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Ethics by design: Responsible research & innovation for AI in the food sector

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ABSTRACT

Here we reflect on how a multidisciplinary working group explored the ethical complexities of the use of new technologies for data sharing in the food supply chain. We used a three-part process of varied design methods, which included collaborative ideation and speculative scenario development, the creation of design fiction objects, and assessment using the Moral-IT deck, a card-based tool. We present, through the lens of the EPSRC's Framework for Responsible Innovation how processes of anticipation, reflection, engagement and action built a plausible, fictional world in which a data trust uses artificial intelligence (AI) to support data sharing and decision-making across the food supply chain. This approach provides rich opportunities for considering ethical challenges to data sharing as part of a reflexive and engaged responsible innovation approach. We reflect on the value and potential of this approach as a method for engaged (co-)design and responsible innovation.

1. Introduction

Predicting and influencing the future is a complex undertaking. It could however be argued that this is what Responsible (Research and) Innovation (RRI) asks innovators to do through Anticipation, Reflexivity, Inclusion and Responsiveness about the implications of their work (Stilgoe et al., 2013). This approach has been adapted by the Engineering and Physical Sciences Research Council (EPSRC) in the UK to become a framework for Responsible Innovation using the acronym for Anticipate, Reflect, Engage and Act (AREA)(EPSRC, 2022) within the context of the societal desirability, ethical acceptability and sustainability of research and innovation (von Schomberg, 2011). This reflective piece describes and illustrates how RRI, regarding an autonomous food allergen tracking system was approached in a multidisciplinary way. This included researchers from disciplines including food systems, design, ethics, computer science, agriculture, chemistry and information systems. It is intended that this illustrated reflection could act as provocation and inspiration for others who find that in order to predict and influence the future of research and innovation, it helps to 'design and make it' first, even if it is yet to exist.

The need to anticipate the future is a challenge shared by designers who have developed a series of methods for doing so in order to inform their work (Coulton et al., 2017; Dunne and Raby, 2013). While attempting to predict a single set future is fruitless, by exploring potential futures we can consider ramifications for the present, and inform design and innovation (Voros, 2001). The reflection set out here concerns the adoption and combination of two design methods to first 'create' a future of a technology through design fiction, and then engage with its potential benefits, harms, and associated amelioration strategies through the use of an 'ethics by design' (Dignum et al., 2018; World Economic Forum, 2020) card-based tool (Urquhart and Craigon, 2021). This paper provides an example of 'ethics by design fiction' for trustworthy autonomous data sharing in the food system.

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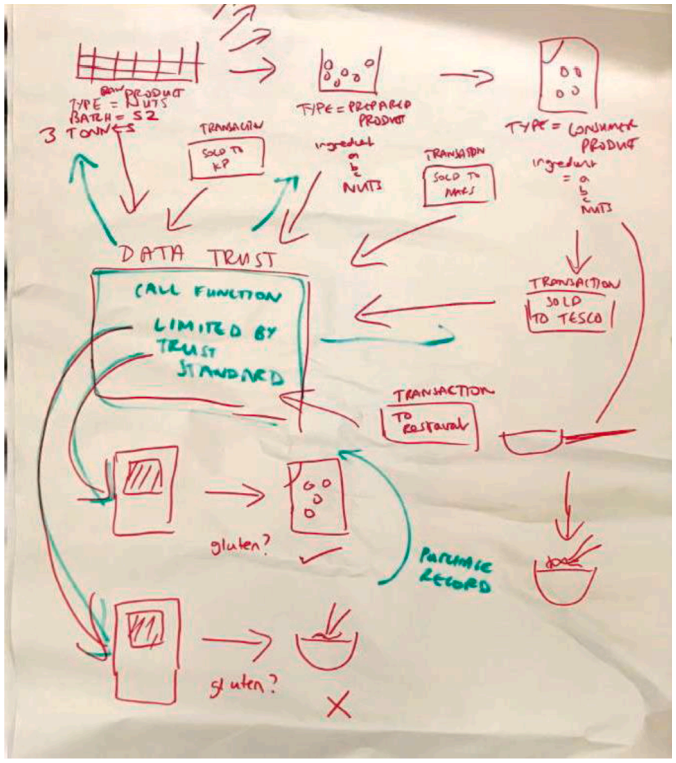


Fig. 1. A sketch created during brainstorming displays the initial allergen data trust scenario, which shows how data about food is potentially shared across the supply chain. A shipment of food containing allergens (e.g. nuts or gluten) described in red moves from the top left corner, clockwise, being distributed amongst retailers and consumers. The arrows represent data about the shipment being communicated back and forth to the data trust (central box). The two boxes at the bottom show an app for example using the data to inform a consumer about the presence or otherwise of allergens in their food.

