (BKH); Le Rissori IIIB (RIIIB); Le Rissori IIIA (RIIIA); Therdonne (THR); Rocourt (ROC); Fresnoy-au-Val S1 (FAV); Bettencourt-Saint-Ouen (BSO)

Table 10.5. Measures of core management strategies for archaeological contexts featuring Levallois technological blade strategies

Context (see legend)	MSV	RIV*	BKH	CRY**	RIIIB**	RIIIA**	THR*	FAV*/**	BSO*/**
MOIS	8	8	8/7	8/7/6	7	7	7/6	5	5
Core Flattening Index (mT/mW)	0.51 (n = 6)	N/A	0.47 (n = 5)	N/A	0.79 (n = 9)	0.95 (n = 4)	0.28 (n = 6)	0.44 (n = 6)	N/A
Core Elongation Index (mL/mW)	0.43 (n = 6)	N/A	1.48 (n = 5)	N/A	0.72 (n = 9)	0.83 (n = 4)	1.17 (n = 6)	1.71 (n = 6)	N/A
Curvature of Convexity: Blank Profile	S: 91% C: 3% T: 6%	S: 62% C: 13% T: 25%	S: 84% C: 13% T: 3%	S: 90% C: 8% T: 2%	S: 65% C: 25% T: 10%	S: 65% C: 30% T: 5%	S: 0% C: 100% T: 0%	S: 71% C: 22% T: 7%	S: 91% C: 9% T: 0%
Lateral Convexity: Blank Cross-section	Tri: 45% Trap: 14% PC: 5% O: 46%	Tri: 13% Trap: 44% PC: 5% O: 37%	Tri: 25% Trap: 19% PC: 9% O: 47%	Tri: 37% Trap: 12% PC: 0% O: 51%	Tri: 37% Trap: 12% PC: 0% O: 51%	Tri: 29% Trap: 24% PC: 0% O: 47%	Tri: 0% Trap: 100% PC: 0% O: 0%	Tri: 36% Trap: 7% PC: 7% O: 50%	Tri: 46% Trap: 18% PC: 0% O: 36%

*sample size = n < 30 ; **part collection analysed
Key: Saint-Valery-sur-Somme (SVSS); Le Rissori IV (RIV); Mesvin IV (MSV); Crayford (CRY); Baker's Hole (BKH); Le Rissori IIIB (RIIIB); Le Rissori IIIA (RIIIA); Therdonne (THR); Rocourt (ROC); Fresnoy-au-Val S1 (FAV); Bettencourt-Saint-Ouen (BSO)

Table 10.6. Measures of core surface dimensions and convexities for archaeological contexts featuring Levallois technological blade strategies

Context (see legend)	MSV	RIV*	BKH	CRY**	RIIIB**	RIIIA**	THR*	FAV*/**	BSO*/**
MOIS	8	8	8/7	8/7/6	7	7	7/6	5	5
Breakage Index Ratio	0.28	0.11	0.09	0.14	0.03	0.20	0.00	0.07	0.00
Elongation Index Ratio	2.39	2.08	2.34	2.48	2.28	2.51	1.92	1.97	1.85
Flattening Index Ratio	0.41	0.39	0.37	0.38	0.41	0.38	0.38	0.32	0.26
Dominant Blade Scar Direction	Uni.	Uni.	Uni.	Uni.	Uni.	Uni.	3-way Centripetal	Bi.	Bi.
Dominant Retouch Morphology	Scaled	Scaled	Scaled	Scaled	Scaled	Scaled	N/A	Scaled	N/A
Dominant Retouch Position	Direct	Direct	Direct	Direct	Direct	Direct	N/A	Direct	N/A
Dominant Retouch Distribution	Continuous	Continuous	Continuous	Continuous	Continuous	Continuous	N/A	Continuous	N/A

*sample size = n < 30 ; **part collection analysed
Key: Saint-Valery-sur-Somme (SVSS); Le Rissori IV (RIV); Mesvin IV (MSV); Crayford (CRY); Baker's Hole (BKH); Le Rissori IIIB (RIIIB); Le Rissori IIIA (RIIIA); Therdonne (THR); Rocourt (ROC); Fresnoy-au-Val S1 (FAV); Bettencourt-Saint-Ouen (BSO)

Table 10.7. Measures of tool-kit morphology for archaeological contexts featuring Levallois technological blade strategies

Context (see legend)	SVSS	MSV*	CRY*/**	RIIIB*	RIIIA*	THR*	ROC	FAV**	BSO**
MOIS	8	8	8/7/6	7	7	7/6	5	5	5
Retouch Ratio (whole)	0.18	0.00	N/A	N/A	0.00	0.00	0.13	0.04	0.07
Cortical Ratio (whole)	0.31	0.00	N/A	N/A	1.00	0.40	0.44	0.27	0.33
Core Exhaustion (Henry's Dimensional)	Exhaustion?	Slight core exhaustion	Slight core exhaustion	Slight core exhaustion	Slight core exhaustion	Slight core exhaustion	Mixed	Slight core exhaustion	Slight core exhaustion
Core Scar Count (mean)	N/A	15.25 (n = 4)	9.00 (n = 1)	9.25 (n = 3)	8.00 (n = 1)	16.67 (n = 3)	8.40 (n = 5)	11.20 (n = 15)	13.00 (n = 18)
*sample size = n < 30 ; **part collection analysed Key: Saint-Valery-sur-Somme (SVSS); Le Rissori IV (RIV); Mesvin IV (MSV); Crayford (CRY); Baker's Hole (BKH); Le Rissori IIIB (RIIIB); Le Rissori IIIA (RIIIA); Therdonne (THR); Rocourt (ROC); Fresnoy-au-Val S1 (FAV); Bettencourt-Saint-Ouen (BSO)									

Table 10.8. Measures of core and tool reduction/intensity for archaeological contexts featuring Laminar technological blade strategies.

Context (see legend)	SVSS	MSV*	CRY*/**	RIIIB*	RIIIA*	THR*	ROC	FAV**	BSO**
MOIS	8	8	8/7/6	7	7	7/6	5	5	5
Presence of crested blades	N	Y?	N	Y	Y	Y	Y	Y	Y
Presence of…									
Lame à crête	N	N	N	N	Y	N	Y	Y	Y
Lame à demi-crête/crête partielle	N	Y?	N	Y	N	Y	Y	Y	Y
Retouched *lame à (demi-)crête*	N	N	N	N	N	N	N	N	Y
Platform Preparation Ratio	0.26	0.00	N/A	N/A	0.00	0.00	0.09	0.21	0.11
Dominant Volume Strategy (R: rotating; Sr: semi-rotating; Fa: facial; Fr: frontal)	R(?)	Fa	Sr?	Fa	Fa	Sr	Sr	Sr	Sr
Dominant Exploitation Strategy	Bidirectional	Unidirectional	Bidirectional	Unidirectional	Unidirectional	Bidirectional	Unidirectional	Bidirectional	Mixed
*sample size = n < 30 ' **part collection analysed Key: Saint-Valery-sur-Somme (SVSS); Le Rissori IV (RIV); Mesvin IV (MSV); Crayford (CRY); Baker's Hole (BKH); Le Rissori IIIB (RIIIB); Le Rissori IIIA (RIIIA); Therdonne (THR); Rocourt (ROC); Fresnoy-au-Val S1 (FAV); Bettencourt-Saint-Ouen (BSO)									

Table 10.9. Measures of core management strategies for archaeological contexts featuring Laminar technological blade strategies

Context (see legend)	SVSS	MSV*	CRY*/**	RIIIB*	RIIIA*	THR*	ROC	FAV**	BSO**
MOIS	8	8	8/7/6	7	7	7/6	5	5	5
Core Elongation Index (mL/mW)	N/A	1.58 (n = 4)	1.04 (n = 1)	0.82 (n = 3)	0.93 (n = 1)	1.43 (n = 3)	2.12 (n = 5)	1.71 (n = 15)	1.70 (n = 18)
Curvature of Convexity: Blank Profile	S: 83% C: 13% T: 4%	S: 100% C: 0% T: 0%	S: N/A C: N/A T: N/A	S: N/A C: N/A T: N/A	S: 100% C: 0% T: 0%	S: 50% C: 0% T: 50%	S: 76% C: 21% T: 3%	S: 79% C: 13% T: 8%	S: 55% C: 35% T: 10%
Lateral Convexity: Blank Cross-section	Tri: 36% Trap: 11% PC: 11% O: 42%	Tri: 100% Trap: 0% PC: 0% O: 0%	Tri: N/A Trap: N/A PC: N/A O: N/A	Tri: N/A Trap: N/A PC: N/A O: N/A	Tri: 50% Trap: 0% PC: 0% O: 50%	Tri: 50% Trap: 25% PC: 0% O: 25%	Tri: 49% Trap: 6% PC: 0% O: 46%	Tri: 40% Trap: 15% PC: 4% O: 41%	Tri: 55% Trap: 18% PC: 0% O: 27%
*sample size = n < 30 ; **part collection analysed Key: Saint-Valery-sur-Somme (SVSS); Le Rissori IV (RIV); Mesvin IV (MSV); Crayford (CRY); Baker's Hole (BKH); Le Rissori IIIB (RIIIB); Le Rissori IIIA (RIIIA); Therdonne (THR); Rocourt (ROC); Fresnoy-au-Val S1 (FAV); Bettencourt-Saint-Ouen (BSO)									

Table 10.10. Measures of core surface dimensions and convexities for archaeological contexts featuring Laminar technological blade strategies

Context (see legend)	SVSS	MSV*	CRY*/**	RIIIB*	RIIIA*	THR*	ROC	FAV**	BSO**
MOIS	8	8	8/7/6	7	7	7/6	5	5	5
Breakage Index	0.48	0.00	N/A	N/A	0.00	0.20	0.50	0.32	0.19
Elongation Index	2.71	2.90	N/A	N/A	3.17	2.37	2.98	2.62	2.55
Flattening Index	0.38	0.55	N/A	N/A	0.48	0.49	0.52	0.47	0.46
Dominant Blade Scar Direction	Uni.	Uni.	N/A	N/A	N/A	Uni.	Uni.	Uni.	Uni.
Dominant Retouch Morphology	Scaled	N/A	N/A	N/A	N/A	No retouch	Scale/burin	Scaled/ stepped	Notch-based
Dominant Retouch Position	Direct	N/A	N/A	N/A	N/A	No retouch	Proximal	Mixed	Direct
Dominant Retouch Distribution	Discontinous	N/A	N/A	N/A	N/A	No retouch	Continuous	Continuous	Continuous
*sample size = n < 30 ; **part collection analysed Key: Saint-Valery-sur-Somme (SVSS); Le Rissori IV (RIV); Mesvin IV (MSV); Crayford (CRY); Baker's Hole (BKH); Le Rissori IIIB (RIIIB); Le Rissori IIIA (RIIIA); Therdonne (THR); Rocourt (ROC); Fresnoy-au-Val S1 (FAV); Bettencourt-Saint-Ouen (BSO)									

Table 10.11. Measures of tool-kit morphology for archaeological contexts featuring Laminar technological blade strategies

10.3.3. Discussion and Summary

The comparative analyses of both Levallois and Laminar technological blade strategies have provided an important role in synthesising the changes apparent throughout the lithic analysis chapters. The four-fold assessment has been instrumental in highlighting commonalities and differences in the character of technological blade strategies throughout the Middle Palaeolithic. Specifically, analyses highlight the increasing proficiency of the Levallois technique throughout the Early Middle Palaeolithic before their observed change in the Late Middle Palaeolithic, and how Laminar technological blade strategies have not necessarily evolved in a discrete step-like model, but rather extended in their proceduralisation, intensity, and amount, building on from already known techniques.

In analysing the attributes of Laminar blade technology, analyses have highlighted the true degree of similarity between contexts within MOIS 5 (and sometimes differences between MOIS 5 sites in the Somme valley and Rocourt), the existence of processes including cresting, the use of various management strategies, the lack of invasive retouch on Laminar examples throughout the Middle Palaeolithic, in addition to their limited, but present, evidence within Levallois-rich technological blade strategies within the Early Middle Palaeolithic. In their morphology, the analyses have further highlighted attributes including consistently higher flattening index, in comparison to Levallois technological blade strategies, and the increased elongation index of Laminar cores throughout the Middle Palaeolithic.

With respect to Levallois technological blade strategies, analyses have described and assessed the character and nature of many technological behaviours including the informality of Levallois blade production systems within the Late Middle Palaeolithic, the high degree of product modification within the Early Middle Palaeolithic, and similarities in the composition of Le Rissori (IIIA) and Le Rissori (IIIB) in terms of their technological blade composition.

These aspects in conjunction with a thorough appreciation of commonalities differences in the morphology of Levallois and Laminar technological blade strategies now permit an assessment of Neanderthal technological and social behaviour through the behavioural potential of the different blade technologies within their Middle Palaeolithic contexts.

Chapter Eleven
Discussion: Understanding Middle Palaeolithic Blade Strategies

11.1. Introduction

Over the last four chapters the archaeological data from a number of blade-bearing contexts have been detailed, analysed through their technological and morphometric attributes, and cross-examined, in relation to other sites analysed, and with respect to the experimental framework discussed in Chapter 6. Through this, many commonalities and differences between the different contexts and blade strategies were detailed in order to assess the influence of whether aspects of artefact design and the behavioural potential of artefacts were important when considering Neanderthal technological and social behaviour, as demonstrated through the archaeological evidence.

