CHAPTER EIGHT

Conclusions and Further Work

This final chapter brings the thesis to a close by returning to the agenda which was established in chapter 1. It summarises the focus of the EM approach on both system development and BPR, and draws conclusions from the discussions and results in the previous chapters. In the final section of this chapter we also discuss briefly some thoughts and open issues which should become the avenues to be explored for future developments about and around EM and BPR as well as other areas of business information systems.

8.1 Research Summary

At the start of the thesis it was stated that the aim of this research is to propose an innovative approach to business process reengineering and the development of associated information systems. The preliminaries about the challenges and potential problems faced in these subjects were firstly summarised (chapter 1). Following this there was an investigation into system development and the current works of BPR (chapter 2 and chapter 3). This included a survey and discussion of two main problems met during the BPR projects: the role of information systems in BPR and the human factors affecting the success of BPR. The former discussion linked the relationship between BPR and system development; whereas the latter discussion concluded the significance of user participation in the process of BPR as well as system development. The principles and concepts of Empirical Modelling were introduced (chapter 4) and a comparison between this approach and object-orientation was also given (chapter 5). Through this comparison, focusing on both their different development processes and the artefacts used, the characteristics of EM as a human-centred and situated computer-based approach was thus emphasised. Finally how EM might be used as an alternative approach to these fields and how this approach could contribute to the solution of problems discussed earlier were considered (chapter 6) and some case studies to illustrate these features were given following this discussion (chapter 7). The following subsections summarise the main work of this research.

System Development and BPR

System development has a close linkage with business process reengineering for several reasons. Not only is one tenet of BPR to exploit IT to support radical change and to view IT as the central enabler of BPR, but there are also many similarities between the process of system development and the process of BPR[1]. But the most significant reason is the impact of information systems upon organisations. As we have concluded in chapter 3, information systems are part of the business environment (the social systems) and their design and use cannot be specified solely in just technical terms. The lack of this consideration has contributed to the high rates of failure for BPR projects. Also it was found in this research that information systems developed in conventional paradigms were unable to implement the newly reengineered processes of BPR or even the existing business processes. The latter has raised the problem of legacy systems which has been increasedly addressed in both academia and business.

Another common problem faced by both system development and BPR is the role of human factors in their processes. BPR fails partly because the approaches put much emphasis on the scale of change (through IT) but fail to consider such change in relation to people or to consider other complex issues such as cultural issues. That is, these BPR projects did not provide the channel for the relevant people (employees, end-users, etc) to participate in the process of BPR. Conventional system development has also faced similar problems. The process of conventional system development was context-free, i.e. independent of the real world environment in which the software system is intended to operate. It was

1. For example, OOSE by Jacobson et al. (1992) and OOBE by Jacobson et al. (1995); or many other object-oriented methodologies for software engineering and for business engineering.

also abstract and phase-based and started from the informal step of eliciting user's requirements. It assumed that users can explicitly describe their requirement. But even if users can describe what they are currently doing, they still cannot describe fully or visualise how they might use the system or how their task might be reengineered. Under this paradigm the users who are (or will be) using the developed systems do not participate in the development process and are not even allowed to change the system in response to their evolving requirements. The systems developed in this manner are not appropriate to the rapidly changing and radically competitive real world, and consequently the organisation will face the legacy system problem mentioned earlier.

The aim of this research has been to find an innovative way to rethink these problems and put them in a different prospective through modelling processes. It has been suggested in this work that EM is an appropriate candidate due to the character of its situated and computer-based models (ISMs). Through the networked computer-based models, the users and developers are enabled to interact with each other in an open-ended manner. This interpersonal interaction supported by EM makes the model reflect closely to the real-world environment and enables the modeller (and all the participants) to take the systems approach to analysing the proposed system and its impact on the real world (the organisation), compared to the conventional methods, like a reductionist approach, which emphasises the individual component behaviours but not the interactions among them.

Review of Empirical Modelling

Empirical Modelling is a new and radically different approach to complex systems design and business modelling. The primary focus of EM is on the comprehension and on the use of computer-based interactive situation models (ISMs) that represent the way in which the aspects of systems behaviour are constructed in terms of agencies, observables and dependencies. On this EM view, computer-based models of business processes can be built in a way similar to that in which human beings make conceptual models of such processes. We can then specialise and circumscribe our models to derive software systems. And in this way EM can offer both cognitive and operational support to BPR from the very early and conceptual stages of modelling (Chen et al., 2000a).

To sum up, EM serves as an open development approach with the following characteristics:

- **Situatedness** A model built using EM is situated because it is the model of the relationship between a situation and the observer. The modeller can directly experience the results from his introduction of changes to the model. Thus the ISM can reflect a change in the real-world situation or new knowledge gained by the modeller. We have described in chapter 6 the roles of ISMs in four main fields most relevant to BPR: for HCI, the ISMs can be used for interface construction; for the development of processes from the ISMs, an observation-oriented analysis and an associated simulation of behaviour can be done along the construction of the model; for requirements engineering, the ISMs serve as a prototype which help to understanding the current problems and visualise the reality of the future system; for decision making the ISMs can be used to explore a set of alternatives for the problems.
- **Computer-Based Artefacts** In EM the computer is used as an interactive and open-ended artefact for facilitating knowledge construction by situated modelling. This is different to the conventional use of the computer as just an application tool for knowledge representation. In EM the computer is used to generate the metaphorical representation of particular states. It helps not only knowledge representation, but also knowledge construction, to enrich the modeller's knowledge. With the aid of networked communication, all the participants in the modelling process can interact with each other in a visible and communicable manner through the synchronisation between the evolution of computer models and individual participant's insights.
- **The Unified Procedure of Development** One advantage of EM is that it makes it possible to take account of the context not only in the construction stage, but also in the operational stage of the system development (Sun, 1999). As illustrated in Figures 4.2, 5.3 and the SPORE framework in Figure 6.1, the knowledge captured by the modeller during the modelling process can be coupled with his existing knowledge of both the external subjects and embedded in the computer-based model, which in turn can be used as the basis for further interaction.