2. The project

This reflection examines prior work done to investigate the ethical implications of data sharing, data trusts and digital collaboration in the food system. This was undertaken by a multidisciplinary working group of experts, interested in the digitalisation of the food system, convened to develop an approach to investigating the '*Ethical dimensions of digital collaboration in the food sector, such as the unintended consequences of AI*'. (see Brewer et al., 2019; Brewer et al, 2021; Brewer and Pearson 2019, for details). We reflect on the novel combination of design methods developed to explore and engage with these issues in a creative, open and engaging way. More detailed discussion of the working group activities can be found elsewhere (Jacobs et al., 2021) but this current reflection will engage with the activities of the project through the lens of RRI and particularly the AREA framework to provide insight into this approach as a potential model for the engagement with the ethical complexity of the development, deployment and use of autonomous systems.

The work of the project included three main activities. These are described, illustrated and the focus of the reflections throughout this paper. These activities were

1 **An Initial Scoping workshop** – This is where the group first met, discussed data sharing within the food sector from their differing perspectives and developed a proposed scenario for exploring it further, concerning tracking allergens through the food supply chain.
2 **Worldbuilding and Design Fiction Development** – The working group developed design fictions to concretise (fictional) instantiations of the allergen tracking system in action. This included worldbuilding, proposal of design fictions concepts and then development of four design fiction artefacts by the working group for ethical engagement and assessment
3 **Moral IT Card Ethical Assessment** – A further workshop was undertaken, with participants external to the working group, to explore the ethical implications raised by these artefacts through the use of a card-based tool in the form of the Moral-IT cards (Urquhart and Craigon, 2021). This resulted in substantive rich discussion of each artefact and the digital collaboration system they instantiated as a whole.

All workshops apart from the first scoping workshop were held online due to Covid-19 restrictions. The aim of this paper is to reflect on the processes of our project work and provide an example for practising engaged, reflective responsible innovation activities by design that could act as a potential methodological inspiration and provocation for other scenarios.

3. Initial scoping workshop

The working group first met in February 2020 to discuss approaches to the '*Ethical dimensions of digital collaboration in the food sector, such as the unintended consequences of AI*'. Discussions from the multidisciplinary group identified the different understandings of ethical terminology across disciplines. This highlighted the need to explore and consider these multiple and different meanings in relation to AI and food, for example around transparency and traceability (Manning et al., 2022). Combining the expertise of the working group members facilitated deeper examination of these multiple meanings, and the establishment of a shared understanding. This was enabled by situating ethical issues via a tangible example (see below and Fig. 1). Speculative design methods were thus chosen to enable development of mutually coherent artefacts (Jacobs et al., 2021) which could also be assessed through the use of the Moral-IT cards.

The concept scenario developed during this discussion was a food allergen tracking system (Fig. 1). This is an example of a scenario in which proposals for data sharing in food systems raise multiple ethical issues, for example safety and privacy. – Allergen tracking involves collating data from across the distributed food system, has serious life or death ramifications, and may involve special categories of data such as health information relating to individuals with associated privacy concerns. The potential system envisaged using data from a variety of food chain stakeholders to provide information on allergen content for food products at different stages of the production and distribution chain. It was intended that this system would utilize automation and AI technology, such as machine learning algorithms to facilitate the sharing of data.

4. Worldbuilding and design fiction development

Subsequent meetings of the working group were convened to build a world and develop design fictions in relation to this allergen tracking scenario.

Design Fiction is a research methodology that aims to create space for discussion around possible futures, through worldbuilding and the creation of artefacts to represent and produce an imagined storyworld with "focus on generating understanding and insights rather than finished products" (Dunne and Raby, 2013 p51). To this end a design fiction is "(1) something that creates a storyworld; (2) has something being prototyped within that story world; and (3) does so in order to create a discursive space" (Lindley and Coulton, 2015 p210). Further discussion of the methodology can be found in Heidingsfelder et al., (2017).