In this section, consistencies of behaviour are discussed with respect to social transmission and diachronic change, in assessing the extent that spatio-temporal traditions of social learning influence and change over time influences the variability demonstrated. Regarding Chapters 6 and 10, aspects of artefact design and the role of raw material variability are then discussed, with the main 'potentials' for each respective strategy discussed. This chapter then concludes by relating technological variability of blade production to the triangle of technological variability as discussed in Chapter 1, and the extent that consistencies in behaviour and variability throughout the Middle Palaeolithic are attributes to notions of function, culture and social transmission, and diachronic change. Technological blade variability can be partially explained through the rationale of function, although other ideas need to be considered, including the plasticity of Neanderthal behaviour and the plasticity of both blade production methods. Throughout, the limitations of the data analysis, and thus the interpretations outlined, are detailed before being addressed further in the concluding chapter.

11.2. The Interpretive Potential of Middle Palaeolithic Technological Blade Strategies

This thesis has documented the most extensive and complete record for the nature and distribution for Levallois and Laminar technological blade strategies throughout the Lower and Middle Palaeolithic. The detailed account of available evidence in Chapter 4 highlights that previous studies (Bar-Yosef and Kuhn, 1999; Delagnes, 2000; Meignen, 2000; Kozlowski, 2001) were just the beginning of much-needed investigations into their nature and distribution throughout Eurasia and Africa. With this now-known dataset, there is a great opportunity to develop a robust spatio-temporal framework for both blade strategies throughout the Lower and Middle Palaeolithic, and differences and commonalities between techniques used in their earliest instances over half a million years ago, their Late Middle Palaeolithic counterparts and everything in between. There is also now an opportunity to thoroughly assess differences in technological blade behaviour within different hominins (Modern Human vs. Neanderthal vs. Contemporary Neanderthal vs. pre-Neanderthal populations) and differences in the associated toolkit of blade production systems. This thesis has provided just a snapshot of Neanderthal technological and social behaviour within one sub-region, and while the discussion can now be referenced alongside evidence in other regions, there is now an opportunity for a larger, more robust, analysis at varying scales of resolution.

11.3. Assessing the Nature of Diachronic Change and Social Transmission among Middle Palaeolithic Technological Blade Strategies and Populations

In investigating spatio-temporal traditions of social learning and consistencies in behaviour throughout the Middle Palaeolithic, and understanding the nature of change throughout, a number of problems are evident. These include: 1) the longevity of the period in question, spanning over two-hundred thousand years; 2) the fragmentary nature of the archaeological evidence for the Middle Palaeolithic (Turq et al., 2013), owing to archaeological bias, the movement of artefacts, and curatorial issues (collections over multiple museums), 3) the periods of possible hiatus, absence and population decline during specific stages of the Middle Palaeolithic; 4) the large area under investigation. Despite this, the technological and morphometric framework has highlighted a large number of technological consistencies.

Analyses of the archaeological data strengthen a trend observed in Chapter 4, with a high-Levallois/low-Laminar blade ratio in the Early Middle Palaeolithic, and a high-Laminar and low-

Levallois blade ratio in north-west Europe documented. Generally, the less-common strategy in each case is more informal, with the majority of Laminar cores from within the Early Middle Palaeolithic featuring a shorter sequence of blade reduction, with little platform preparation, rejuvenation and sequence depth (as determined through core preparation, rejuvenation and a low Laminar count). Similarly, for Levallois blades documented between c. 130,000-71,000 BP, blade cores appear more fortuitous, with products more irregular in comparison to the Early Middle Palaeolithic.

Comparative analyses of the lithic data on a broad temporal-resolution also highlight a number of commonalities and shared technological behaviours for both strategies. These include, for the Early Middle Palaeolithic, general patterns in the transformation of Levallois artefacts with Levallois blade-rich contexts featuring a high-retouch percentage (c.40%), rich in notches and denticulates, and scaled retouch, both continuous in nature. This differs from Laminar technology in the Early Middle Palaeolithic, where more fortuitous non-invasive retouch is documented. In addition, analyses have highlighted general patterns in the adoption and transformation of *éclats débordants,* as with Levallois blades, within the same assemblage (despite difficulties in attributing some pieces to one or the other technique). Similarities in the morphology (see below), scar count, and degree of exhaustion for both strategies were also noted.

Exceptions to this dichotomy, of a non-extended to extended approach to Laminar technology throughout the Middle Palaeolithic, do exist. This includes the adoption of Levallois-based behaviours within a Laminar technological sequence at Saint-Valery-sur-Somme (Chapter 7), and despite a low blade count for both strategies, the extended nature of Laminar cores documented at Therdonne (N3). In this model, both technological and morphometric analyses highlight the N3 layer as representing an intermediate between both Middle Palaeolithic periods, with a lack of retouched Levallois blades and an extended sequence of semi-rotating blade production akin to MOIS 5 examples documented. Other exceptions to the rule have also been noted within the wider literature, including the extended use of both strategies at Angé (Locht et al., 2008a), and the extensive use of Laminar blade strategies within the Early Middle Palaeolithic of Western Asia (Barkai et al., 2005, 2009). This pattern is perhaps exclusively European in nature, given the shift to a low-Laminar Late Middle Palaeolithic in Western Asia.

A number of other temporal relationships or trends have also been documented throughout this thesis. These include for Levallois blade production, increasing blank elongation, product standardisation, and technological competency for Levallois products throughout the Early

Middle Palaeolithic. For Laminar blade production, increasing core elongation, the increasing use of cresting as the initiation of the blade sequence, and the increased use of core maintenance strategies were documented. These trends in increasing elongation and standardisation demonstrate the competency with which Neanderthals could transform raw material into a homothetic core configuration through careful consideration of the core's geometry. Both strategies not only demonstrate increasing skill or accumulated technological behaviour in the ability to produce increased numbers of increasingly elongated products, but also the ability for Neanderthals to problem-solve and react to problems in the production of blades, using the cumulative knowledge Neanderthals possess.

While changes in blade technology may not be reflective of technological evolution through a step-like saltationist model *per se,* as Révillion (1995) argues, they may still have some chronological meaning. The increasing technological plasticity and suites of technological behaviour demonstrate that, while all contexts at present cannot be attributed to one continuous tradition of social learning, the accumulated knowledge highlights a temporal dimension and possible relationship from more 'direct' examples of blade production to examples as seen in MOIS 5, throughout both glacial and interglacial periods. Perhaps this last fact, that both blade strategies can be documented in cold steppe-like and warmer open periods, highlight the problem in explaining either strategy through large-scale ecological and environmental factors.

On a higher-resolution scale of analysis, technological and morphometric analyses have further highlighted several behavioural consistencies between contexts of the Somme Valley and potentially further afield, and within sequences in Belgium and the UK. Chapter 7 documented two Laminar-rich blade industries in the Somme Valley both dating to MOIS 5a: Bettencourt-Saint-Ouen (N2B) and Fresnoy-au-Val (Série 1). As inter-context analyses (Chapter 10) demonstrated, both sites feature a number of parallel behaviours and artefact commonalities. These include similar blade and core elongation indices, similar cortical and retouch ratios, and similar preparation and exploitation strategies, all on locally sourced high-quality flint. Furthermore, similarities in the toolkit composition of these contexts (the use of point and flake-based industries) further demonstrate their technological equivalence. Similarities in these behaviours are also documented at other sites including Villiers-Adam-Le Petit Saule (N2) (Locht et al., 2003) and Riencourt-les-Bapaumes (C/12) (Ameloot-Van der Heijden, 1993, 1994; Goval and Herisson, 2006), but further primary lithic analysis is essential to determine the nature of their equivalence. The combination of the analyses undertaken would agree with arguments hypothesised by Depaepe (2007), but not assessed through a quantitative framework, that these contexts feature the same mimetic or suite of behaviours.

The extent to which these behaviours are akin to a technocomplex *sensu* Clarke (1968) is problematic for reasons outlined in Chapter 4, but present knowledge would suggest that there is some form of inter-connected cultural network in north-west Europe during MOIS 5.

In Chapter 8, the Belgian MOIS 5a context of Rocourt was analysed, with a number of technological affinities to Bettencourt-Saint-Ouen (N2B) and Fresnoy-au-Val (Série 1) being noted. These include an extensive sequence of blade technology through decortification, platform preparation, initiation through cresting, and the transformation of artefacts akin to those in the Upper Palaeolithic. A number of dissimilarities to both Bettencourt-Saint-Ouen (N2B) and Fresnoy-au-Val (Série 1) were also noted, including the core dimensions, the density of site occupation, and the lack of other technologies noted. While experimental analyses assessed the shape and form of blade products, they did not consider how the shape and raw material morphology alters core dimensions and elongation. Analyses did demonstrate that Neanderthals at the site of Rocourt used elongated nodules and blocks, and differences between contexts may be attributed to the available nodule shape. Further work, examining the entirety of the Bettencourt-Saint-Ouen (N2B) and Fresnoy-au-Val (Série 1) contexts are necessary in order to understand, to the truest extent, the nature of mimetic behaviour present and which variables reflect local circumstances (e.g. nodule shape). As this is poorly quantified and defined, further investigations would quantify the degree of similarity and difference. Despite this, a spatial-temporal tradition of shared knowledge could be hypothesised through these contexts.

Also in Chapter 8, the three horizons of Le Rissori were discussed and analysed, with technological analyses highlighting consistencies in the morphological and technological components; with almost parallel retouch and cortical ratios, blank profiles and core morphologies were documented within the Le Rissori (IIIA) and (IIIB) horizons. Analyses would suggest that the horizons represent at least two horizons, with many technological differences noted between Le Rissori (IV) and later layers. However, further work, examining both SRPH and IRSNB collections, in addition to renewed excavations and investigations will further our understanding of the Le Rissori complex and whether the three horizons represent one, two, three or even more layers, and if three, the demonstration of consistent behaviour throughout the later stages of MOIS 7. In contrast to the Le Rissori complex, the MOIS 8 context of Mesvin (IV) presents a number of stark differences (Chapter 10). The extent of the differences noted, in addition to examination of the overall toolkit (as noted through visual inspection and the relevant literature), suggests that these do not represent consistent behaviours associated with some uniform cultural affinity, despite the presence of Levallois blades. This may be representative of multiple populations, or represent localised changes in the Neanderthal toolkit, however the more parsimonious explanation would be that these represent two isolated traditions of knowledge.

In Chapter 9, investigations into two British Early Middle Palaeolithic horizons highlighted a concentration of highly-transformed Levallois blade material using local high-quality raw material south of the River Thames. As these collections are heavily reworked, being part of a much larger original collection, and featuring multiple provenances and different collections, it would be difficult to create a true comparison. However, analyses of extant material highlight a number of similarities with respect to the production and transformation of large Levallois blades within the Thames landscape. Further work is necessary, through robust investigations of the collections, in order to understand the extent to which these are similar.

All these analyses therefore demonstrate considerable difference and similarity among various contexts throughout the Middle Palaeolithic. They highlight, to some degree, consistent shared behaviours among various horizons within the same context, and within specific regions, sometimes as part of a 'culture', sometimes as part of the Neanderthal technological repertoire used when necessary, or a combination of the two. One final aspect worth considering is understanding whether different Middle Palaeolithic blade contexts are of a specific contemporaneity, whether strict, geological, or occupational *sensu* Conard and Adler (1997). Particularly, it was noted by Antoine in Locht (2002) that a number of Levallois-Laminar contexts were in fact homogenised, and the result of long-term diachronic colluvial deposition (see Chapter 4 for the Colluvial Deposition Hypothesis). From this it was interpreted in Locht et al. (2010a) that horizons featuring Levallois and Laminar material were therefore of differing age and contemporaneity. A number of issues were raised in Chapter 4, including the number of examples throughout the Middle Palaeolithic, the number of non-slope contexts, and possible differences in the rate of colluvial deposition. As Bettencourt-Saint-Ouen (N2B) and Fresnoy-au-Val (Série 1) are, however, situated within low mechanical environments, with little chemical alteration, analyses of their taphonomic histories provide little insight into issues of contemporaneity. As such, further work is essential in validating or disproving the Colluvial Deposition Hypothesis. This includes a thorough assessment of all blade-context stratigraphies, spatial analyses of lithic material, and testing of sedimentation rates.

11.4. Understanding Differences in Artefact Design among Middle Palaeolithic Technological Blade Strategies

Central to this thesis has been the behavioural potential of the artefacts examined and the role of artefact design, i.e. the potential of an artefact to be used for a number of activities, 'engineered' by its overall morphology to perform (with some consideration of the technological strategy). This was examined through both an archaeological and experimental framework and is summarised in Table 11.1.

