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Chapter VII

An Empirical Investigation of Requirements Specification Languages: Detecting Defects While Formalizing Requirements

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ABSTRACT

A well-known side-effect of applying requirements specification languages is that the formalization of informal requirements leads to the detection of defects such as omissions, conflicts, and ambiguities. However, there is little quantitative data available on this effect. This chapter presents an empirical study of requirements specification languages, in which two research questions are addressed: Which types of defects are detected by a requirements engineer during formalization? Which types of defects go undetected and what happens to those types in a formal specification? The results suggest looking explicitly for ambiguities during formalization,

because they are less frequently detected than other types of defects. If they are detected, they require immediate clarification by the requirements author. The majority of ambiguities tend to become disambiguated unconsciously, that is, the correct interpretation was chosen, but without recurring to the requirements author. This is a serious problem, because implicit assumptions are known to be dangerous.

INTRODUCTION

The use of a requirements specification language (RSL) in requirements engineering (RE) has manifold benefits. Precise requirements models allow better communication among various stakeholders; checks of completeness and consistency, and proofs of safety properties can be automated; and the dynamic behavior of the requirements models can be simulated. Furthermore, they make the RE process more repeatable than if ad hoc techniques were applied. According to Sommerville and Sawyer (1997), RSLs are a "vehicle for the analyst to add clarity to the fuzzy picture provided by the stakeholder requirements, domain constraints…They are concerned with imposing a structure on the vague notion of a system." It is this characteristic that leads to a frequently reported side-effect of the application of RSLs: defects in the initial requirements are detected during the development of requirements models (see, e.g., Wing, 1990; Sommerville & Sawyer, 1997; Easterbrook & Callahan, 1997).

We subsume under the term *requirements specification languages* both requirements modeling languages and formal methods for describing requirements. A requirements modeling language offers a graphical language with a formal syntax, that is, a set of diagram elements, and a semi-formal semantics, which is typically stated in natural language. One example of a requirements modeling languages is the Unified Modeling Language (UML) (OMG, 1999). A formal method offers a language with a formal syntax and formal semantics. In most cases, this language is mathematical, but also graphical and tabular languages have been proposed. A formal method allows describing requirements rigorously and analyzing them extensively. Examples of formal methods include SCR (Heitmeyer, Jeffords, & Labaw, 1996), SDL (ITU, 1993), VDM (Jones, 1990), and Z (Spivey, 1992). A *requirements model* is a set of requirements that is represented using a single RSL. It is a formalized statement of requirements. In contrast, the term *requirements document* denotes in this chapter an informal statement of requirements given in natural language.

This chapter reports on an empirical study aimed at answering two research questions about the defects spotted in informal requirements during formalization. A *defect* is a product anomaly in a requirements, design, or code document that leads to a misbehavior of a software system. We focus on conflicts,

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