The working group anticipated, reflected, engaged and acted, individually at first, to create their storyworlds around the envisaged allergen data sharing scenario. This individual work formed the basis for

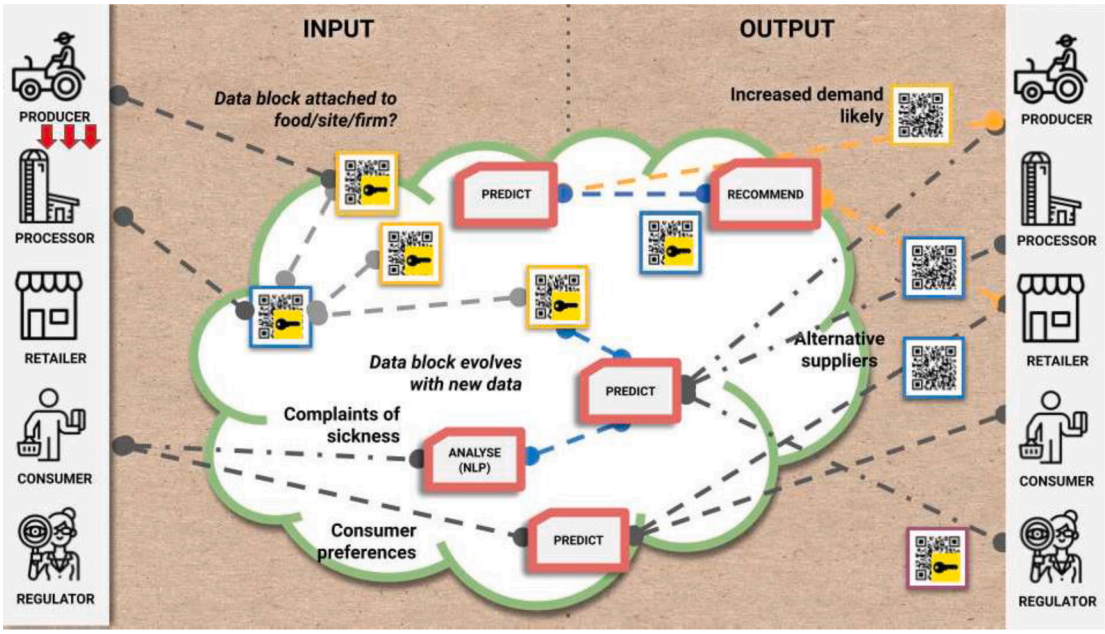
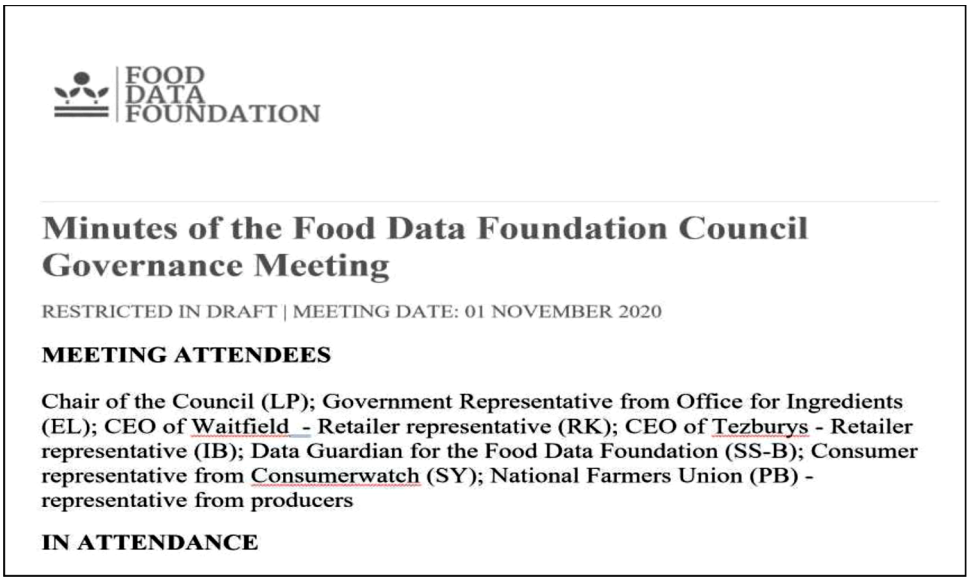


Fig. 2. To combine and structure our working group's conceptions of what a data trust might look like, we constructed a world-building diagram showing key relationships and how data moves between actors.



FOOD DATA FOUNDATION

Minutes of the Food Data Foundation Council Governance Meeting

RESTRICTED IN DRAFT | MEETING DATE: 01 NOVEMBER 2020

MEETING ATTENDEES

Chair of the Council (LP); Government Representative from Office for Ingredients (EL); CEO of Waitfield - Retailer representative (RK); CEO of Tezburys - Retailer representative (IB); Data Guardian for the Food Data Foundation (SS-B); Consumer representative from Consumerwatch (SY); National Farmers Union (PB) - representative from producers

IN ATTENDANCE

Fig. 3. Fictional minutes initiated discussion on how such a board's ethical review processes would function and what governance structures were in place for certification of new technological applications.

engagement with the ethics of such a system. These individual anticipations and reflections were then collated to inform a worldbuilding workshop facilitated by the group members with design expertise. For example, Fig. 2 shows the mapping of the fictional worldbuilding scenario created by the group, including the multiple actors involved.