Experimental analyses successfully discriminated technological blade strategies through their two-dimensional planform shape, with Levallois blades featuring more convex and wider profiles, and Laminar blades featuring narrower profiles of greater elongation. Analyses of lineal measurements also demonstrated that Levallois blades were flatter with more acute edge angles, wider cross-sections and more usable edge per blank/blade. Laminar blades, in contrast, produced longer lineal edges, an edge angle typically six degrees more obtuse in comparison to Levallois blades, and increased usable edge per weight of stone. In assessing the degree to which each strategy can be considered 'standardised' or 'more standardised' both strategies have their own merits, depending on the variable considered. For Laminar technological blade strategies, width morphologies are more consistent, and from observational analysis of the experimental blades produced, Laminar cores require less maintenance in comparison to Levallois technology, allowing a greater number of standardised products. And while Levallois products feature a lower elongation index on average, data demonstrate a more standardised elongation in addition to a tighter clustering of flattening and edge angle.

	Attribute	Laminar Technological Blade Strategy	Levallois Technological Blade Strategy
Retouch potential	Edge angle and relative sharpness	Thicker and duller	Flatter and sharper
	Cutting edge per blade	Less cutting edge	More cutting edge
	Planform morphology	Narrower with longer edges	Wider with more convex edges
Portability potential	Size	Varying size: can reach small dimensions (<40mm)	Larger and don't tend to reach smaller dimensions (<40mm)
	Cutting edge per weight of stone	More cutting edge per weight of stone	Less cutting edge per weight of stone
	Amount of blades produced per core	More blades per core produced	Less blades per core produced

Table 11.1. A summary of attributes analysed for technological blade strategies and the two main 'potentials' discussed herein

Throughout, analyses highlighted the allometric relationship of variables and the importance of size in understanding the extent and range of morphological variation which blades exhibit. Analyses demonstrated the influence of size on edge angle, and the range of edge angles among different strategies, and with respect to the amount of cutting edge per weight of stone, with smaller blades producing more cutting edge per weight of stone and edge angle. This former point, that smaller-sized blanks produce more acute mean angles, has been previously noted before in a number of technological strategies (Mackay, 2008; Terradillos-Bernal and Rodriguez-Alvarez, 2012; Key and Lycett, 2014). This thesis now demonstrates and supports this relationship within blade technology and blade production methods. While little difference is noted for working edge angle between the smaller examples of both blade strategies, the feasibility of producing small Levallois blades (<50mm) needs to be considered as Levallois core exhaustion occurs quicker, as analyses demonstrate – these aspects are discussed in more detail below.

Finally, analyses also emphasised the equivalence and practicality of *éclats débordants* equivalent to Levallois blades with respect to their cutting edge on the unworked surface, with no statistical difference noted. While their use as been demonstrated throughout the analysis chapters and within the wider literature (Beyries and Boëda, 1983), this thesis is the first to demonstrate the lack of difference among these products. Future follow-up research through use-wear and functional studies will further analyse and investigate this relationship in detail.

In their totality, experimental analyses have highlighted that, despite the view that blade strategies are homogenised in their form and technique (e.g. Bourguignon et al., 2006; Delagnes et al., 2007; Delagnes and Rendu, 2011), this relationship is more complex than previously thought, with both strategies featuring a number of commonalities and differences. These patterns and results are further supported through comparative analyses of the archaeological material examined (Chapter 10), and include the discrimination of blade products through their two-dimensional geometric morphometric analysis, differences associated with their width, flattening index, in addition to the economisaton of raw material (core exhaustion and the amount of cutting edge per weight of stone).

If the artefacts and analyses through the previous chapters are interpreted through their behavioural potential and function, a consideration of their 'performance attributes' (Skibo and Schiffer, 2001: 143) is essential. Discussed in detail in Chapter 4, the formal properties of an artefact, partly due to its morphological and technological characteristics, influence the capability of that artefact to be used within a specific context or activity (Schiffer and Skibo, 1987), and that the organisation of behaviour or 'engineering' (Eren and Lycett, 2016) of artefacts, with specific technologies or decisions, can influence their performance in a given activity (Schiffer and Skibo, 1987; O'Brien et al. 1994; Bleed, 2001; Skibo and Schiffer, 2001). Through this lens, the different aspects of the products' morphology may be indicative of their overall performance in relation to specific tasks. However, the degree of difference for one specific morphological attribute may not have any noticeable difference when used in a specific task - what may be of statistical significance may not necessarily be of behavioural or archaeological significance.

One important example is the edge angle of both technologies. While differences in edge angle have been viewed as a direct indication of the function of an artefact (Bowler et al., 1970; Spechy and Koettig, 1981), the difference in edge angle is of much larger variance than documented in this thesis (c.20-25 degrees). Studies suggest that both Levallois and Laminar technological blade products possess an edge angle akin to whittling knives (Semenov, 1964) and have been viewed through ethnographic observation (Gould et al., 1971) to have been used in various cutting activities. Their angle is also noted as not being typically associated with activities of wood-working, bone-working, skin-softening or heavy shredding (Wilmsen, 1968). Work by Atkins (2009) also supports this view of blades being used for slicing and cutting activities, noting that an increased edge angle restricts a tool's penetrative ability by decreasing the cutting stress (force per unit area), essential for the initiation of a cut and the ensuing splitting material. Their use in slicing and cutting can therefore be assumed, but how well can these strategies perform in such tasks in comparison to flakes or each other?

Author(s)	Artefact type	Angle (range – 1 SD)
Key and Lycett (2014)	Unmodified flake	29-43°
Wilmsen (1968)	Unmodified flake	20-40°
Eren and Lycett (2016)	Levallois preferential flake	59-32°
Eren and Lycett (2016)	Levallois preferential *débitage*	46-19°; 42-17°
This thesis	Laminar blade	30-56° (mean: 42.94°)
	Levallois blade	27-47° (mean: 36.73°)

Table 11.2. Edge angle ranges for unmodified blades and flakes throughout the archaeological literature and in relation to this thesis (shaded green)

When compared to unmodified flakes, blade strategies do not appear to serve any advantages in the cutting edge angle produced (Table 11.2). Analyses indicate that Laminar technological blades produced an edge angle ranging from 30-56° (mean: 42.94°), with Levallois technological blades producing an edge angle ranging from 27-47° (mean 36.73°). Nevertheless, the mean angles for blades produced are in the upper quartile of all unmodified flakes, with flakes appearing to generally feature a sharper edge in comparison to blade techniques. With respect to other Levallois strategies, results from Eren and Lycett (2016) demonstrate that Levallois blades produce similar ranges in edge angle to Levallois preferential products, with Levallois preferential *débitage* is more acute and sharper. While this is generalised and requires more research, it must be hypothesised that blades strategies do not represent solely an attempt to produce the sharpest edge possible, given the abundance and sharpness of other on-site strategies available, including other Levallois products (Eren and Lycett, 2012) and that both Levallois and Laminar blades strategies were not adopted concurrently, given differences in their edge angle. Perhaps the amount of continuous acute edge represents why both strategies were adopted, with both strategies providing more effective kinetics in comparison to other artefacts featuring a sharp angle - in relation to slicing and cutting due to their edge circumference and the amount of lineal usable edge. This may serve one advantage in comparison to flake products. At present, it is difficult without the inclusion of further experimental analyses to determine the technological performance of each strategy in relation to each other and in relation to flake-based strategies.

Considerations of individual attributes therefore allow some investigation into how the engineering of an artefact's morphology may influence their performance within a given activity; however, individual attributes do not account for the overall behavioural potential of an artefact. Perhaps a more robust model in contrast of individual attributes is to consider multiple aspects of the morphology in conjunction, allowing a more holistic understanding of the artefact's behavioural potential. Using the logic of Eren and Lycett (2016) and Eren et al. (2013) that advantages of particular attributes allow logical consistency of hypothesis invoking intent, an assessment incorporating multiple technological and morphological considerations allows a more credible hypothesis invoking intent in comparison.

Through this lens, Levallois recurrent elongated products can be viewed as featuring greater retouch potential i.e. a greater capacity for retouch. This is supported through the combination of four attributes: 1) an increased mean width, 2) a lower flattening index, 3) a more acute edge angle, and 4) a greater amount of usable edge per blade (note: not weight of stone). With studies demonstrating that less force is necessary to remove a flake, allowing a product to be retouched more easily (Hiscock, 1979; Sheets and Muto, 1972), these four attributes can be theorised as aiding a greater retouch potential/capacity, requiring less force to be expended. In this, the retouch of Levallois products can be viewed as a response to microfracturing, an important aspect worth stressing, as dulling of the blank-edge dictates how frequently a tool-edge must be resharpened and thus its potential use-life extended (Collins, 2008). While this may come at the expense of modifying the cutting ability of an artefact, and potentially a new activity through the creation of a steeper angle, the use-life of the artefact is increased. And as more acute angles are more susceptible to edge microfracture (Tringham et al., 1974), this may be more necessary for Levallois blade products. This is supported through the high percentage of retouch documented in Early Middle Palaeolithic Levallois blade-rich contexts, with c. 40% of all Levallois blade products documenting retouch, often continuous and of high coverage. As these are discovered close to the source of the raw material, the transformation represents only an extended use-life within the immediate landscape and not to the extent where artefacts are viewed as 'curated' *sensu* Binford (1979), however this cannot be fully ruled out for all examples. While caution is necessary in classifying the retouch as anthropogenic in nature, and not resulting from taphonomic processes (i.e. mechanical damage), as this is only apparent on Levallois products, it can be argued that most, if not all examples, were retouch-based in their identification. A retouch-potential argument for Levallois blades (and preferential flakes) may also explain why tools with more robust edge angles are absent in south-east England, e.g. handaxes (Scott and Ashton, 2011). In this example, Levallois blades become favoured as part of the problem-solving routine, replacing the necessity for bifacial reduction, and the replicability to produce long robust cutting edges. Further research is, however needed into the functional properties of both industries.

As noted in Chapter 4, one method of problem-solving (Nelson, 1991; Gamble, 1986) relates to the portability of toolkit, and increasing the portability or carrying capacity of the toolkit (Ebert, 1979; Gould, 1969; Nelson, 1991; Kelly, 1988). In becoming more efficient and portable, strategies including optimising the amount of cutting edge are regularly adopted, and decreasing the size of the products necessary. If a more holistic approach to Laminar technology is therefore considered, it features greater 'portability potential'. This is supported through analyses demonstrating: 1) the increased amount of working edge per weight of stone, and thus 2) a greater number of blades per core (even if preparation and maintenance is omitted), 3) a greater degree of core exhaustion, and 4) the ability to produce considerably smaller blades. Each permit the immediate transformation of high-quality raw material and allow a variety of different mobility strategies, given the lack of preparation needed following the initiation of the sequence. With this, and a consideration of microfracturing (as above), it would be unnecessary to retouch Laminar blades as invasively as Levallois blades, as a greater number of blades can be produced. Should a blade become dull, the abundance of blades avoids the necessity of retouch. This supports with the archaeological evidence from the previous chapters with instances of low retouch percentages (c. 1-10%), often localised and non-invasive in nature.

One final and important consideration is the way raw material type influences artefact design and its impact upon Middle Palaeolithic blade technology. Analyses of the four different flints (of varying homogeneity) demonstrate that the majority of morphological differences noted through the experimental analyses (e.g. flattening index, usable edge per weight of stone, two-dimensional planform shape) are apparent, irrespective of the type of flint used. Raw material does determine to some degree within group variance (e.g. the degree of elongation), however differences between Laminar and Levallois technological blade strategies are mostly upheld. Other factors, including the invasiveness of the technique (e.g. edge angle), or the size of the artefact produced (e.g. cutting edge per weight and edge angle) appear to be more important than the different types of flint used. As all artefacts within this thesis utilised local high-quality homogeneous and fine-grained flint, the pertinence of the experimental assemblage is amplified, and it is possible to conclude that the morphological differences demonstrate within the archaeological evidence were not the result of the raw material, but determined by the specific technological strategy.

More generally, the size and shape of the raw material used does not influence, to a large degree, whether a Laminar core was adopted. Throughout, a large number of Laminar cores possess a flat cortical face with a facial or semi-rotating/*semi-tournant* technique, which could not be converted into a rotating/*tournant* technique. These were, as a result, left unmodified with a homothetic morphology limited to one face of the core. This, however, only influenced the extent of blade production and not the adoption of a Laminar technique. Throughout the archaeological analyses, a variety of different core morphologies and sizes were utilised, including larger blocks and small pebbles (e.g. Fresnoy-au-Val), globular/spherical, elongated, and lenticular morphologies. With respect to the Levallois technique, given the lack of small Levallois blades produced, and the flattening index of Levallois cores, it can be assumed that nodule size and shape does affect the ability to produce Levallois technological blades too; however, further work is necessary to determine its extent.

In sum, a consideration of the behavioural potential of artefacts highlights contrasting properties with respect to the blade technologies examined. In isolation, different attributes suggest some difference, but individually lack credibility in explaining changes noted throughout the archaeological record. When multiple variables are considered, the different strategies can be more credibly assessed, revealing differences in the retouch potential and portability of artefacts examined. Furthermore, a consideration of raw material quality (among flints) highlights its minor influence with respect to artefact design; however, the general differences in morphology and technology are upheld.

