

CHAPTER 8 RESEARCH METHODOLOGY AND DESIGN

8.1 Introduction

This chapter gives a brief overview of the field of research methodology. It contains a review of a variety of research perspectives and approaches which are used within the field of computing and information systems and describes the methodology used in this thesis.

8.2 Research Methodologies

Research methods can be classified in various ways, however, one of the most common distinctions is between quantitative and qualitative research methods.

- **Quantitative research methods** - were originally developed in the natural sciences to study natural phenomena. Examples of quantitative methods now well accepted in the social sciences include surveys, laboratory-based experiments and simulations.
- **Qualitative research methods** - were developed in the social sciences to enable researchers to study social and cultural phenomena. Examples of qualitative methods are action research, case study research and ethnography. Qualitative data sources include observation and participant observation, interviews and questionnaires, documents and texts, and the researcher's impressions and reactions.

The motivation for pursuing qualitative research, as opposed to quantitative research, comes from the observation that the main characteristic which distinguishes humans from the natural world is the human ability to communicate. Qualitative research methods are designed to help researchers understand people and the social and cultural contexts within which they live. [Kaplan and Maxwell, 94] argues that the goal of understanding a phenomenon from the point of view of the participants and its

particular social and institutional context is largely lost when textual data are quantified.

Cornford [Cornford, 96] offers the following warning in relation to the pursuit of qualitative research methods:

“Qualitative researchers are less certain as the possibility of the pursuit of a value-free, time and place independent, fact...the qualitative researcher, in seeking out the individuals experience and awarding it its own value, must accept a more subjective view of reality.”

[Archer, 88] suggests that within the broad heading of qualitative research there are three distinct rationales. First, there is a position that sees qualitative research as complementary to a quantitative approach and providing access to research questions that otherwise might not be accessible. The second position sees qualitative research as a precursor and poor relation, providing an entry point into new fields of study that may be subsequently treated by ‘hard’ approaches. In this way qualitative research provides reconnaissance and orientation before the main research effort. The third position is one which sees qualitative research as the only true approach, and a significant improvement on the ‘pseudo-science’ practiced by those who adhere to quantitative approaches. This view is based upon a notion of social science being in an immature or pre-science stage in which “empirical research cannot go beyond a sort of (natural) history, conducted in a disciplined fashion” [Archer, 88].

8.2.1 Research Methodologies in Computing

The question of how to undertake research within the discipline of computing and information systems is a topic that increasingly exercises the minds of those who work within this domain [Mumford et al., 84] [Galliers, 92]. There have been attempts to map out a broad research agenda for the discipline of computing [Boland and Hirschheim, 87] [Keen, 91]. The overall research endeavour in computing, as in any

other discipline, involves many different styles and types of work. Loosely, these may be considered as two streams, one of 'theoretical' research and one of 'empirical' research. Theoretical research is concerned with developing and refining a body of abstract understanding of phenomena and issues. It may be undertaken through a purely mental set of procedures, though sometimes these will need to be fed with stimuli from outside sources. Empirical research, on the other hand, is work that concerns itself more centrally with observing events in the world (sometimes in a laboratory setting) and then seeking to 'make sense' of what is observed.

There are three distinct approaches to research within the domain of computing and information systems [Cornford, 96]:

- **Constructive research** - is concerned with developing frameworks, refining concepts and pursuing technical developments. The concern here is with 'models and frameworks which do not describe any existing reality, but rather help to create a new one'.
- **Nomothetic research** - is concerned with exploring empirical data in order to test hypotheses of a general character about phenomena studied. Such research emphasises systematic protocols and hypothesis testing within the scientific tradition.
- **Idiographic research** - is concerned with exploring particular cases or events and providing the richest picture of what transpires. Idiographic research emphasises the analysis of subjective accounts based on participation or close association with everyday events. In information systems there is a strong tradition of case studies which may be seen as idiographic research.

[Straub et al., 94] provide a classic taxonomy of styles of research within information systems:

- **Laboratory experiments** - These imply a research activity that is undertaken within controlled conditions. Within an experimental research design, the researcher manipulates some variables and observes the results.

Most often, data will be quantitative in nature and will relate to a limited number of phenomena.

- **Surveys** - a single survey provides a cross-sectional picture of affairs at a point in time. The basic technique may be extended to provide longitudinal data by repeating the process over time. Commonly, the researcher has to acknowledge that while a small scale survey can provide interesting information from a real population, it is not statistically representative.
- **Reviews** - one way to describe research in this category is to suggest that it looks backwards rather than forwards. That is, the researcher is concerned with charting the development of a set of ideas and with placing them within a descriptive framework. A well executed review of prior work can make its own research contribution by providing a more refined understanding of the theoretical and empirical work which has been done in a particular area.
- **Case studies** - a case study is an in-depth exploration of one situation. The strength of a case study is in the richness of data that can be obtained by multiple means when researchers restrict themselves to a single situation. This leads people to recommend the case study approach for topics and areas of study which are novel or which have little theory as yet [Cornford, 96]. The case study, in this way, might be seen as a preliminary research exercise out of which potential theories can be developed for subsequent validation through other methods.