The individual reflections and worldbuilding workshops led to the development of 7 proposed artefacts to illustrate and capture potential ethical issues raised. Four of these design fiction artefacts were chosen by the group for further development. The group worked in teams of two to create each artefact (See Figs. 3–8).This process translated these reflections and engagements into appropriate 'diegetic prototypes' (Lindley and Coulton, 2015) or physical manifestations of envisaged elements of the speculative data trust scenario to form the basis for future ethical reflection, engagement and potentially action.

The four resultant design fiction artefacts were intended to represent and provoke discussion around aspects of the speculative data trust scenario and allow people interacting with them to identify and explore areas of potential ethical significance. Some of the ethical challenge areas were based on the prior working group discussions and activities and were consciously built into the chosen prototypes The artefacts were intended to provide, parallel, differing perspectives on and 'entry points' into the world and data trust model created through the worldbuilding process; providing insight into different areas of ethical importance and highlighting different avenues for engagement with this model and the ethical issues it may cause. These artefacts were as follows:

- **Minutes** – A set of meeting minutes from the Food Data Foundation Council Governance Meeting (Fig. 3)

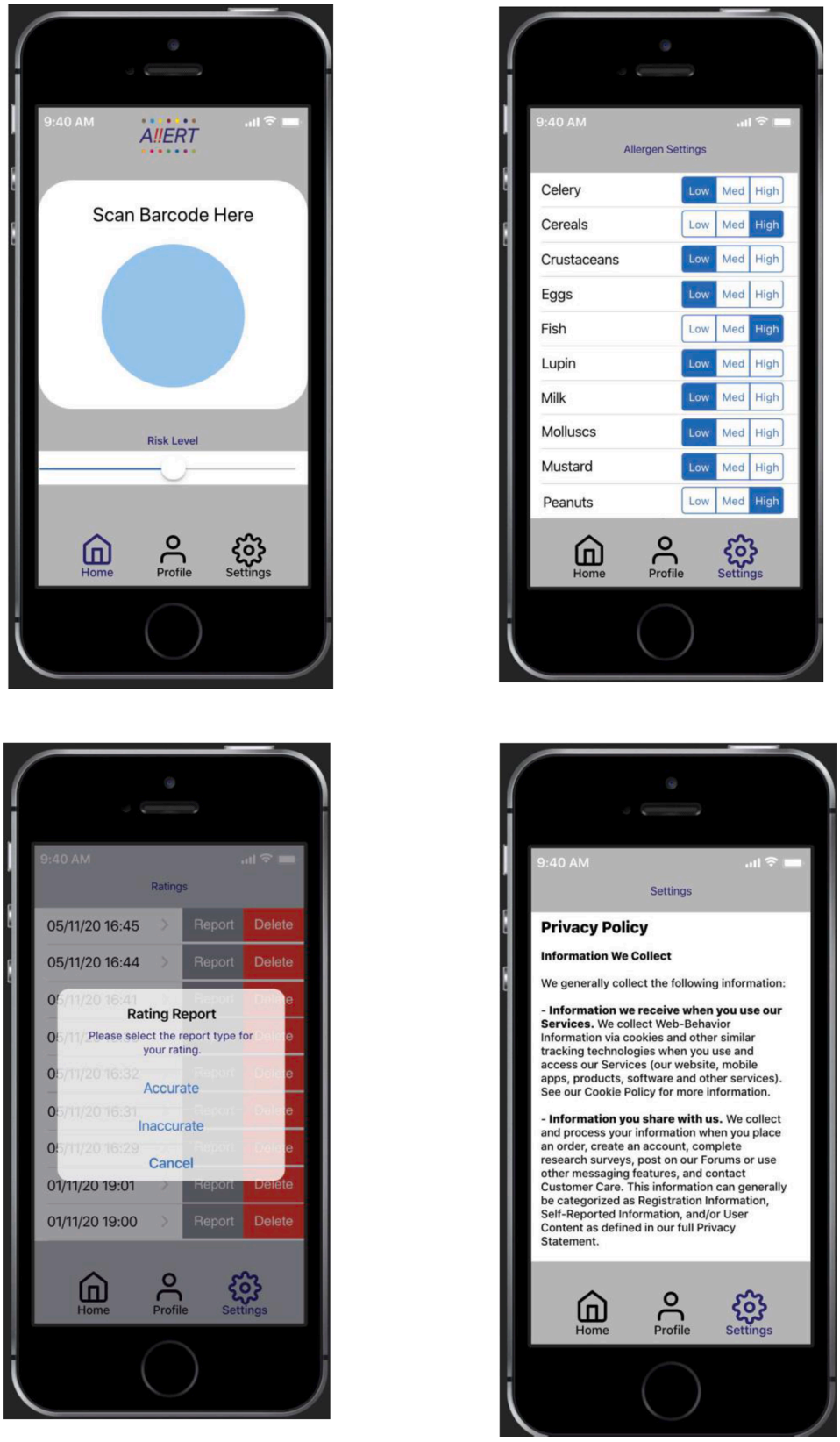


Fig. 4. The fictional mobile application ALLERT allows a user to scan for allergen information, set their personal preferences and sensitivities to 14 key allergens, report inaccuracies, and review the privacy policy.



Fig. 5. In our fictional documentary, various actors within the food chain comment on a challenging situation resulting from inaccurate data being shared and acted upon within a food supply chain.

- This included an ethical review of a proposed mobile application, and discussion of related governance concerns for the data trust. These fictional minutes highlighted and enabled engagement and reflection on aspects of stakeholder roles and responsibilities.

- **ALLERT App** –Wireframes and screenshots of a mobile application called ALLERT to allow users to track allergens (Fig. 4)
  - This materialised a (fictional) mobile application called ALLERT which allowed the public to track allergens, based on users' own data and data collated from the supply chain data trust. This was intended to show how end users may interact with data from the data trust system and raise questions around privacy and the use of special categories of data.
- **Documentary** – A short video clip from a documentary highlighting stakeholders' views of the consequences of a false alert arising from the data trust system. (Fig. 5)
  - A three-minute video represented an excerpt from a (fictional) documentary set in the future. It described a false allergen alert from the data trust system and its effect on stakeholders, who were given their own voice, to act as an example of what might go wrong with data sharing in the food system.