11.5. Accounting for Neanderthal Technological Blade Variability: Why?

Both sections 11.3 and 11.4 have outlined in detail particular aspects of blade technology, with section 11.3 detailing the degree of (dis-)similarity among a number of different contexts throughout the Middle Palaeolithic, and section 11.4 detailing differences and similarities in the artefact design of the technological strategies utilised (Table 11.1). So what does this all mean? How can we account for the variability witnessed in Middle Palaeolithic blade technology?

Both blade strategies possess an edge equipped for butchery related activities (cutting and slicing), with neither appearing, at present, to have any noticeable difference in their butchery potential. With a lack of faunal remains for many of the contexts investigated (e.g. decarbonisation of fauna in many MOIS 5 contexts), and limited use-wear analyses, it is difficult to assert or even test if particular-sized fauna or particular species were transformed using specific blade types. Furthermore, with edge angles comparable to flake technology, the desirability of blade products may be directed towards the length of usable edge, and in their retouch (Levallois) and portability (Laminar) potential within an immediate landscape. This model is, however, flexible, and the reactionary nature of Neanderthal behaviour needs to be considered - the ability to react to different circumstances within the raw material - in addition to the plasticity of the two technologies (as exemplified at Saint-Valery-sur-Somme). As contexts most often feature a deficit of one particular blade technology, the plasticity of technologies and techniques (the need to change technique given an issue in the raw material, or material shape) may in part help explain their concurrency. In the small number of instances where there is an abundance of both strategies, e.g. Angé (Locht et al., 2008b), these may represent the accumulation of multiple behaviours, within a long-term occupation as suggested by the assemblage size (number of artefacts: 23573; number of cores: 1800).

Both periods of the Early and Late Middle Palaeolithic appear to demonstrate some element of a cultural component, or spatio-temporal traditions of social learning, as noted above. This is identified within the Northwest Technocomplex (see Chapter 4), and possibly the two horizons of Le Rissori (IIIA/IIIB), assuming stratigraphical integrity. While these two separate examples feature different compositions in the make-up of the tool-kit, it cannot be concluded whether these contexts represent one continuous tradition of social learning or not, given the plasticity of Neanderthal technological behaviour and general trends documented throughout the Middle Palaeolithic. A more parsimonious explanation would assume these represent differing traditions of social learning, or just reflective of the broader technological repertoire. however further research is necessary in understanding how other sites not analysed here relate to the data and findings from this thesis. This could include contexts from both periods of the Middle Palaeolithic in north-west Europe and further afield.

Finally, while chronological sequences of technological successions (long-term/short-term diachronic change) have been attributed to other phenomena within the Middle Palaeolithic (Bosinski, 1967; Jelinek, 1982), it would be difficult to define a succession of industries or changes within an inter-context level. Many of the sites examined are ephemeral and represent only one horizon (e.g. Saint-Valery-sur-Somme, Mesvin (IV), Rocourt). In those that feature multiple layers (Bettencourt-Saint-Ouen, Le Rissori and Therdonne), a general increase and decrease in the number of Laminar and Levallois technological blade strategies is observed; however, these appear discontinuous and do not show similarities at present. Besides this, a general trend in the ratio of Middle Palaeolithic Levallois and Laminar technological blade strategies can be observed, but reconstructing a series of successional toolkits or industries is problematic. As noted in Chapter 4, further work is necessary in providing a more robust spatio-temporal framework, particularly in the Early Middle Palaeolithic.

In sum, of the three main aspects of functional variability - site-function, social transmission and diachronic change - not one can account for technological blade variability documented within the Middle Palaeolithic. A consideration of function through 'retouch potential' and 'portability potential', however, supports many of the arguments discussed in the archaeological literature, including mobility in the Late Middle Palaeolithic (e.g. Koehler et al. 2014), as well as providing a starting point for discussions of the Early Middle Palaeolithic toolkit (e.g. the role of bifacial industries in relation to Levallois blade technology).

11.6. Summary

This chapter has abridged analyses from the previous four chapters and investigated, with a consideration of the wider literature, the main questions within this thesis. It has detailed aspects of function and the behavioural potential of blade strategies, and investigated their influence alongside aspects of social transmission and diachronic change, highlighting the importance of all three aspects. While the 'potentials' may not necessarily explain every aspect of technological variability, they provide a basis for understanding many of the patterns documented within archaeological literature on both blade strategies, and highlights the possibilities of products from both techniques. This chapter has also outlined many considerations for future studies, expanded upon in the final chapter.

Chapter Twelve
Conclusion

12.1. Overview

In its entirety, this thesis forms a unique contribution to the study of Middle Palaeolithic technological and social behaviour, using a novel methodology and an original dataset to assess the nature of its variability. Incorporating an archaeological and experimental framework of just under one and a half thousand artefacts, this thesis has demonstrated:

1. The most accurate and up-to-date record for the spatial and temporal distribution of technological blade strategies throughout the Lower and Middle Palaeolithic periods (Chapter 4);

2. Differences in the morphological and technological characteristics of Laminar and Levallois blade strategies in both an experimental and archaeological framework (Chapters 6, 7, 8, 9 and 10);

3. Consistencies in behaviour observed within the Early and Late Middle Palaeolithic contexts, supporting notions of a spatio-temporal tradition of social learning within MOIS 5 (Northwest Technocomplex), over multiple MOIS 7 horizons in Belgium (assuming Le Rissori represents three discrete units), and to some extent in the UK during the Early Middle Palaeolithic (Chapters 7, 8, 9 and 10);

4. The potential role artefact design complementing the greater Middle Palaeolithic toolkit through the 'retouch potential' of Levallois technological blade products, and the 'portability potential' of Laminar technological blade products (Chapters 6, 10 and 11).

12.2. An Assessment of the Research Questions

Throughout the thesis, three main research questions and one secondary question were addressed in order to assess:

To what extent do aspects of artefact design and the behavioural potential of artefacts provide a better understanding of Neanderthal technological variability, diachronic change, and social behaviour in the European Middle Palaeolithic?

These four questions are addressed below.

Research Question 1

What are the differences or commonalities in the chaîne opératoire, use, and modification of Laminar and Levallois blade débitage are observed throughout the Early and Late Middle Palaeolithic of north-west Europe?

This thesis has highlighted a variety of differences and consistencies in the *chaîne opératoire* and modification of both technological blade strategies throughout the Middle Palaeolithic. Throughout the Early Middle Palaeolithic, evidence for Laminar technological blade strategies are documented, albeit lower in quantity in comparison to Levallois blade strategies. Irrespective of whether this is the immediate transformation of material within an ephemeral appearance in the landscape (e.g. Saint-Valery-sur-Somme), or in more densely occupied horizons (e.g. Therdonne (N3)), these quantities do not match those of Levallois material in the Early Middle Palaeolithic, or Laminar blade contexts in the Late Middle Palaeolithic. Within the Late Middle Palaeolithic, the widespread proficiency and plasticity of the Laminar technology is attested, with increased evidence for rejuvenation (through the production of overshots, semi-cresting/cresting and platform renewal) and the extensive exploitation of blades through a homothetic morphology. While analyses have highlighted consistencies in the presence of discrete behaviours associated with Laminar technological blade products throughout the Middle Palaeolithic, this thesis demonstrates that the accumulation of behaviours is more visible within MOIS 5. This could be explained through several reasons including increased population/network size, in association with a more desirable environmental niche, or societies which produce more archaeological material, but also because of archaeological preservation or recovery bias (e.g. the work of INRAP in MOIS 5 contexts).

Within the Early Middle Palaeolithic, evidence for Levallois technological blade strategies is widespread, and demonstrates increasing elongation, standardisation and proficiency, with high percentages of invasive continuous retouch. In contrast, towards the end of the Early Middle Palaeolithic and throughout MOIS 5, Levallois blade technologies appear more ephemeral and informal in nature, decreasing in quantity. Further research is however necessary in determining such a pattern for a wider area.

Through these analyses, a wide variety of consistent behaviours were observed, suggesting spatio-temporal patterns of shared behaviour within both Early and Late Middle Palaeolithic contexts, including the possible evidence at Le Rissori, contexts within the UK, and with respect to contexts in MOIS 5. Extensive morphological and technological analyses provide a quantitative framework for hypotheses made by Depaepe (2007), with regards to a cultural affinity in MOIS 5 based on the presence of blade technology.

In their use, unretouched blades feature edges equivalent to flake-based technologies and are assumed to have been used in a variety of cutting and slicing-based activities. This interpretation applies to both glacial and interglacial periods.

Research Question 2

How do Levallois and Laminar technological blade end-products differ in terms of their artefact design, behavioural potential and desirability? What is the role of raw material variation in shape and in the nature of Levallois and Laminar technological blade end-products?

Throughout Chapters 6 and 10, the blank forms for both blade strategies were detailed for their artefact/behavioural potential and desirability, in an extensive morphometric and technological assessment.

Analyses highlighted a variety of commonalities and dissimilarities and it was concluded that Levallois technological blade strategies provide greater 'retouch potential' in comparison to Laminar technological blade strategies, given their flatter and wider morphology, more acute edge angle, and in the increased amount of edge per blade. Levallois blade strategies, however, require greater preparation and cores cannot be exhausted/utilised to the same extent as Laminar artefacts. Analyses also concluded that Laminar technological blade strategies provide greater 'portability potential', given the greater number of blades which can be produced, the ability to produce smaller blades, and the increased amount of cutting edge per weight of stone.

Through traditional and geometric morphometric methodologies it was observed that differing flint characteristics do not alter the main observations made, with the invasiveness and morphology of the raw material proposed as more pertinent variables of end-product shape, form and artefact shape.

Research Question 3

Can an explanation, grounded in hypotheses of function and artefact design, explain the use of Levallois and Laminar technological blade strategies in isolation and in conjunction, and the shift from Levallois-rich blade contexts in the Early Middle Palaeolithic to Laminar-rich contexts in the Late Middle Palaeolithic?

An examination of goodness-of-fit fails to explain entirely through purely a functional perspective why both techniques were adopted in conjunction, with reasons for their co-occurrence stemming from the plasticity of Neanderthal behaviour and their ability to react and modify technological behaviour when problem-solving. Furthermore, given specific aspects of artefact design are comparable to other technological strategies (e.g. edge angles compared to unretouched flakes), it is hypothesised that individual attributes alone do not explain the use of both technological strategies, and the shift from one technology to another.

The accumulation of the advantages in both techniques, the 'potentials', however, may explain to some extent their use, as these complement the greater toolkit. The retouch potential of Levallois blade (and preferential) strategies may explain their preference in comparison to handaxe strategies within some instances of the Early Middle Palaeolithic (e.g. south-east England), and thus extends the use-life of the artefact. For Laminar technology, the portability potential implies a more mobile toolkit, supporting research on more mobilie toolkit patterns within the Late Middle Palaeolithic (Goval, 2008; Koehler et al. 2014). This model, however, cannot explain all aspects of variability alone, and culture, similarities in behaviours adopted in both techniques and the ability to adapt strategies must be taken into consideration, given suggestive technological consistencies in behaviour in parts of the Middle Palaeolithic, as noted throughout the thesis.

Secondary Research Question

Does primary recording of each context's taphonomic history support or hinder arguments made by Locht et al. (2010a) and Antoine (2002) regarding the 'Colluvial Deposition Hypothesis'?

Analyses of the taphonomic history of artefacts suggested to have been affected by the Colluvial Deposition Hypothesis failed to demonstrate any difference between the two different technological strategies. However, as these are in low mechanical environments, differences would be subtle and potentially unrecognised. Given a number of considerations including the number of contemporaneous contexts before and after MOIS 5, and the nature of sedimentation for these other records, it is difficult to categorise these other contexts within this hypothesis. Further examination of spatial data, sedimentation rates, and stratigraphies of other blade-bearing contexts is however necessary in determining the contemporaneity of MOIS 5 assemblages.

12.3. Future Work

These four questions, and the analyses throughout, highlight the extent with which studies of artefact design can provide an insight into Neanderthal technological and social behaviour. The framework highlights commonalities on varying scales of inference, and provides a replicable and testable method for assessing change in behaviour and technique throughout the Middle Palaeolithic. However, the accumulation of material within this thesis represents only a starting point in understanding the nature of technological blade strategies within the European Middle Palaeolithic and functional approaches to Neanderthal technological behaviour. There are a number of different directions this research can take.

12.3.1. Producing a Higher-Resolution Temporal Framework

In providing a better understanding of regional patterns, and the nature of technological and social behaviour throughout the Middle Palaeolithic, it is essential that a more robust fine-grained chronological framework is produced. While there is a corpus of contexts throughout MOIS 5 to feature absolute dates, as noted in Chapter Four, the Early Middle Palaeolithic record is more fragmented, with chronostratigraphic dating taking precedence. Where assemblages are mixed, combining recent excavations and historic collections, continuing investigations and new excavations should be encouraged.

12.3.2. Studies of Regional Variability: An Extension of a Lithic Methodology

This thesis focussed on a number of contexts within north-west Europe, to allow the extensive nature of the technological and morphometric analyses undertaken. Future studies of both technologies in isolation and in conjunction, incorporating lithic analyses, would provide a better understanding of the specific behaviours. undertaken in the production of blade products, and would permit inter-regional comparative studies on the origins and significance of technological blade strategies.

