FINDING THE PROBLEM: THE FOUNDATION OF THE REQUIREMENTS ENGINEERING PROCESS

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INTRODUCTION

This paper examines the cognitive processes involved in problem finding as part of the Requirements Engineering (RE) process. It describes intensive field research that provided rich understanding of the practices of systems analysts. The paper makes three contributions to cognitive research in Information Systems. Firstly, three characteristics of analysts' problem finding in the early stages of the RE process are identified. Some of these observations have been noted previously in other domains. However, it is the combination of characteristics that typifies problem finding in the RE process. The importance of these characteristics is demonstrated through a comparison of the practices of an expert and a novice analyst. Secondly, observation of analysts' exploration of the problem space has led to an revised definition of opportunism that is applicable to problem finding. Thirdly, empirically-based understanding of the cognitive processes involved in problem finding provides for practical improvements to the early stages of the RE process. The paper concludes with suggestions for training, supporting and managing analysts during their problem finding activities.

THE RESEARCH

Finding and understanding the organisational problem to be addressed by a new information system (IS) is one of the most important aspects of systems development. It lays the foundation for all subsequent systems development activities. Inaccurate or inadequate identification of the problem may lead to delivery of a technically excellent system that does not provide business value to the organisation. Problem finding is undertaken by systems analysts during the early stages of the RE process. Significant time is spent on 'digging deeper' to understand the nature of the underlying problem. This is a crucial but poorly understood process.

Intensive field research was used to build understanding of analysts' cognitive processes in the early stages of RE. Structured-case (Carroll and Swatman 2000), a method for iterative theory building from qualitative data, was employed in the research. The method provides for clear and documented links between the research themes, the data and the findings. Structured-case includes an explicit stage for reflection on the findings. This includes critical analysis of tentative findings through a search for disconfirming evidence and alternative explanations.

Three case studies were undertaken; each case was chosen to examine different aspects of analysts' practices. Sixteen analysts were studied using document analysis, observation, participant observation and interviews. Some meetings were video-taped, many of the interviews were audio-taped and extensive notes were taken at the remainder of the meetings and interviews. Diagrams and notes produced by the analysts were collected as organisational documents. The researcher's on-the-spot interpretations were captured in extensive field notes. All tapes and notes were transcribed and analysed. The research focus on cognitive processes meant that analysis strategies suited to process data were required (Langley 1999). Case narratives were written. Initial coding centred on the processes of elicitation, representation and validation and the area of the problem about which information was being elicited. The outcomes were depicted using a range of graphical representations including time lines, a 'spider's web' of issues and an issues hierarchy as shown in Figure 2 of the paper. Reflection and critical analysis of tentative findings was supplemented by presentations of the findings to a panel of experts.

FINDINGS

Examination of analysts' practices when finding problems identified three key characteristics of analysts' cognitive processes. These characteristics are described and explained through reference to existing cognitive concepts. Comparison of the practices of an expert and a novice analyst highlights the importance of these characteristics to successful problem finding. The characteristics of analysts' cognitive processes are:

1. Oscillation in amounts of detail held by analysts. It was observed that analysts accumulated and periodically consolidated information throughout information gathering sessions. This indicates that the analysts are constructing

a mental model of the problem. Consequently, analysts may repeat questions at different times because information that cannot be added to the current mental model is discarded and must be elicited at a later time. It appeared that experienced analysts are tolerant of ambiguity and were able to refine their mental models in some areas while retaining ambiguity about other, more intractable areas

2. Unpredictable movement around the problem space. In Case 1, most sessions started with a key issue to be explored but information was elicited about other issues throughout the session. It was noted that the analyst moved the focus of his questioning from one part of the problem to another, often before all the details about the first part had been elicited. This movement was not just a reaction to difficulties that were encountered. At times it was evident that the client's responses raised a new issue that was investigated by the analyst. Graphical representations of this movement indicated that the analyst also investigated the problem at different levels of abstraction, moving between concrete and high-level issues. Deeper understanding of this movement is gained through reference to opportunism that describes how people adapt their plans, goals or activities in response to changing circumstances (Hayes-Roth and Hayes-Roth 1979; Khushlani, Smith and Howard 1994). In this research project, the analysts explored *issues* rather than followed a plan or pursued goals. Therefore, opportunism in problem finding is defined as adaptation of activities in response to changing understanding of the problem.

3. Identification of the nature of the problem through insight. The analysts built fragments of understanding of the problem by accumulating and consolidating detail through their investigation of different parts of the problem. These fragments are the basis of understanding of the problem as a whole. There was often a clear point when the analyst integrated these fragments and identified the problem. This was observed in Case 1 and described by several of the highly-rated analysts in Case 2. Insight is a sudden flash of thought or inspiration that involves 'seeing' a problem in a new way. Insight is not the result of persistence or incremental construction of a solution; in fact Mayer (1992:74) suggests that the problem solvers cannot predict if they are close to solving a problem prior to insight.

Comparison of an experienced and a novice analyst in Case 3 illuminated the importance of the characteristics of problem finding observed in the first two cases. The experienced analyst explored the problem space opportunistically while the novice's exploration was pre-planned and linear. Although both analysts accumulated the same amount of information, the expert organised and consolidated the information more quickly and effectively. The expert developed a useful mental model, identified the problem, shut down further information gathering and worked to refine a solution. The novice had difficulty in constructing a mental model, sought to gather additional information and did not develop a parsimonious understanding of the problem.

IMPLICATIONS

These findings have implications for undertaking and managing the early stages of the RE process. It is essential to train analysts in the skills that are used in practice. These include interviewing skills (e.g. asking the right question and listening and responding to interviewees), using plans as tools of analysis rather than prescriptions for action, and skills in organising information. The importance of experience suggests the value of mentoring programs for novice analysts. Methods, tools and techniques for analysts are needed that support exploration of the problem space as it occurs in practice; these could include general problem solving techniques and issue-identification tools. Strategies for managing problem finding include supporting flexible and creative activities, scheduling sufficient time for the process (to prevent premature closure of information gathering) and using project managers who have experience in RE (they are more likely to be skilled in monitoring the progress of this cognitive process). There is also a need for further research to detail and evaluate strategies for improving problem finding that are based on understanding of analysts' cognitive processes in real-world RE activities.

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