- **Packaging** – Smart packaging where information concerning allergens and other issues is presented to the consumer via a small information screen updated continuously via the internet. (Figs. 6 and 7)
  - The smart packaging used data made available through the data trust. It provided data from the system to the end user of the food product in the form of a label updated live and in real time via the internet. This highlighted, for example, the likely presence of allergens in the product, if it had been recalled, or data relating to its manufacture, raising questions around data quality, ethical production processes and sustainability.

Linking the artefacts together to create a cohesive world required the design of logos for the key organisations represented, to be used across the artefacts (Fig. 8)

5. Moral-IT card ethical assessment

As the next stage of the process, these four design fiction objects were presented and discussed in a separate online workshop to external participants through a combination of videos and images, made available via interactive links. To ethically assess the data trust represented by the design fiction objects, the workshop participants conducted an adapted version of the Moral-IT process described by Urquhart and Craigon (2021).

Card based tools are well established in design (Peters et al., 2020; Roy and Warren, 2019, Wolfel and Merrit 2013) and have been developed from pure design tools and towards more reflective tools for engaging with ethics of science and the 'ethics by design' of technology (Felt et al., 2014, 2018; Urquhart and Craigon, 2021). Through providing information in an abstract form, in the place of an expert (Felt et al., 2014), such cards provide an anchored (Urquhart and Craigon, 2021), narrative infrastructure (Felt et al., 2018) with an interpretive flexibility (Felt et al., 2014). This serves to 'level the playing field' for discussions about ethics by treating all participants and their contributions equally through a structured process of card use. Their use triggers conversations, raises ideas and introduces perspectives that may otherwise go unconsidered without the cards (Urquhart and Craigon, 2021).

Participants were asked to use the cards (Figs. 9–11) to help them identify and discuss potential ethical *benefits* as well as ethical *harms* of the data trust system. The substantive discussions of this workshop are not considered in depth here, but Fig. 11 gives an indicative illustration of the discussions held through the cards selected and discussed.

The following examples highlight the complexity and nuances of discussion sparked by this process. Participants viewed that data sharing as represented by the four design fiction objects could provide benefits,



Fig. 6. We constructed a physical representation of our fictional smart packaging to give an immersive experience of how it functions; this was conveyed to participants in an online workshop via a video.



Fig. 7. The packaging displays a range of information 'live', updated via the internet from the data trust. The label cycles through different screens providing a range of information about the food.



Fig. 8. To give verisimilitude to the design fiction objects, logos were designed for the key actors: the company who created an app, the national governance body, and the data sharing institution.