12.3.3. (Re-)Defining the Northwest Technocomplex

Future research is needed in defining the specific technological and spatio-temporal consistencies associated with the Northwest Technocomplex. While analyses have highlighted commonalities in the technological component of Laminar industries at Fresnoy-au-Val (Série 1) and Bettencourt-Saint-Ouen (N2B), a broader analysis of contemporary MOIS 5 contexts would define the spatial extent of shared behaviours more confidently. Furthermore, analyses of other earlier contexts would assess whether there was a longer, more persistent, presence of the Northwest Technocomplex.

12.3.4. Furthering Methods of Functional Morphology #1: Finite Element Analysis and the Application of 3D Geometric Morphometrics

In assessing the behavioural potential of artefacts, and comparative technological studies of function, two-dimensional geometric morphometrics were utilised. This allowed an in-depth study of artefact two-dimensional planform shape, technological blank variance, and the role of raw material in their shape. This, however, provided only one perspective of artefact shape and not the global shape of the artefact. Aspects including blade curvature, cross-section, and the relationship between the three different orthogonal projections are absent, and as three-dimensional analysis of bifacial studies have highlighted, lateral and superior views are of equivalent importance in understanding shape variance (Stade and Hoggard, submitted). Many potential avenues can be undertaken in analysing the global shape of both Levallois and Laminar technological strategies. One potential framework is through Multiple Factor Analysis, a concatenation-based analysis of multiple two-dimensional Principal Component scores, i.e. planform PCA scores in conjunction with lateral and superior PCA scores (Escofier and Pagés, 1998; Pagés, 2002). The use of Multiple Factor Analysis is relatively new to archaeology, only being applied in two case studies: 1) in a comparative study of stone weights of little or no modification (Marcelo et al., 2015), and 2) in the discrimination of various social teaching methods with respect to handaxe production (Stade and Hoggard, submitted). Alternative three-dimensional approaches to lithic analysis include the creation of a new three-dimensional geometric morphometric framework utilising geometrically-governed landmarks i.e. type two landmarks (*sensu* Bookstein, 1991), or through a new three-dimensional (semi-)landmark approach incorporating aspects of surface shape through sliding semilandmarks. As blades are of a known orientation, with a ventral and dorsal surface, issues of orientation raised in Stade and Hoggard (submitted) are not a problem, and such a methodology should be both credible and insightful.

In addition, recent applications in the biological and non-biological applications of Finite Element Analysis within archaeological analyses (Kilikoglou, 2002; Levy and Dawson, 2009; D'Anastasio et al., 2013) have demonstrated the potential for theoretical modelling in understanding the internal mechanics and structure of various archaeological materials. With respect to lithic analyses, only a handful of studies have acknowledged this potential, utilising the method for understanding the fracture mechanics of different raw materials (e.g. Patten, 2005). Finite Element Analysis has the potential to provide a framework for understanding technological blade strategies with respect to their use-life and function, providing a quantitative, robust and controlled environment for the testing of Levallois and Laminar edge angles, in a wide variety of applications (e.g. slicing and scraping behaviours of various levels of force). Furthermore, Finite Element Analysis provides lithic analysts with an ability to understand and quantify differences in the edge-function of various raw materials (e.g. sandstones, quartzites, flints and cherts).

12.3.5. Furthering Methods of Functional Morphology #2: Experimental Approaches

While Finite Element Analysis provides a theoretical framework for understanding the function and use of various Middle Palaeolithic technologies, through computerised modelling, a holistic analysis would complement results from Finite Element Analysis with actual experimentation on various contact materials. Can differences between the use and performance of these blade strategies be observed? Do Levallois blades microfracture quicker given their more acute angle, as determined by this thesis? In hypothesis-driven archaeology, there is a real necessity for both experimental stone artefact replication, and the testing and modelling of differences through robust and scientific experimental protocol (Eren et al., 2016); this can include analyses of various raw material types, different Laminar blade production strategies (frontal vs. semi-rotating strategies), individual dexterity and performance, and a temporal dimension.

12.3.6. Furthering Methods of Functional Morphology #3: Use-Wear Analyses

In complementing the theoretical and experimental approaches to behavioural potential, extensive use-wear analyses will primarily investigate the role of both technological blade strategies throughout the Middle Palaeolithic. Investigations will allow a comparison of both Levallois and Laminar strategies, but also differences in the use of unretouched and retouched Levallois blade products, and unretouched and retouched Laminar products. This would allow comparisons between Laminar retouched blade types, and retouched blades produced in the Upper Palaeolithic, allowing a thorough comparative analysis of behaviour between Neanderthal and Modern Human populations, and similarities and differences in technological behaviour.

12.3.7. Analyses of Overall Site Composition and Assemblage Spatial Organisation

Finally, a consideration of the greater blade-bearing context(s) and their spatial relationship throughout the site is essential in determining the relationship between blade technologies, the different individual reduction strategies, the relationship between Levallois and Laminar technologies, and the overall assemblage. Several contexts within this thesis (Bettencourt-Saint-Ouen, Fresnoy-au-Val, Therdonne, and Rocourt) all featured detailed spatial data, however this was beyond the scope of the thesis, given the amount of time necessary to thoroughly appreciate and understand the spatial data available.

12.4. Concluding Remarks

It is evident that our understanding of differential Neanderthal blade behaviour in the Middle Palaeolithic is in its infant stages of development. With this thesis I hope to have demonstrated the importance of quantitative assessments of Middle Palaeolithic blade technology, and how extensive analyses of both experimental and archaeological material can provide a valuable insight into aspects of consistent behaviour throughout the Middle Palaeolithic. This thesis also represents an initial assessment of Middle Palaeolithic blade strategies through a geometric morphometric methodology, and it is hoped that its relevance can begin to be understood within future studies.

Appendix

Appendix 1 (Experimental Framework - Additional Information)

Ingham Flint Number of Blocks/Nodules used: 3 Dimensions (mm): 195 x 175 x 138 / 195 x 195 x 175 / 225 x 245 x 392 Individual Weight (g): 6234 / 5920 / 8214 Total Weight (g): 20368
West Runton Flint Number of Blocks/Nodules used: 4 Dimensions (mm): 183 x 192 x 199 / 195 x 143 x 285 / 219 x 327 x 204 / 123 x 218 x 156 Individual Weight (g): 4936 / 5462 / 6731/ 4831 Total Weight (g): 21960
Caistor St. Edmunds Number of Blocks/Nodules used: 4 Dimensions (cm): 155 x 193 x 161 / 189 x 140 x 194 / 210 x 278 x 285 / 141 x 121 x 292 Individual Weight (g): 5143 / 4859 / 6831 / 4912 Total Weight (g): 21745
Beer Flint Number of Blocks/Nodules used: 4 Dimensions (cm): 149 x 210 x 240 / 225 x 245 x 192 / 523 x 80 x 142 / 150 x 194 x 165 Individual Weight (g): 5472 / 5939 / 6142 / 2820 Total Weight (g): 20373

Appendix 2 (Principal Component Metadata)

Levallois vs. Laminar Technological Blade Products (Archaeological)

PC	Eigenvalue	Variance (%)	Cumulative Variance (%)
1	0.007212	52.999	52.999
2	0.001919	14.104	67.103
3	0.00152	11.172	11.172
4	0.000565	4.1548	15.3268
5	0.000494	3.6312	3.6312
6	0.000307	2.2566	5.8878
7	0.000261	1.9172	1.9172
8	0.000234	1.7165	3.6337
9	0.000193	1.4173	1.4173
10	0.000131	0.96433	2.38163
11	1.19E-04	0.87633	0.87633
12	8.36E-05	0.61448	1.49081
13	7.01E-05	0.51539	0.51539
14	6.53E-05	0.47956	0.99495
15	5.75E-05	0.42262	0.42262
16	4.40E-05	0.32366	0.74628
17	4.19E-05	0.30771	0.30771
18	2.76E-05	0.20278	0.51049
19	2.36E-05	0.17348	0.17348
20	2.33E-05	0.17132	0.3448

Levallois vs. Laminar Technological Blade Products (Experimental)

PC	Eigenvalue	Variance (%)	Cumulative Variance (%)
1	0.01253	56.895	56.895
2	0.0029	13.169	70.064
3	0.002704	12.279	12.279
4	0.000805	3.6566	15.9356
5	0.000618	2.806	2.806
6	0.0004	1.8162	4.6222
7	0.000316	1.4333	1.4333
8	0.000296	1.3425	2.7758
9	0.000246	1.1155	1.1155
10	0.000176	0.80114	1.91664
11	0.000157	0.71286	0.71286
12	1.01E-04	0.45756	1.17042
13	9.35E-05	0.42444	0.42444
14	8.58E-05	0.38956	0.814
15	8.02E-05	0.36421	0.36421

16	6.04E-05	0.27415	0.63836
17	4.83E-05	0.21951	0.21951
18	4.07E-05	0.18501	0.40452
19	3.53E-05	0.1605	0.1605
20	3.29E-05	0.14923	0.30973

Levallois vs. Laminar Technological Blade Products (Ingham Flint)

PC	Eigenvalue	Variance (%)	Cumulative Variance (%)
1	0.014152	56.506	56.506
2	0.003573	14.267	70.773
3	0.00284	11.341	11.341
4	0.000969	3.8678	15.2088
5	0.000731	2.9205	2.9205
6	0.000596	2.3788	5.2993
7	0.000358	1.4299	1.4299
8	0.000299	1.193	2.6229
9	0.000251	1.004	1.004
10	0.000187	0.74862	1.75262
11	0.00017	0.67883	0.67883
12	1.15E-04	0.45916	1.13799
13	1.12E-04	0.44647	0.44647
14	9.60E-05	0.38319	0.82966
15	8.92E-05	0.35621	0.35621
16	5.98E-05	0.23863	0.59484
17	4.72E-05	0.18834	0.18834
18	4.03E-05	0.16074	0.34908
19	3.76E-05	0.15018	0.15018
20	3.58E-05	0.14294	0.29312

Levallois vs. Laminar Technological Blade Products (West Runton Flint)

PC	Eigenvalue	Variance (%)	Cumulative Variance (%)
1	0.01253	56.895	56.895
2	0.0029	13.169	70.064
3	0.002704	12.279	12.279
4	0.000805	3.6566	15.9356
5	0.000618	2.806	2.806
6	0.0004	1.8162	4.6222
7	0.000316	1.4333	1.4333
8	0.000296	1.3425	2.7758
9	0.000246	1.1155	1.1155
10	0.000176	0.80114	1.91664
11	0.000157	0.71286	0.71286

12	1.01E-04	0.45756	1.17042
13	9.35E-05	0.42444	0.42444
14	8.58E-05	0.38956	0.814
15	8.02E-05	0.36421	0.36421
16	6.04E-05	0.27415	0.63836
17	4.83E-05	0.21951	0.21951
18	4.07E-05	0.18501	0.40452
19	3.53E-05	0.1605	0.1605
20	3.29E-05	0.14923	0.30973

Levallois vs. Laminar Technological Blade Products (Caistor St. Edmunds)

PC	Eigenvalue	Variance (%)	Cumulative Variance (%)
1	0.01506	55.215	55.215
2	0.003634	13.322	68.537
3	0.00353	12.943	12.943
4	0.001204	4.413	17.356
5	0.000949	3.4802	3.4802
6	0.000555	2.0347	5.5149
7	0.000439	1.6099	1.6099
8	0.000345	1.2646	2.8745
9	0.000267	0.97937	0.97937
10	0.000227	0.83103	1.8104
11	0.000169	0.61839	0.61839
12	1.37E-04	0.50388	1.12227
13	1.09E-04	0.39942	0.39942
14	8.46E-05	0.31021	0.70963
15	7.27E-05	0.26646	0.26646
16	5.97E-05	0.21901	0.48547
17	5.43E-05	0.19896	0.19896
18	4.88E-05	0.17891	0.37787
19	4.14E-05	0.15195	0.15195
20	3.37E-05	0.12355	0.2755

Levallois vs. Laminar Technological Blade Products (Beer Flint)

PC	Eigenvalue	Variance (%)	Cumulative Variance (%)
1	0.007945	54.421	54.421
2	0.002241	15.351	69.772
3	0.002034	13.935	13.935
4	0.000481	3.293	17.228
5	0.000446	3.0527	3.0527
6	0.000231	1.5801	4.6328
7	0.000218	1.4958	1.4958

8	0.000163	1.1131	2.6089
9	0.000128	0.87545	0.87545
10	0.000105	0.72129	1.59674
11	8.53E-05	0.58426	0.58426
12	7.56E-05	0.51782	1.10208
13	5.95E-05	0.40785	0.40785
14	5.57E-05	0.38178	0.78963
15	4.49E-05	0.30764	0.30764
16	4.03E-05	0.27584	0.58348
17	2.81E-05	0.19238	0.19238
18	2.42E-05	0.16591	0.35829
19	2.11E-05	0.14464	0.14464
20	1.67E-05	0.11412	0.25876

Appendix 3 (Supporting Statistics)

Length (Levallois vs. Laminar)