The term 'research' itself may take on a range of meanings and thereby be legitimately applied to a variety of contexts [Eilon, 79]. Indeed, there is no single or commonly agreed approach to conducting research in the field of computing and information systems.

8.3 Choosing a Research Approach

Zuboff offers the following commentary in relation to the choice of a research methodology [Zuboff, 88]:

“Behind every method lies a belief. Researchers must have a theory of reality and of how that reality might surrender itself to their knowledge-seeking efforts. These epistemological fundamentals are subject to debate but not to ultimate proof”.

The choice of method depends on many factors, in particular the nature of the research being undertaken and constraints on that research. As previously presented, research in the field of software engineering (as a specialism within the field of computing) tends towards qualitative research methods. This is due in the main to two influencing factors; the nature of the research and the time frame within which the research is conducted.

In general, software engineering research does not represent classical hypothesis testing to which empirical methods such as statistical tests can be applied [Cornford, 96]. Rather, software engineering research is more often concerned with the appropriateness of a methodology, technique or computer system for a given purpose. Such non-empirical methods usually yield large amounts of qualitative and anecdotal evidence which must be rigorously analysed to discover underlying trends. In addition, due to the dynamic and rapidly evolving nature of software systems and technologies, the time frame within which research must be evaluated is usually many times smaller than that of other domains. For example, in domains such as medicine, the evaluation of new drug therapy requires a longitudinal study over a number of years. By contrast, the domain of software engineering is so rapidly evolving that the time to market necessitates a shorter time period within which to evaluate the entity under study.

[Jeffery and Votta, 99] offer the following opinion on quantitative approaches to software engineering research:

“At this point in time, there is no widely held collective agreed model of the definition and role of empirical (quantitative) software engineering”.

[Seaman, 99] advocates qualitative methods in software engineering research with the following commentary:

“The principal advantage of using qualitative methods in software engineering is that they force the researcher to delve into the complexity of the problem rather than abstract away from it . Thus, the results are richer and more informative...however, qualitative results are often considered ‘softer’ or ‘fuzzier’ in technical communities, but then so are the problems we study in software engineering.”

The research described in this thesis is typical of many software engineering research projects. By its nature it does not lend itself to empirical techniques of quantitative study, rather to the qualitative research methods. This presents the questions of which method, approach and style is more appropriate to this research and why. In order to satisfy the objectives of this research a number of issues must be addressed:

- An enquiry into the current state of art and practice in the software industry with regard to the usage of software project planning tools was necessary. The purpose of this enquiry was to assess the position of existing project planning tools, thus highlighting the potential benefits of incorporating intelligent assistance into project management tools.
- It was also necessary to develop some form of yardstick which may be used to assess the architecture developed in this thesis and measure (in some form) its appropriateness.
- Some appropriate form of evaluation of the prototype system was also required. This evaluation should have regard to a number of aspects, including the prototypes position with regard to existing project planning tools and users perception of the system itself and its benefits as an intelligent assistant system.

Each of the above issues has a corresponding impact in relation to the choice of research methodology:

- The most appropriate mechanism to assess the current state of art and practice in the software industry with regard to the usage of software project planning tools was to conduct a survey of software project managers who are users of such tools. It was not necessary to provide a comprehensive in-depth study of software project planning tool users, rather the purpose of the survey was to obtain an appreciation of the type of tools that are being used by project managers and to obtain a better understanding of the actual state-of-practice regarding these tools. As this survey is concerned with user opinion and perception, qualitative methods would be more appropriate than quantitative methods.
- In order to develop a yardstick against which to assess the proposed architecture, it is first necessary to conduct a review of the architecture of existing related systems. From this a set of desirable architectural characteristics can be derived, against which the proposed architecture may be compared.
- The most appropriate form of evaluation of the prototype system would be to expose the system to actual users, i.e. software project managers in commercial organisations. There are a number of options for an evaluation such as laboratory experiments, where a group of users are exposed to the prototype system in a controlled environment, or a case study situation where a 'real world' project is reconstructed and executed using the prototype system.

From the above it is clear that qualitative research methods are more appropriate for this type of software engineering research project. This leads to the question of which is the most appropriate approach to take. A mixture of constructive and idiographic approaches would be the most suitable, as the constructive approach is concerned with developing new frameworks and models for technical development and as such it fits with the task of developing a novel architecture to support the development of an intelligent assistant system. In addition, idiographic research approaches may be regarded as a supporting approach to the conducting of user trials for the prototype system.

The final decision on style of research has been addressed above with the use of surveys on existing tool users and reviews of software architectures. The user trials may be seen as a preliminary case study through which a decision may be made in respect to subsequent validation.

The overall approach to evaluation of this research may be characterised as a combination of participation and observation. The decisions in relation to the choice of research methodology for this work have been motivated by a number of factors, including practical considerations such as the time frame and available resources. It may be that the 'ideal' approach would be to conduct a more in-depth study over an extended period of time, with a larger number of people involved in the survey and user trials process.

8.4 Summary

This chapter described the field of research methodology and provides a review of a variety of research perspectives and approaches that are used within the field of computing and information systems. Further, it has described the research method, approach and style which shaped this thesis.

Chapter 9 contains an overview of the user trials process as well as details on the actual user trials themselves. A summary of the results of these trials and the feedback gained from users is then provided.