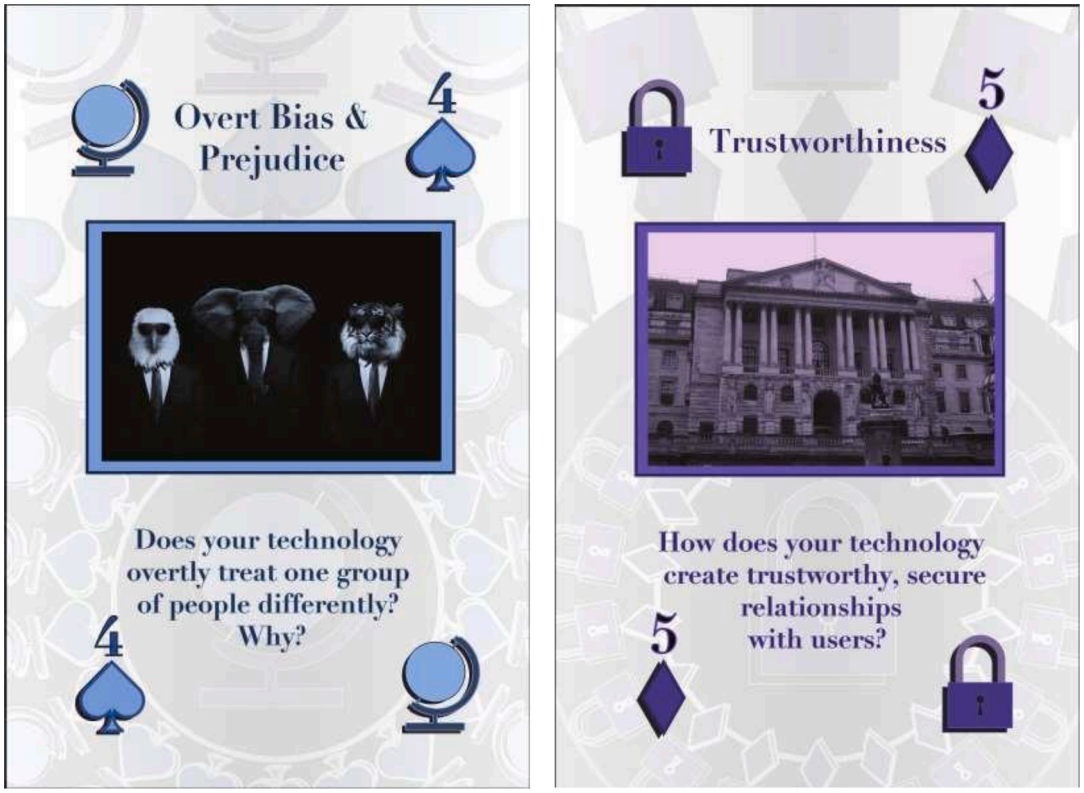


Fig. 9. Two example Moral-IT cards. Participants had to choose which cards related to the design fiction objects for the group, for example in terms of potential benefits or harms.

such as to wellbeing or physical safety, (Fig. 11 top). Providing up to date information on the presence of allergens in food would lead to an improvement in the physical safety of those affected. However, the participants were also concerned that harms may arise around bias and prejudice, fairness and trustworthiness (Fig. 11 bottom). When considering things going wrong, they questioned if the impact on stakeholders would be distributed fairly, moreover if some would be unfairly impacted if they were associated with an error or harm, which was not their fault, but would become associated with their product, as illustrated in the documentary.

Considerations of participation, user empowerment and power asymmetry (Fig. 11 centre) were more contested, being identified as both sources of potential benefit and harm of data sharing through the system. Greater openness of data was identified as something that would potentially allow stakeholders to challenge existing power asymmetries in the food system, yet concerns were raised that the existing imbalances may be reinforced or exacerbated depending on the specific implementation of the system. Such reflections indicate that ethical