Saint-Valery-sur-Somme Two-sample test unavailable	Mesvin (IV) *Mann-Whitney U* : 32 *z* : -2.1102 *p* : 0.0348 *Monte Carlo p* : 0.0330	Baker's Hole (various) Two-sample test unavailable
Crayford (various) Two-sample test unavailable	Le Rissori (IV) Two-sample test unavailable	Le Rissori (IIIB) *Mann-Whitney U* : 15 *z* : -1.2437 *p* : 0.2136 *Monte Carlo p* : 0.2356
Le Rissori (IIIA) *Mann-Whitney U* : 38 *z* : -0.8169 *p* : 0.4140 *Monte Carlo p* : 0.4337	Therdonne (N3) Two-sample test unavailable	Rocourt Two-sample test unavailable
Bettencourt-Saint-Ouen (N2B) *Mann-Whitney U* : 88 *z* : -1.3198 *p* : 0.1868 *Monte Carlo p* : 0.1919	Fresnoy-au-Val (Série 1) *Mann-Whitney U* : 160 *z* : -1.6205 *p* : 0.1051 *Monte Carlo p* : 0.1033	Experimental (multiple) *Mann-Whitney U* : 12629 *z* : -3.3417 *p* : 0.0008 *Monte Carlo p* : 0.0007

Width (Levallois vs. Laminar)

Saint-Valery-sur-Somme Two-sample test unavailable	Mesvin (IV) *Mann-Whitney U* : 15.5 *z* : -2.8436 *p* : 0.0044 *Monte Carlo p* : 0.0025	Baker's Hole (various) Two-sample test unavailable
Crayford (various) Two-sample test unavailable	Le Rissori (IV) Two-sample test unavailable	Le Rissori (IIIB) *Mann-Whitney U* : 26 *z* : -0.4025 *p* : 0.6872 *Monte Carlo p* : 0.6988
Le Rissori (IIIA) *Mann-Whitney U* : 33 *z* : -1.0804 *p* : 0.2799 *Monte Carlo p* : 0.2825	Therdonne (N3) Two-sample test unavailable	Rocourt Two-sample test unavailable
Bettencourt-Saint-Ouen (N2B) *Mann-Whitney U* : 98 *z* : -1.0903 *p* : 0.2755 *Monte Carlo p* : 0.2757	Fresnoy-au-Val (Série 1) *Mann-Whitney U* : 49 *z* : -3.8007 *p* : 0.0001 *Monte Carlo p* : 0.0001	Experimental (multiple) *Mann-Whitney U* : 10287 *z* : -5.5041 *p* : 0.0001 *Monte Carlo p* : 0.0001

Cutting edge per weight of stone (Levallois vs Laminar)

Saint-Valery-sur-Somme Two-sample test unavailable	Mesvin (IV) *Mann-Whitney U* : 17 *z* : -2.8936 *p* : 0.0072 *Monte Carlo p* : 0.0039	Baker's Hole (various) Two-sample test unavailable
Crayford (various) Two-sample test unavailable	Le Rissori (IV) Two-sample test unavailable	Le Rissori (IIIB) *Mann-Whitney U* : 2 *z* : -2.1409 *p* : 0.0322 *Monte Carlo p* : 0.0016
Le Rissori (IIIA) *Mann-Whitney U* : 19 *z* : -0.8676 *p* : 0.3855 *Monte Carlo p* : 0.4140	Therdonne (N3) Two-sample test unavailable	Rocourt Two-sample test unavailable
Bettencourt-Saint-Ouen (N2B) *Mann-Whitney U* : 70 *z* : -0.7388 *p* : 0.4600 *Monte Carlo p* : 0.4818	Fresnoy-au-Val (Série 1) *Mann-Whitney U* : 77 *z* : -2.9462 *p* : 0.0032 *Monte Carlo p* : 0.0011	Experimental (multiple) *Mann-Whitney U* : 13224 *z* : -2.7918 *p* : 0.0052 *Monte Carlo p*: 0.0059

Thickness (Levallois vs. Laminar)

Saint-Valery-sur-Somme Two-sample test unavailable	Mesvin (IV) *Mann-Whitney U* : 47 *z* : -0.8305 *p* : 0.4062 *Monte Carlo p:* 0.4211	Baker's Hole (various) Two-sample test unavailable
Crayford (various) Two-sample test unavailable	Le Rissori (IV) Two-sample test unavailable	Le Rissori (IIIB) *Mann-Whitney U* : 6 *z* : -1.8833 *p* : 0.0597 *Monte Carlo p*: 0.0533
Le Rissori (IIIA) *Mann-Whitney U* : 31 *z* : -1.1859 *p* : 0.2356 *Monte Carlo p*: 0.2461	Therdonne (N3) Two-sample test unavailable	Rocourt Two-sample test unavailable
Bettencourt-Saint-Ouen (N2B) *Mann-Whitney U* : 103 *z* : -1.0081 *p* : 0.3134 *Monte Carlo p* : 0.3233	Fresnoy-au-Val (Série 1) *Mann-Whitney U*: 218.5 *z* : -0.7722 *p* : 0.4399 *Monte Carlo p* : 0.4294	Experimental (multiple) *Mann-Whitney U*: 11210 *z* : -1.4415 *p* : 0.1494 *Monte Carlo p* : 0.1439

Edge Circumference (Levallois vs. Laminar)

Saint-Valery-sur-Somme Two-sample test unavailable	Mesvin (IV) *Mann-Whitney U* : 11 *z* : -2.3718 *p* : 0.017701 *Monte Carlo p* : 0.0095	Baker's Hole (various) Two-sample test unavailable
Crayford (various) Two-sample test unavailable	Le Rissori (IV) Two-sample test unavailable	Le Rissori (IIIB) *Mann-Whitney U* : 33 *z* : -1.7637 *p* : 0.077778 *Monte Carlo p* : 0.0814
Le Rissori (IIIA) *Mann-Whitney U* : 52 *z* : -1.2929 *p* : 0.19604 *Monte Carlo p* : 0.203	Therdonne (N3) Two-sample test unavailable	Rocourt Two-sample test unavailable
Bettencourt-Saint-Ouen (N2B) *Mann-Whitney U* : 67 *z* : -1.8855 *p* : 0.059364 *Monte Carlo p* : 0.0592	Fresnoy-au-Val (Série 1) *Mann-Whitney U* : 125 *z* : -2.4027 *p* : 0.016276 *Monte Carlo p* : 0.0135	Experimental (multiple) *Mann-Whitney U* : 11555 *z* : -4.3331 *p* : 1.4704 E-05 *Monte Carlo p* : 0.0001

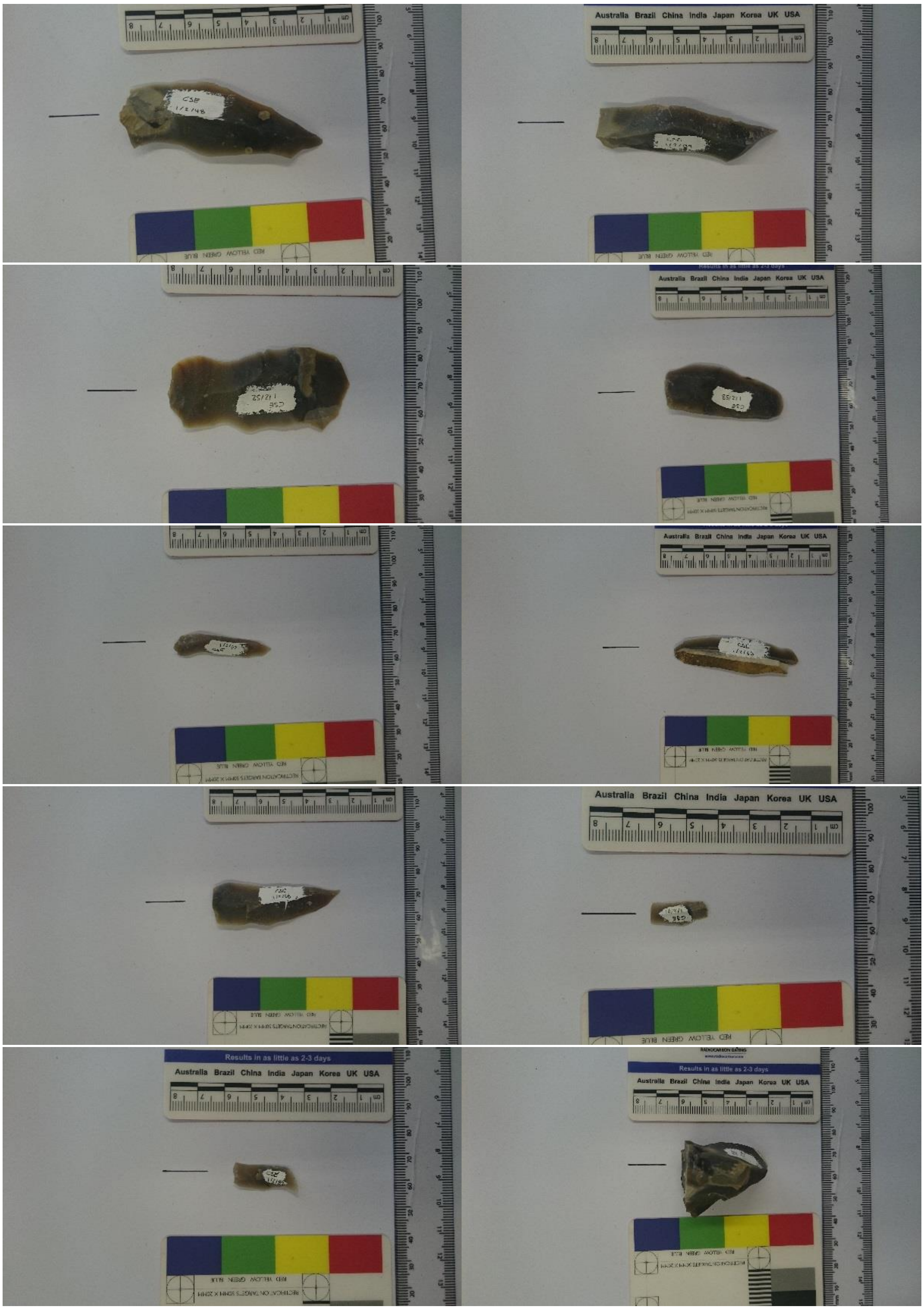
Flattening Index (Levallois vs. Laminar)

Saint-Valery-sur-Somme Two-sample test unavailable	Mesvin (IV) *Mann-Whitney U* : 39 *z* : -1.1666 *p* : 0.24338 *Monte Carlo p* : 0.2557	Baker's Hole (various) Two-sample test unavailable
Crayford (various) Two-sample test unavailable	Le Rissori (IV) Two-sample test unavailable	Le Rissori (IIIB) *Mann-Whitney U* : 2 *z* : -2.1675 *p* : 0.030194 *Monte Carlo p* : 0.015
Le Rissori (IIIA) *Mann-Whitney U* : 13 *z* : -2.1345 *p* : 0.032799 *Monte Carlo p* : 0.0284	Therdonne (N3) Two-sample test unavailable	Rocourt Two-sample test unavailable
Bettencourt-Saint-Ouen (N2B) *Mann-Whitney U* : 140 *z* : -0.12625 *p* : 0.089954 *Monte Carlo p* : 0.9065	Fresnoy-au-Val (Série 1) *Mann-Whitney U* : 86 *z* : -3.074 *p* : 0.0021124 *Monte Carlo p* : 0.0017	Experimental (multiple) *Mann-Whitney U* : 6437 *z* : -6.3352 *p* : 2.371 E-10 *Monte Carlo p*: 0.0001

Appendix 4 (Selected Photographs)

