

UML-B Survey Questionnaires and Responses

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1. Introduction

This document presents the data obtained from a survey conducted on the UML-B method [1]. The survey aimed to assess the usability of the method, particularly the notation used, from the developers' perspective. The usability in the assessment context means the understandability, learnability, operability and attractiveness of the notation in supporting the modelling process. The assessment was conducted by using a usability evaluation framework namely the Cognitive Dimensions of Notations (CD) [2-3] with the usability criteria suggested by the International Organization for Standardization (ISO) [4-6]. As usability depends on the notation and the tools provided by the environment, the framework was also used to evaluate the tools accompanied the UML-B method, namely the Rational Rose [7] and the U2B tool [8], whenever appropriate.

This document is intended to record the responses rather than explain the survey. The detailed explanation of the survey execution and data analysis are included in [9]. The data presented in this document are based on ten respondents, who responded to the survey so far. The data are expected to expand in future.

2. Questions and Results

The following paragraphs present the responses for each of the questions in the UML-B survey questionnaires. The first fourteen questions reflect the dimensions of the Cognitive Dimensions framework while the subsequent five questions represent some of the usability aspects suggested by the ISO. The last question is comments for further improvement.

2.1 Visibility and Juxtaposability (ISO: Operability/Attractiveness)

Question: *If you need to compare different parts of your UML-B model (e.g. between diagrams or windows of different operations etc.), how easy is it to view them at the same time in Rose?*

Very Difficult				Very Easy
-2	-1	0	1	2

Why?

This question assessed the ability of the UML-B method to allow the user to view every component of its model simultaneously or view two related components side by side at a time. Due to the fact that the current version of UML-B method resides in the

Rational Rose application, the assessment particularly concerned the ability of the application to support the above user's activities.

The Table 1 below shows the distribution of answers. It can be seen that three of the respondents considered the activities as "easy" and "very easy". They commented that navigation in Rose was generally easy as they could view different parts of the model at the same time by opening several windows. For instance, the application allowed them to compare different operations either from one class or different classes simultaneously. They also found that switching around the windows was pretty straightforward.

There were four respondents who regarded the activities as "neither difficult nor easy", which contributed to the median value. These respondents had a mixture of agreement on the ability of the application to support the activities. They agreed that the application supported the viewing of multiple windows. However, having to view several windows and switch between them at the same time was problematic. For instance, they had difficulties in viewing a class diagram and its statechart diagrams at the same time, which made the process of mapping the operations in the class diagram and the transitions in the statechart diagrams tedious and error-prone. Besides, having several displayed windows at the same time could be confusing.

The remaining respondents considered the activities as "difficult" since besides the above limitations, they discovered other user-friendliness issues. They found that some common modelling functionality was not visible on the toolbar. For instance, there was no **Aggregation** icon on the toolbar and they needed to get it through several intricate steps, which was not obvious. In fact, they found that the **Help** in the application was not so helpful.

Table 1. "Visibility and Juxtaposability" dimension

-2	-1	0	1	2	Total
V. difficult	Difficult	Neither difficult nor easy	Easy	V. easy	
0	3	4	1	2	10
Median : 0					

2.2. Viscosity (ISO: Operability)

Question: *If you need to rebuild/restructure your UML-B model (e.g. due to change in ideas or requirements or solutions), how easy is it to make the changes?*

Very Difficult				Very Easy
-2	-1	0	1	2

Are there any particular changes that are particularly difficult or tedious to make? If Yes, which ones?

This question assessed the degree of effort required by the user to perform a change in the UML-B model. The change in this regard includes editing the diagrams and the respective semantics of the model in Rose as well as retranslating the model to a B

The Table 4.1 and 4.2 below show the distribution of answers. It can be seen that six of the respondents considered making mistakes in the diagrams as “neither difficult nor easy”, which contributed to the median value. These respondents agreed that modelling using the diagrams was simple. However, since the diagrams would be translated to a B model at the end, they had to be more careful and conscious. Each time they added a feature to the diagrams, they tended to transform the UML-B model to the B model using the U2B tool in order to see the effects. They wanted to ensure the added feature had the effect that they intended in the B model, besides being able to verify the model using the prover.

