Using Z: the impact of specification upon quality

Chris Roast and Jawed Siddiqi

Sheffield Hallam University, Sheffield, S1 1WB, UK

Tel: +44 (0)114 225 2907

Fax: +44 (0)114 225 3161

Email: c.r.roast@shu.ac.uk

URL: http://www.shu.ac.uk/~cmscrr

The study reported is concerned with the human factors that can influence the effectiveness with which a design representation notation is exploited. We report an empirical study focusing upon the task of completing a formal specification expressed in the Z notation. The study illustrates how the requirement to employ a formal specification notation can have a deterimental influence upon the validity of the solution produced.

Keywords: Formal Specification, Z, Human Factors

1 INTRODUCTION

Although a specific design representation notation may be 'functionally adequate' and thus capable of fulfilling its role in development, it is important for users of the notation to take proper advantage of that capability. If key features of a notation are in effect un-usable, or misused, then its intended strengths may be over shadowed by what experts would see as its inappropriate use.

Examining the use, and human factors, of notations has been a common theme in HCI. Specific studies have largely focused upon programming notations (Ratcliffe & Siddiqi, 1985; Green, 1989; Green & Petre, 1996; Petre & Winder, 1988). More recently, similar concerns have focused upon specification notations (Brun & Beaudouin-Lafon, 1995; Siddiqi, 1998).

2 THE STUDY

Z is a popular mathematical design notation within software engineering education its use is encouraged especially in the context of safety critical applications. The study assesses the task of completing a partial Z specification — one containing a full natural language commentary but omitting some elements of the required Z. Specifically, we consider two influences upon such a task:

1. the influence of the problem domain and setting.
2. the influence of having to use the notation.

For a Z specification to serve as a valid design representation it is important for the problem and setting to be correctly represented, hence the first of these two influences should be encouraged. The second influence, that of the notation, is hard to avoid but should not detract from the first. We speculate that in completing a partial specification one of these influences will take priority in determining the approach to the solution taken by notation users.

Solution Approaches

A specification completion task was prepared in which the problem domain characteristics differed from the concepts that are immediately available in the Z notation. The problem is summarised in figure 1. As in empricial studies of program development, different classes of solution are characterised by 'templates' that are taken to be indicators of different user strategies for approaching the problem.

A pilot study was used to develop two solution templates to the problem: **S** solutions are based on the new video being higher than the current with no video ranked between the current and the new video, and; **C** solutions involve incrementing the value used to index

The system specified is a browser for looking through a library of videos, where the currently selected video is displayed. There is a pre-defined *horror* scale for which each video is given a rating (between 1 and 10).
Specify in Z an operation which sets the currently shown video to the next more horrific video in the library.

Figure 1: A summary of the specification completion task

the videos.

In terms of *quality of solution*, **S** solutions address the problem domain accurately, where as **C** solutions are reliant upon unwarranted assumptions about the domain. Correspondingly, we propose that in terms of *strategy*, **S** solutions demonstrate a strong influence of the problem domain, and **C** solutions indicate that notational characterisitics have taken priority.

Problem Comprehension

A supplimentary pilot study was conducted to confirm that the problem domain and setting did not implicitly encourage the unwarranted assumptions presupposed in the poorer quality **S** solutions. Out of 14 subjects, 9 (64%) selected a informal **S** solution example, 3 (21%) selected an informal **C** solution example, and two were undecided. This provided a good indicator that the problem setting on the whole was correctly interpreted in a context where its formal specification is not considered.

The Experiment

The subjects were 22 students on the final year of a degree level software engineering course, all had been introduced to the Z notation. The subjects attempted the specification completion task and the majority finished within the avaliable time. The results showed a tendancy towards the poorer quality solutions: **S** solutions 7 (37%), **C** solutions 12 (63%) and three subjects made insufficient progress.

In conjunction with the preliminary studies, these results strongly indicate that the use of the specification notation influences the strategy adopted in completing the specification. In cases where the notation characterisitics do not readily match those of the problem domain, validity and correctness of the specification takes second place to the use of the notation.

3 CONCLUSIONS

These findings add substance to concerns regarding the effective and appropriate use of complex and highly powerful notations, such as specification languages (Monk et al., 1994; Leveson, 1998). The fact that expert and experienced specifiers can confidently provide elegant and accurate solutions is in reality of little import. The fact that for non-experts the notation effectly degrades the quality of solution is an indicator that formal specification notations require considerable attention if they are to effectively serve their intended purpose.

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