Experimental blades and blade debitage

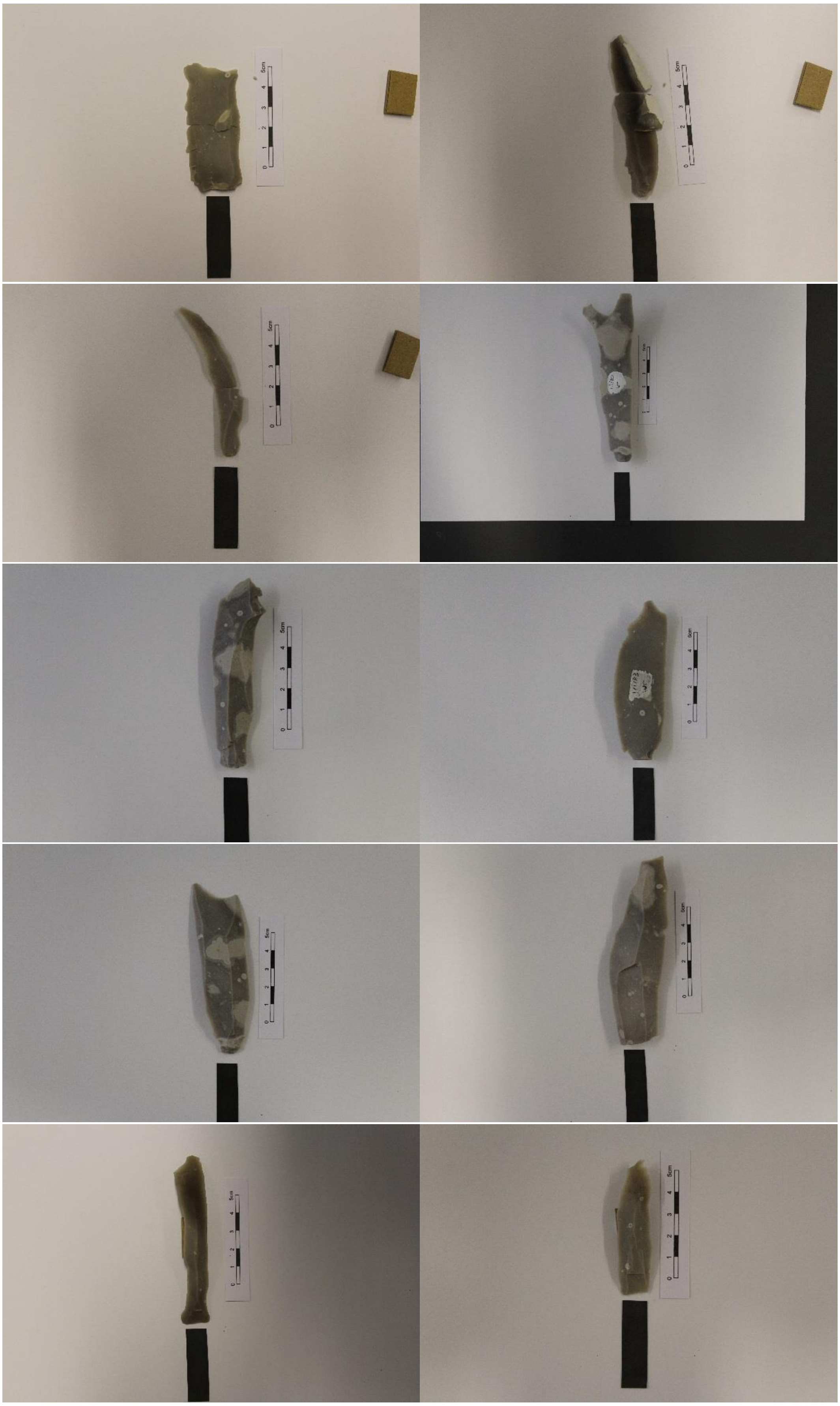
Caistor St. Edmund Flint

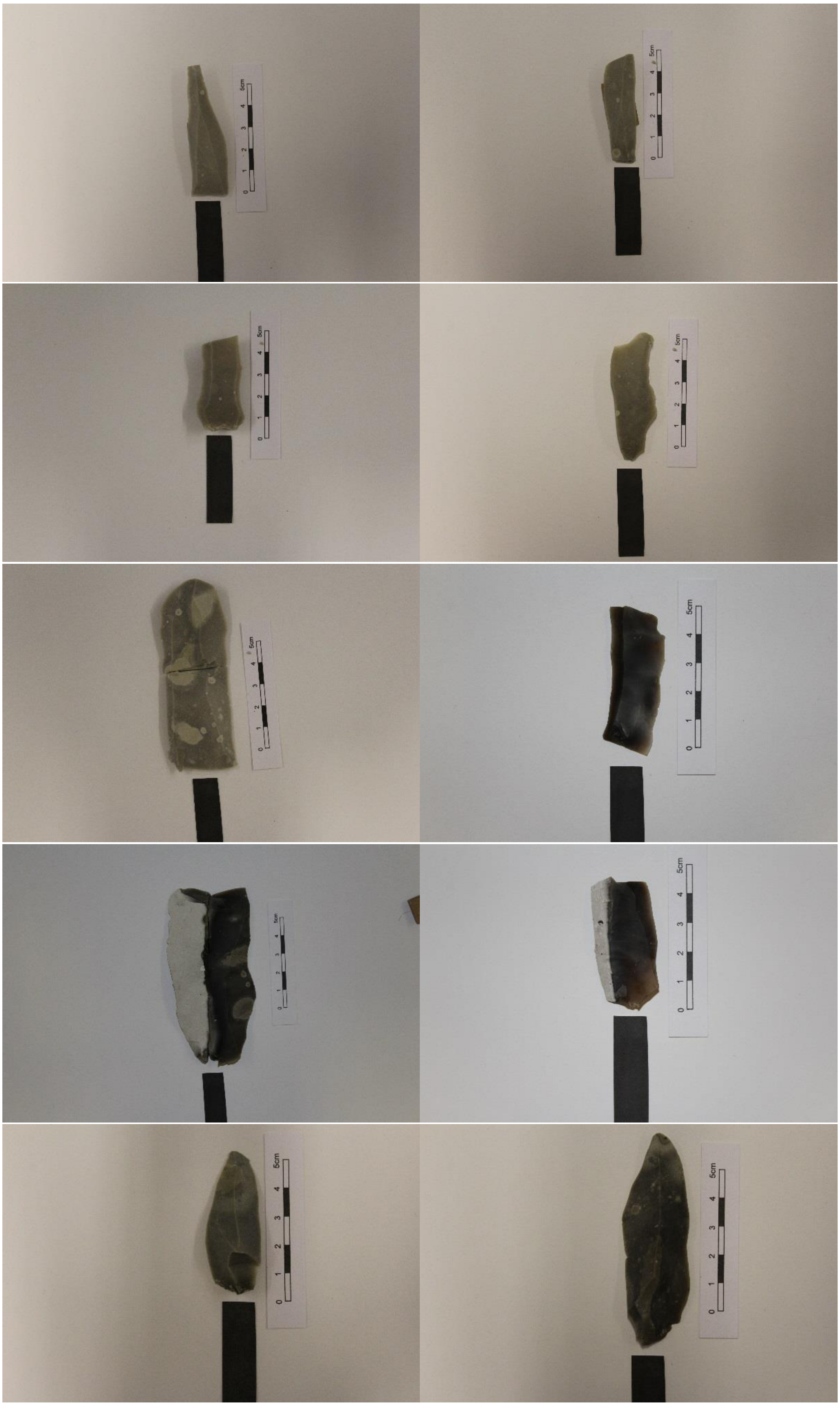

Australia Brazil China India Japan Korea UK USA
Results in as little as 2-3 days

Beer Head Flint


BR 4/2/87
BR 4/2/92
BR 4/2/94
BR 4/2/110
BR 4/2/116
BR 4/2/122
BR 4/2/124
BR 4/2/134
BR 4/2/139
BR 4/2/9

West Runton Flint





Ingham Flint

References Cited

Archaeological blades and blade debitage

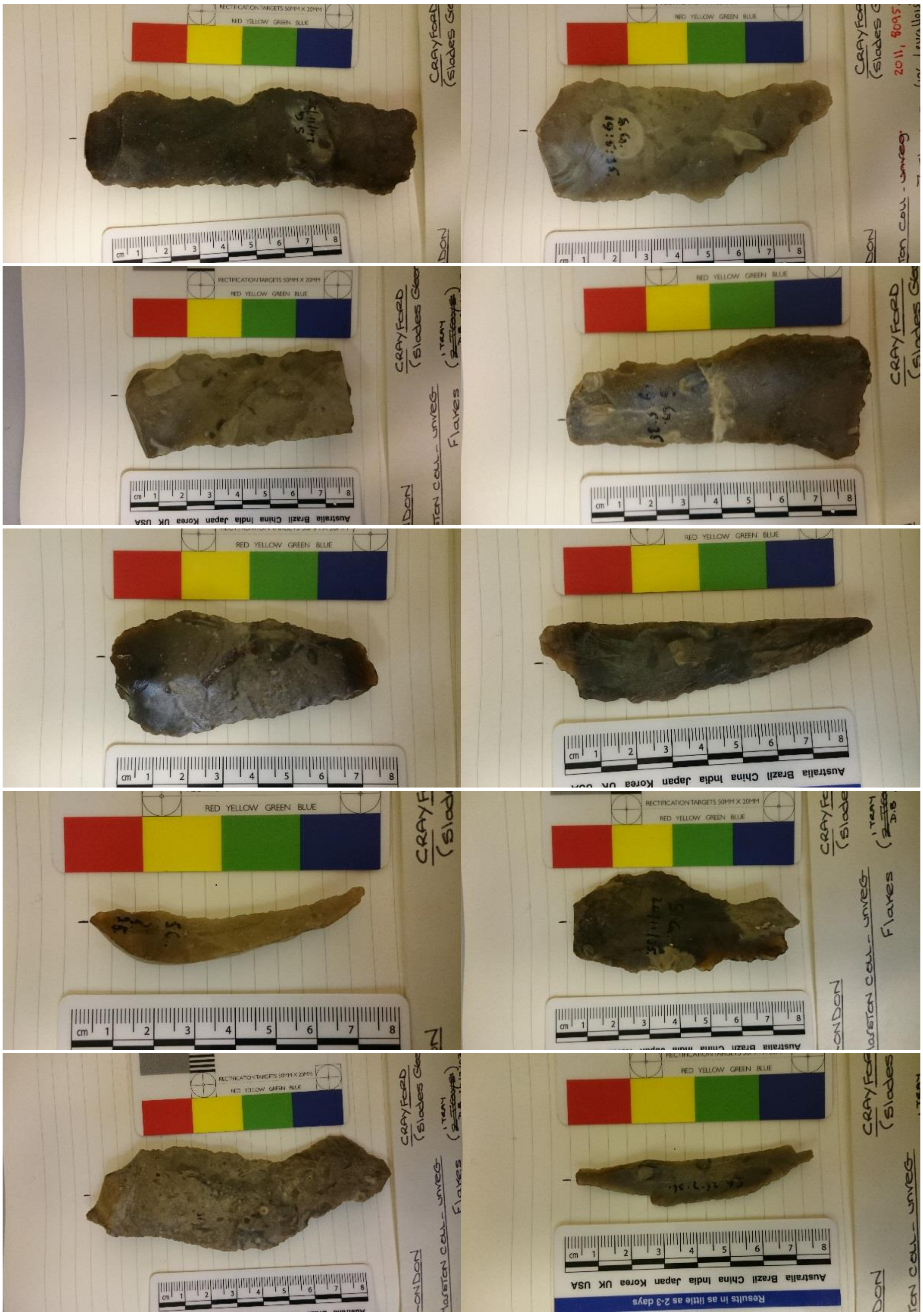
Baker's Hole


8 CMS
RECTIFICATION TARGETS 50MM X 20MM
261109
256780

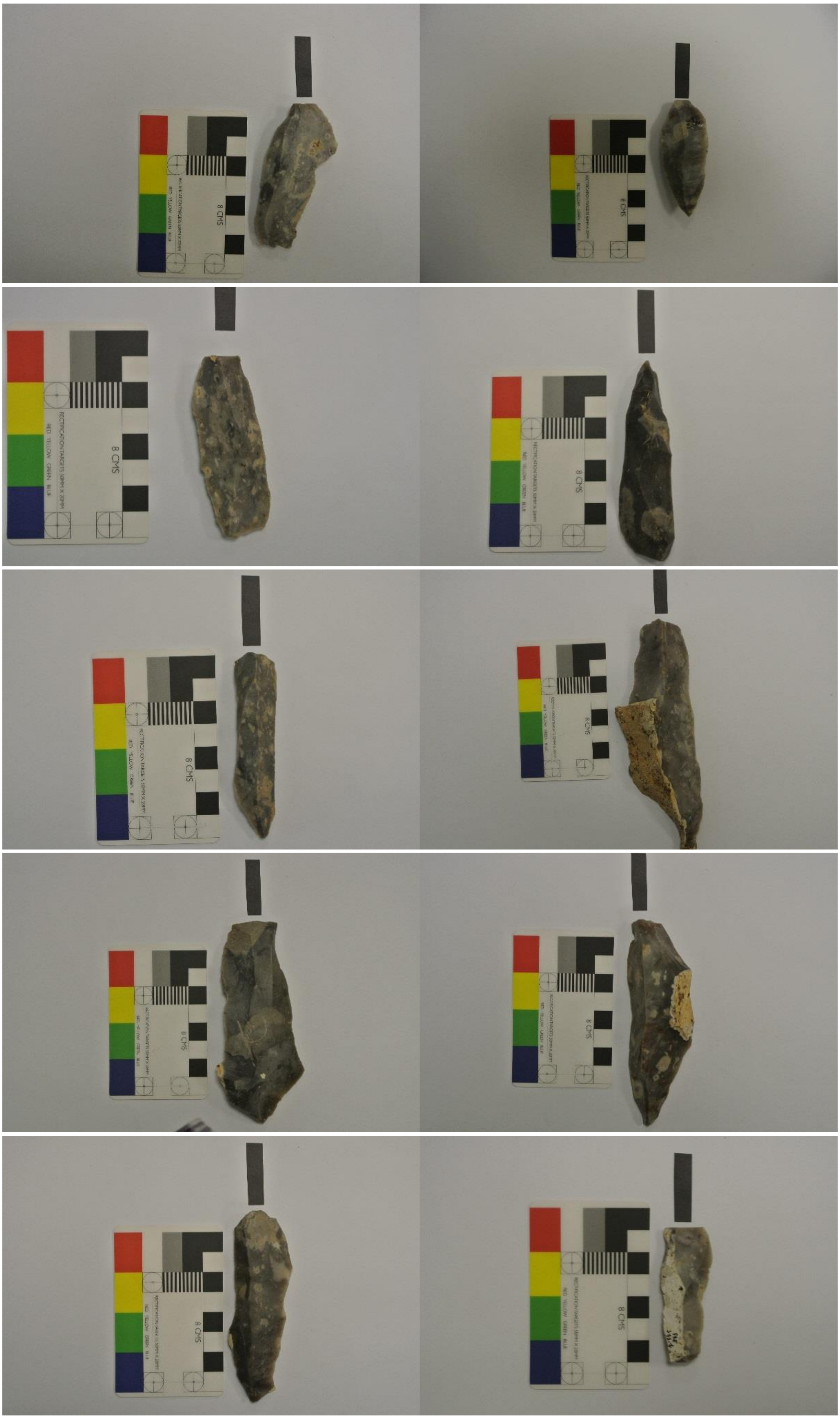
Bettencourt-Saint-Ouen (N2B)