Two respondents commented that making mistakes in diagrams was “easy” and “very easy” because of the limitation of the Rose application itself, which did not synchronise the changes made to the class diagram with the statechart diagram. The mistakes were not obvious until they run the prover. In addition, one respondent found that the multiplicity of associations had to be given more thought during the modelling. This was because unsuitable multiplicity could violate the invariants of the B model even though the multiplicity seemed to make sense in the diagrams. The remaining two respondents thought it was “difficult” to make mistakes because even if they did, the mistakes could easily be identified and corrected.

In contrast, eight of the respondents believed that it was “easy” and “very easy” to make mistakes when defining the formal semantics using the B syntax. Since the semantics had to be specified literally through typing, there was always a tendency to make mistakes such as wrong variables names, data types, inappropriate use of clauses and typos. Moreover, the syntax checking had to be done manually as there was no such facility in Rose. Having the semantics scattered around different parts of the models made the task troublesome, as the semantics could not be viewed easily at once. Any mistakes in applying the B syntax could only be realised when they transformed the UML-B model to a B model and run the prover. Several respondents also highlighted that the mistakes were “easy” to make due to lack of understanding, documentation and experience on the UML-B method. In fact, they were also new in the B method and were novice users of UML, which made them prone to errors.

The remaining two respondents believed that it was “difficult” to make mistakes due to the formality imposed by the B syntax.

Table 4.1 “Error Proneness” dimension: Diagram

-2	-1	0	1	2	Total
V. Difficult	Difficult	Neither difficult nor easy	Easy	V. easy	
0	2	6	1	1	10
Median : 0					

Table 4.2 “Error Proneness” dimension: Syntax

-2	-1	0	1	2	Total
V. Difficult	Difficult	Neither difficult nor easy	Easy	V. easy	
0	2	0	6	2	10
Median : 1					

2.5. Progressive Evaluation (ISO: Operability)

Question: *Can you stop modelling your UML-B model at any time you like and check your work so far (i.e. by translating it to B model using U2B and performing model validation and verification in B tools)?*

No **Not Sure** **Yes**

Why?

This question assessed the ability of the UML-B method to allow the user to evaluate his or her work in progress at any time. The evaluation process involves the transformation of the UML-B model to the B model using the U2B tool and the execution of the prover. The question required the respondents to indicate whether or not it is possible to stop modelling at any time to check their work so far. The respondents had to state why if it was not possible.

The Table 5 below shows the distribution of answers. It can be seen that majority of the answers were “yes”. The remaining respondents were not sure or thought it was not always possible depending on at what stage they stopped. They believed major elements of the UML-B model needed to be specified correctly before translating the model to the B model. Otherwise, they found that the error messages generated by the U2B tool and the prover were too intimidating.

Table 5. “Progressive Evaluation” dimension

No	Not Sure	Yes	Total
1	2	7	10

2.6. Hard Mental Operations (ISO: Understandability/Learnability)

Question: *Do you find any complex or difficult tasks to work out in your head when modelling your UML-B model?*

No **Not Sure** **Yes**

If Yes, what are they?

This question assessed the degree of mental processes required for the user to understand the notation and to keep track of what is happening. The question required the respondents to indicate whether or not they found any complex or difficult tasks to work out in their heads when modelling the UML-B model. The respondents had to state what the difficulty was, if any.

The Table 6 below shows the distribution of answers. It can be seen that six of the respondents stated the answer as “no”. One of these respondents commented that the visual aspect of the UML-B model helped in reducing the hard mental operations, which would exist in the traditional B modelling.

Four respondents found some complex tasks to work out in their heads. Two of the respondents found that writing correct semantics for the model was hard. One respondent discovered that by having semantics in the statechart diagram made the transformed B model more complex. For instance, the transitions in the statechart diagram were translated as nested conditions in the B model, which seemed to create conflicts with the already defined conditions. One respondent believed that having to consider and integrate two modelling styles, UML and B, at the same time was indeed a mental burden.