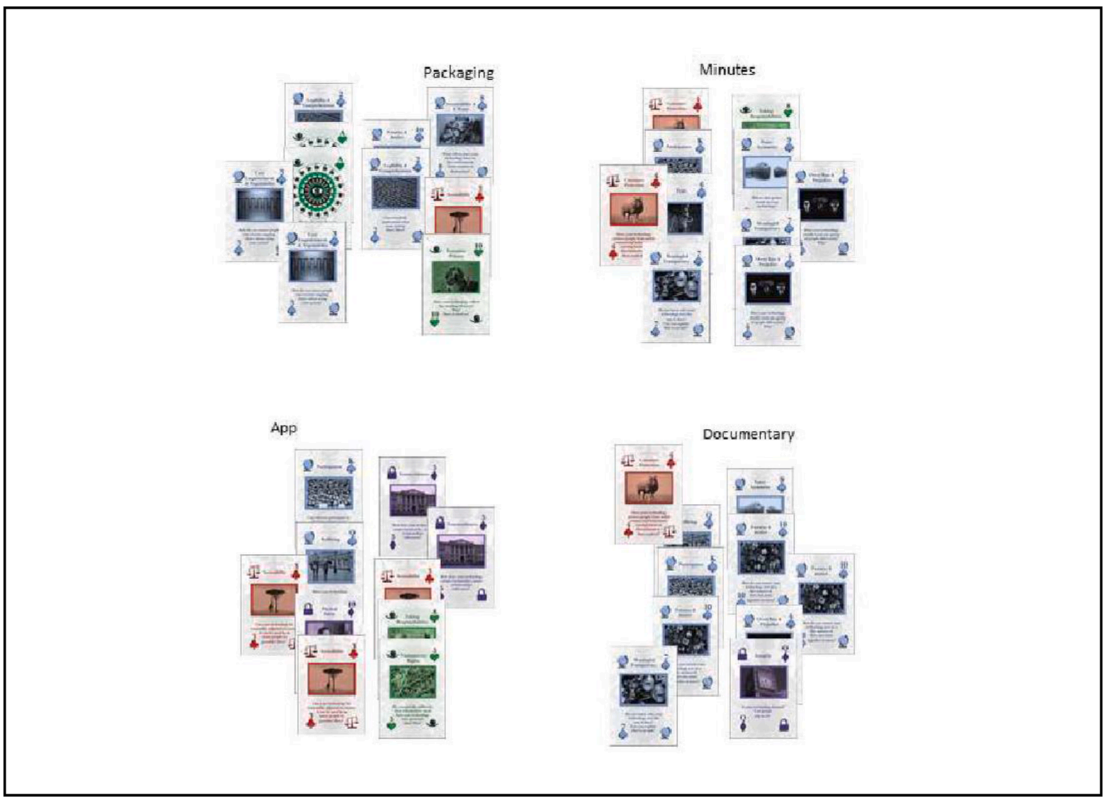


Fig. 10. Workshop participants discussed the design fiction objects in groups and selected cards representing the potential benefits (on the left) and harms (on the right) of each group relating to the design fiction object under consideration.

considerations are interlinked, context-dependant and often contested: For example, the overall issue of 'trust' of the system was identified as including concerns of 'over trust' or 'blind trust' where harm may result in a lack of valuable caution or critical reflection on using or contributing data to such a system.

6. Reflections

As an example of a methodology for Responsible Research and Innovation several key reflections emerged from this process:

Putting the technology first

As noted above, ethics, of AI and more generally, is bound up with conceptual terms, for example wellbeing, power asymmetry and bias (as shown on cards in Fig. 11), that are subject to multiple, context-dependant meanings. Responsible innovation goals, including for example ethical acceptability or societal desirability are again similarly subject to context dependant meanings. Such ambiguity may hinder communication and genuine progress towards shared understanding of these issues and goals. By following the methodology described and illustrated here, the potential difficulty of terminology and language was mitigated by 'creating' the technology first, and then situating ethical consideration around the design fiction objects. The design fiction objects raised different and unexpected ethical issues which would not have been considered otherwise. Heidingsfelder et al. (2017) attribute this quality of design fiction objects to the distinction between professional terminology and "tangible expression" as they report:

> "As opposed to professional terminology, such "tangible expression" is accessible to most people and thus can help involve a broad variety of social actors and perspectives."pg 47

For example, on presentation of the smart packaging, concerns were immediately raised regarding its sustainability due to the power it would require, and the waste that may be produced by integrating screens into every piece of packaging. Through attempting to address one ethical concern (of highlighting previously unidentified allergens through the provision of up-to-date information) an unintended consequence and different ethical concern was therefore revealed. Such interlinked ethical concerns and tradeoffs were highlighted which would not have emerged in abstract consideration of concepts in isolation such as 'sustainability'. They only did so through the building of a world and its associated artefacts.

Visibility of AI or its implications

Whilst putting the technology first grounds the discussion of ethical implications, it also provides valuable insight into the ethical consideration of AI. Our process puts the focus on the *implications or consequences* of AI that are materialised yet remain invisible or opaque in their operation. The users of the technology, in this case, those who assessed the artefacts cannot have a full appreciation of the objects and how AI contributes to their operation. On reflection this is a strength of the method, giving it greater verisimilitude, ecological validity or 'true to lifeness'. The design fiction objects did not reveal the role of AI in their operation. Instead, users experienced consequences which may be attributable to AI, other factors, or more likely a complex intertwined combination of both. For example in the documentary raising interconnected issues of fairness and power asymmetry due to a false allergy alert.