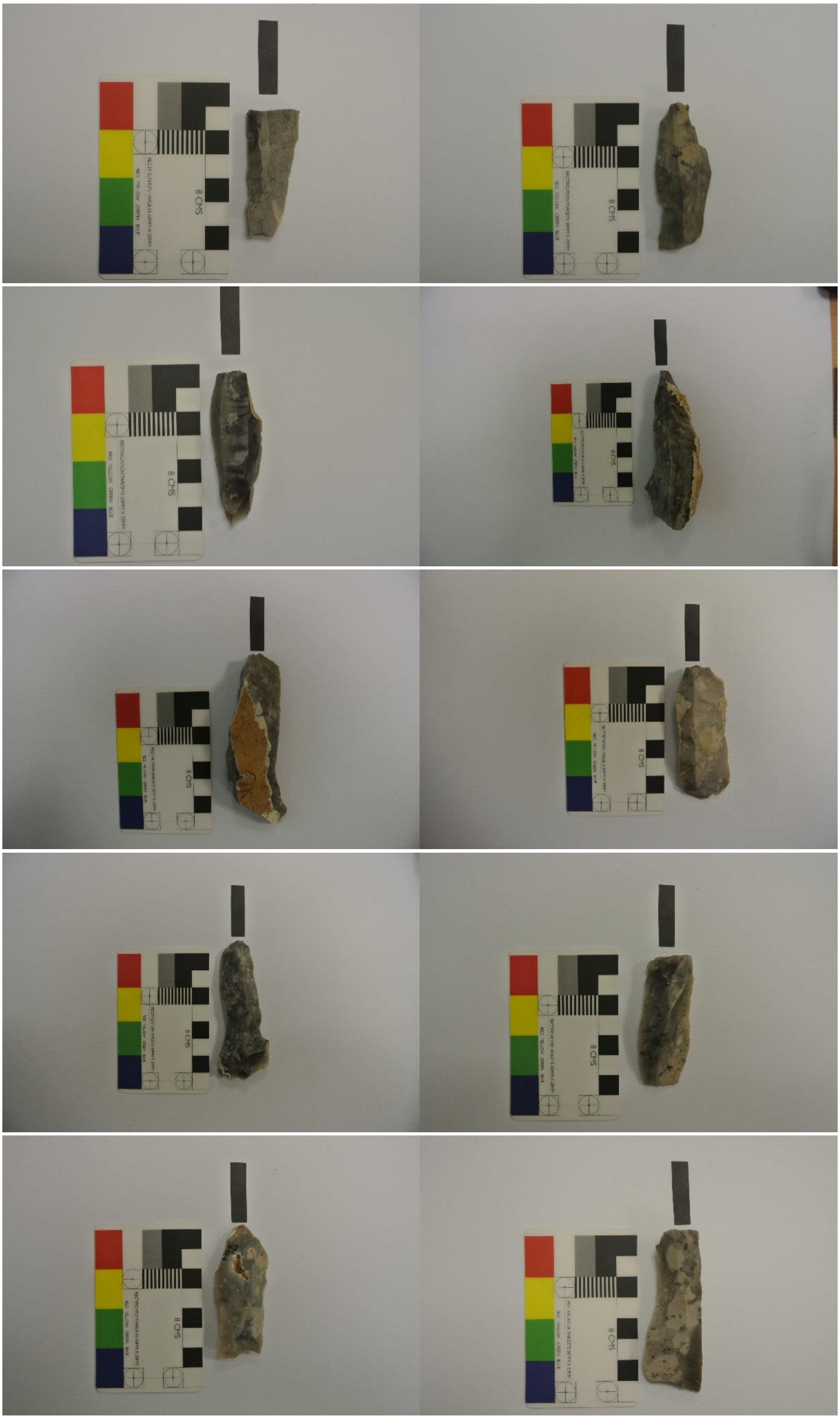

80 F 6.3
1
AA 40

Crayford (various)


RED YELLOW GREEN BLUE
RECTIFICATION TARGETS 50MM X 20MM
CRAYFORD
Flakes
Australia Brazil China India Japan Korea UK USA
Results in as little as 2-3 days

Fresnoy-au-Val (S1)





Le Rissori (IIIA)

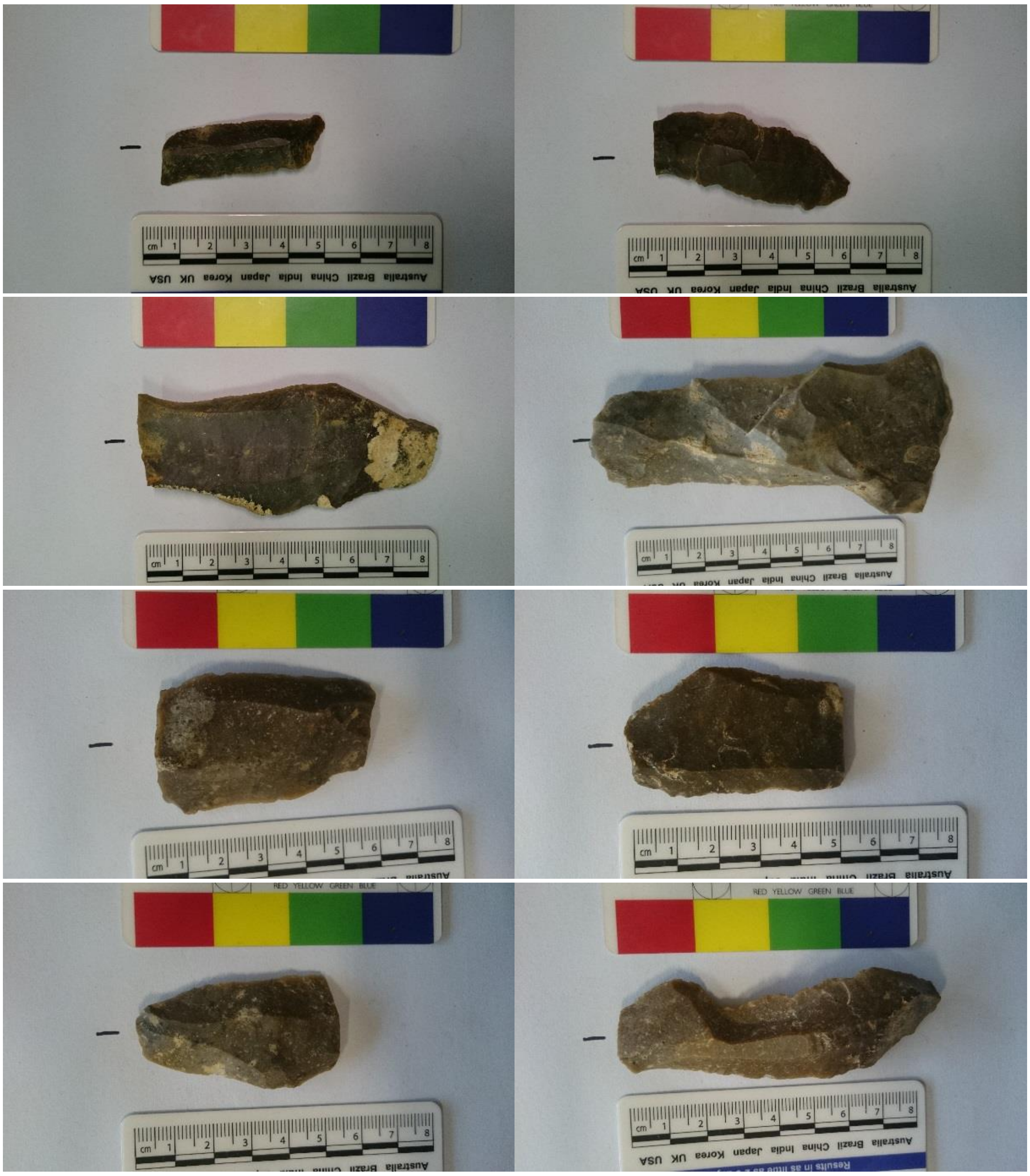

RECTIFICATION TARGETS 50MM X 20MM
RED YELLOW GREEN BLUE

 References Cited

Le Rissori (IIIB)

References Cited

Le Rissori (IV)



Mesvin (IV)

References Cited

Rocourt

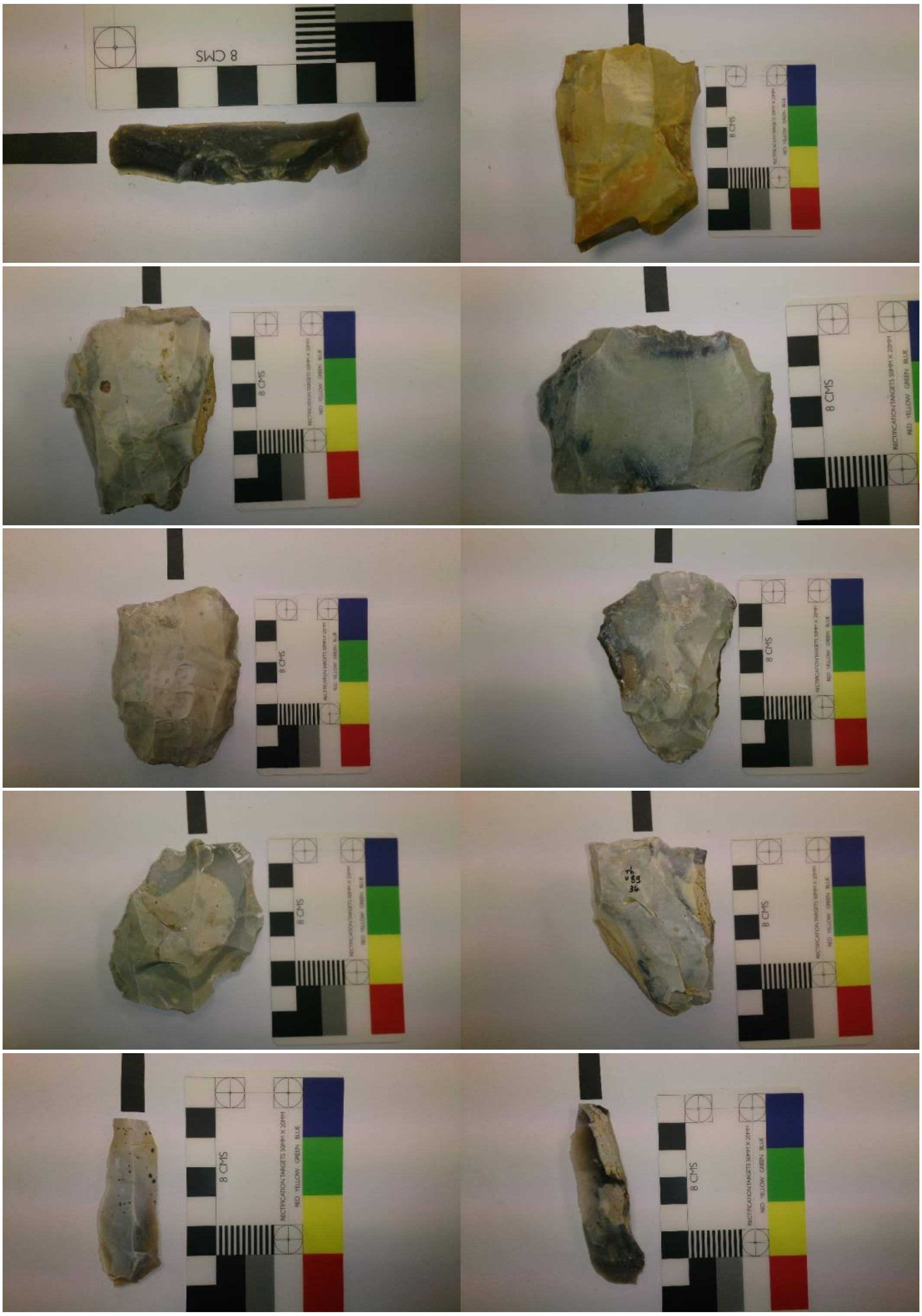

Results in as little as 2-3 days
Australia Brazil China India Japan Korea UK USA


RED YELLOW GREEN BLUE

Saint-Valéry-sur-Somme (MVR)


8 CMS
+AB 76
+AB 76
+AB 11

Therdonne (N3)



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