Table 6. “Hard Mental Operations” dimension

No	Not Sure	Yes	Total
6	0	4	10

2.7. Consistency (ISO: Understandability/Learnability)

Question: *Are there any parts in the UML-B model that seem to be similar in functionality but the UML-B method makes them appear different?*

No *Not Sure* *Yes*

If Yes, what are they?

This question assessed whether similar semantics in the notation are presented in a similar syntactic manner. The question required the respondents to indicate whether or not they found any parts in the model that seem to be similar in functionality but the method makes them appear different. The respondents had to state what the parts were, if any.

The Table 7 below shows the distribution of answers. It can be seen that six of the respondents stated the answer as “no”. The remaining respondents were not sure whether or not the parts exist.

Table 7. “Consistency” dimension

No	Not Sure	Yes	Total
6	4	0	10

2.8. Hidden Dependencies (ISO: Understandability/Learnability)

Question: *Do you find any structure dependencies in UML-B model (i.e. one part explicitly relies upon or is determined by or uses or requires another part) where the dependency is not fully visible?*

No *Not Sure* *Yes*

If Yes, what are they?

This question assessed whether there is any relationship between two parts such that one of them is dependent on the other but the dependency is not fully visible. The

question required the respondents to indicate whether or not they found any structure dependencies in the model. If they did, the respondents had to state what parts that were involved.

The Table 8 below shows the distribution of answers. It can be seen that four of the respondents stated the answer as “yes”. These respondents found that as pieces of information were scattered around different parts of the UML-B model, the relationship between these parts were not so visible until the model was generated to a B model by the U2B tool. Besides, there was implicit B syntax (other than the ones that they explicitly stated), which was created automatically by the U2B tool based on certain elements in the diagrams. The respondents found that it was not obvious, which they took some time to absorb.

The remaining respondents stated that they did not find any hidden dependencies.

Table 8. “Hidden Dependencies” dimension

No	Not Sure	Yes	Total
6	0	4	10

2.9. Secondary Notation (ISO: Attractiveness)

Question: *Does Rose allow you to make notes or convey extra information beyond the UML-B model to yourself (e.g. comments, use different fonts, layout)?*

No *Not Sure* *Yes*

If Yes, please state the possible actions.

This question assessed the ability of the UML-B method to allow the user to provide supporting information to the model by using notation other than the official semantics. As the UML-B model resides in the Rose application, the assessment particularly concerned the ability of the application to support the above user’s activity. The question required the respondents to indicate whether or not they could make notes or convey extra information beyond the model to themselves. The respondents had to state the possible actions, if any.

The Table 9 below shows the distribution of answers. It can be seen that all respondents stated the answer as “yes”. The respondents found that the notes and the documentation facility in Rose were very useful for this purpose.

Table 9. “Secondary Notation” dimension

No	Not Sure	Yes	Total
0	0	10	10

Table 12. “Provisionality” dimension

-2	-1	0	1	2	Total
V. Bad	Bad	Neither bad nor good	Good	V. good	
2	3	1	3	1	10
Median : - 0.5					

2.13. Premature Commitment (ISO: Attractiveness/Operability)

Question: *Can you go about any task in any order you like in the UML-B method?*

No *Not Sure* *Yes*

Why?

This question assessed whether the notation used in the UML-B method enforces the user to make decisions prior to modelling or there is any task ordering constraints. The question required the respondents to indicate whether or not they could go about any task in any order they liked.

The Table 13 below shows the distribution of answers for question (13). It can be seen that nine of the respondents commented that there was no task ordering constraints. They generally believed that they could start modelling as they liked. However, they found it was more logical to start with the diagrams before specifying the semantics for the operations using the B syntax.

Table 13. “Premature Commitment” dimension

No	Not Sure	Yes	Total
0	1	9	10

2.14. Abstraction Management (ISO: Attractiveness/Operability)

Question: *Does the UML-B method insist you start the modelling task by defining or grouping things first before you can do anything else?*

No *Not Sure* *Yes*

If Yes, what sort of things?

This question assessed whether the notation used in the UML-B method enforces any level of grouping mechanism. The question required the respondents to indicate whether the method insisted they start modelling task by defining or grouping things before they could do anything else.