Pragmatically connecting ethical issues highlighted through this method to steps for the (ethical) development of AI may therefore be difficult. This is outweighed however by the method's value in highlighting AI as usually invisible with complex interlinked ethical implications. For example, participants highlighted how the implications of AI are subject to different national, regional and cultural contexts, and their varying attitude to trust and technology. Such considerations are vital given the globalized nature of the food system and other socio-technical systems, 'trustworthy' 'autonomous' or otherwise. Researchers and developers are therefore enabled and encouraged to think and



Fig. 11. The three spreads show the aggregated card selections for the data trust scenario in response to all design fictions; benefits at the top, harms at the bottom, and in the centre cards selected for both. Cards shown – Top – Privacy Ace ' Think of a time you were amazed by a new technology. Why?', Due Process, Physical Safety, Wellbeing, Consumer Protection, Duty of Care. Middle – Trust, Meaningful Transparency, Legibility & Comprehension, Power Asymmetry, User Empowerment and Negotiability, Accessibility, Participation. Bottom – Resilience and Low Redundancy, Special Categories of Data, Fairness and Justice, Overt Bias and Prejudice, Liability, Taking Responsibilities, Trustworthiness.

engage more widely around their work, a key component of RRI, as Heidingsfelder et al. (2017) observe of design fiction objects:

> 'They help transcend the limitations of specific terminologies or methodologies and transform diverse, and also intercultural, perspectives into shared visions. Finally by providing a tangible presentation of proposed functionality, they can encourage engineers and researchers to focus their attention not only on the science of prospective inventions, but also their design.'pg 48

Open and engaging.

The multidisciplinary team complemented the nature of the challenges posed by sharing data in the food system. This multidisciplinarity was supported and fostered by creating fictions based in objects and images rather than language which mitigated the difficulties of discipline specific language and jargon. The creative approach of world-building was central to this with the process *as well as* the resulting artefacts being equally important in revealing and identifying ethical issues which would have otherwise gone unconsidered. Viewing this through the lens of responsible innovation shows how the central processes of anticipation, reflection, engagement and action are intertwined and not a consecutive discrete process to *"enable people from a broad variety of social and professional backgrounds to explore and express their preferences for future technologies"* (Heidingsfelder et al., 2017 pg 46)

Part of an iterative design process?

We acknowledge that the example discussed here comprises only a few individual artefacts to provide insight into a world. However, as suggested by participants, the reflections prompted by the artefacts could potentially form part of an iterative process whereby designers could return to their process with lessons learned to create another, improved and hopefully more ethical and desirable technology (and world). Potentially, with more prominent considerations of the sustainability of their solutions than before with each step revealing more. Whilst this potential iterative process '*stands in contrast to clear and definite knowledge, it can shed light on the vast darkness of this unknown.*' (Heidingsfelder et al., 2017 pg 47)

The approach discussed here allowed for varied participation and inclusion of a wide range of voices of different backgrounds and expertise, providing different entry points for participants into the storyworld. This gives our approach the potential to act as a model for responsible innovation in other areas to include different groups, voices and perspectives. Engaging with the societal desirability of research and innovation is at the heart of RRI and our approach potentially addresses some of the barriers and issues of other methods of ethical engagement assessment and considerations (Felt et al., 2009).

7. Conclusions

The combination of engaged world-building and card-based ethical assessment shows the potential of this approach as a method for engaged (co-)design and responsible innovation. Engaging with technology through 'real' design fiction artefacts enabled working group members and workshop participants to move beyond language and terminology. They were able to assess the complexity of the ethical implications of the use of AI, through tangible speculative design artefacts and their deployment. Workshop participants situated the artefacts in the wider context of their own lives to identify potential shortcomings, make alternative design suggestions, and identify ethical tradeoffs and dilemmas. These would have been less apparent had they considered digital collaboration and data sharing in the food system in more abstract terms.

Throughout the three-stage process described here there was considerable **anticipation** and **engagement** in focusing on the issue of

data sharing and collaboration in the food system. This led to an ongoing process of **reflection** and **action** in building the world and design fiction artefacts. These were then the subject of **engagement** from stakeholders who ethically assessed them using the Moral-IT cards. This laid the foundation for potential **action** in terms of identified design decisions to mitigate potential harms and maximise benefits. The world may have been fictional, but the lessons and insights gained were real in their value to informing the responsible development of data sharing in the food sector and beyond.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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