The Table 14 below shows the distribution of answers. It can be seen that six of the respondents commented that they did not think the method insisted them to define or group things when they started the modelling. They generally found the process was natural. They would define or group things whenever required.

This question assessed the accessibility of the UML-B method. In particular, the question required the respondents to indicate how easy to become familiar with the method and to be able to use it in their task efficiently without referring to the documentation.

The Table 18 below shows the distribution of answers. It can be seen that four of the respondents found that it was “easy” and “very easy” to become familiar with the method. Once they were clear on how to use the notation correctly and had some practice in using it, the task was pretty straightforward where the documentation could be neglected. However, they admitted that the difficult part was to understand how the notation and the transformation worked as a whole.

Four respondents felt that the task was “difficult” and “very difficult” because the method integrates both UML and B. They found that learning these two notations particularly the B syntax had consumed much of their time. Moreover, they needed to learn how the two notations should be integrated in the UML-B model. They found that using the method was easy but mastering it was quite difficult.

Two respondents commented the task as “neither difficult nor easy”. There were some parts of the method such as statechart and association that required them to refer to the documentation quite often.

Table 18. UML-B method’s accessibility

-2	-1	0	1	2	Total
V. difficult	Difficult	Neither difficult nor easy	Easy	V. easy	
1	3	2	2	2	10
Median : 0					

2.19. Operability of the UML-B Method

Question: *How easy is it to do modelling using the UML-B method compared to the traditional B method?*

Very Difficult					Very Easy
-2	-1	0	1	2	

If you are given the choice in modelling, which method would you choose: UML-B or B? Why?

This question assessed the operability of the UML-B method. In particular, the question required the respondents to indicate how easy to do modelling using the UML-B method compared to the traditional B method. The respondents were also required to indicate their choice in modelling, that is, which method that they would prefer to use in modelling.

The Table 19.1 and 19.2 below show the distribution of answers. It can be seen that four of the respondents found that it was “easy” and “very easy” to model a system using the UML-B method compared to the traditional B method. These respondents

generally agreed that the modelling was easy using the UML-B method because the main elements of the model could be illustrated graphically using the UML diagrams. The diagrams indeed made the process of specifying semantics for the model more obvious. Besides, they found that much of the effort and trouble in modelling a B specification could be overcome due to the automatic transformation provided by the U2B tool. The tool was seen as capable of preventing more errors to be made on the model.

Four respondents regarded the task as “difficult” and “very difficult” because they had to integrate both styles of modelling, UML and B, at the same time. Having several different ways to specify the semantics, the UML-B method had caused some confusion to these respondents. In addition, the lack of training and comprehensive documentation was also a factor that made the method difficult to them.

In general, six respondents preferred the UML-B method to the traditional B method. Despite the limitations mentioned above, these respondents believed that the UML-B method would be useful and easier to use, if they were given more time and exposure to the method. They could see the potential of the method as it is much more closer to the realism.

Table 19.1 UML-B method’s operability

-2	-1	0	1	2	Total
V. difficult	Difficult	Neither difficult nor easy	Easy	V. easy	
1	3	2	4	0	10
Median : 0					

Table 19.2 Method attractiveness

UML-B	B	Both	Total
6	2	2	10

2.20. Further Improvement

Question: *Can you think of obvious ways that the design of the UML-B method and U2B could be improved? What are they?*

The last question of the survey provided the respondents an opportunity to raise any issue of using the UML-B method and the U2B tool. The respondents were also allowed to suggest any possible improvement that could be made on the method and its accompanied tools. Below are some of the issues and areas for improvement highlighted by the respondents:

- Provide syntax checking at the early stage, that is, during the UML-B model stage rather than having to transform the model to a B model to do the simple syntax checking.
- Provide dropdown list for the B syntax where the user could select the appropriate ones in order to avoid typos.
- Provide automatic changes in all the respective parts of the model.
- Provide a more functional and user-friendly interface for the U2B.
- Provide more comprehensive documentation on the method and its accompanied tools.

3. Summary

This document presents the feedback received from the survey conducted on the UML-B method. The survey investigated the usability of the method, particularly the notation used. The main purpose of the document is to record the survey responses (raw data) rather than analysis. The data act as the basis for the analysis documented in [9].

References

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