Participative Process Modelling and Participative BPR

We have emphasised in chapter 3 and chapter 6 that BPR will not be successful without the support and active participation of its people, and concluded that BPR should be people-centred. In chapter 6 we proposed two concepts to emphasise the importance of people participation in the modelling process: *participative process modelling* and *participative BPR*. The SPORE framework, and the EM approach proposed in section 6.4 to system development and BPR, were all centred around this 'tenet'. Through the user participation in the modelling process, we can take the holistic view of the cross-functional interactions and processes in the real-world context rather than the piecemeal engineering of isolated parts of a system (either computer system or business system). The main potential advantage of EM is that it provides an ideal environment for participants to interact with each other in a flexible and open-ended manner. This character and flexibility of ISMs encourage a different kind of relationship between human modellers and the automated business activity. And the potential benefits of introducing the SPORE framework here are its flexibility, openness and the richness of interaction possible between many participants in the modelling environment. This interpersonal interaction within the distributed EM environment can model the agencies in two levels: (1) the modeller as an *external* observer can shape the agency in the context of his role in the task, such as developers or users (for this we referred to 'participative modelling of processes' in chapter 6); or (2) the modeller as an *internal* observer can act as an agent to carry out the interaction between agents through pretend play ('modelling of participative process'). This being-participant-observer approach (as named by Sun, 1999) under the EM framework enables the participants to shape the agency within the system in their customary context rather than the modeller's context. And participants' interaction with, as well as the construction of, ISMs enable a mode of operation which is loosely tied to a routine process, and encourages a creative, opportunistic, situated (re-)thinking and problem-solving activity.

8.2 Summary of Contributions

The principal contribution and focus of this work is the introduction of Empirical Modelling for integrating the development of software systems and business process reengineering, and promoting human participation in both processes. The following subsections outline the primary contributions of this thesis and the limitations of this research.

Primary Contributions

The primary contributions of this thesis can be summarised as follows:

- The framework of applying EM for software system development has been proposed by previous researchers in this group (that is, Ness, 1997 and Sun, 1999). This thesis extends their work by investigating the potential of EM as an approach for linking the development of software systems with BPR in which such systems are playing the role of an enabler for BPR. For example the SPORE framework, which was proposed for the situated modelling of cultivating system requirements, is extended to be a framework for the modelling of business situations. As described in chapter 6, many existing BPR analyses do not address the implementation issues of both BPR and its supporting systems. The EM approach, which combines both the implementation and other activities in system development, can address such issues by integrating the analysis and implementation of the supporting system for BPR.
- This thesis introduces the concepts 'participative process modelling' and 'participative BPR', and proposes two levels of modelling for integrating both contextual modelling and system development (cf. section 6.4). Through the distributed EM tools, different participants, either in the business area (such as managers, personnel or BPR analysts), or in the technical area (such as system designers or programmers), should be involved in the modelling process and communicate with each other by interacting with ISMs.
- The investigation of the comparison between EM, object-orientation and use-case approach for system development. This comparison clarifies some concepts which may seem similar in each

approach but their ontological status may be fundamentally different. Clarifying such differences will give a direction for further work on investigating the potential of EM in both system development and business modelling which will be pointed out in the next section.

Limitations of the Research

During the research, this author has met some difficulties and several limitations. Such limitations may partly result from the scope of this research, and partly from limited time and resources available.

- The aim of this research has been to introduce EM as the approach for different groups of people (who are directly or even indirectly relevant) to be involved in the process of system development or business modelling. However there are some social issues, such as user satisfaction or worker resistance, which cannot be fully addressed in our approach. This is what Checkland (1993) emphasises that social phenomena are too complex to model especially when we are a part of them. Such social issues can only be highlighted through other (non-technical) methodologies which – as beyond the scope of this thesis – will be another research subject in other disciplines such as psychology or business.
- The human interaction is so complex that no methods can totally model or describe such behaviours (cf. SSM in (Checkland and Scholes, 1990) and 'ethnomethodology' in (Goguen, 1996)). The existing distributed EM tools (**`dtkeden`**) provides four modes which are obviously not sufficient for modelling of complex business situations. Further a more friendly user-interface design for existing EM tools, such as icon or window-based interface, could be helpful for users without technical background to be involved and thus participate in the process of modelling.
- Some concepts about object-orientation described in chapter 2, as well as the comparison between EM and OO made in chapter 5, result from the best knowledge of the author at the time of his research. However, as new concepts and new applications have been continuously added to the object-oriented methodologies[2], some problems and disadvantages mentioned may have been

2. For example the association 'uses' in the use case model described in (Jacobson et al., 1992) has been replaced by 'includes' in the new version of UML (UML 1.3 or newer).

modified and improved. Similarly in BPR, new concepts and new approaches may have been developed after this research. Further investigation and comparison between EM and other methods may be needed and will be helpful for clarifying the situations to which EM can be applied.

8.3 Further Work

There is clearly future work to be done on exploring the scalability of the EM approach and the derivation of other applications from the models. The research represented in this thesis has addressed some of the fundamental problems with system development and BPR, and these give the direction for the further work in these areas. This section provides an overview of some areas of future interest.

The first is the possible applications of EM in software system development. The work in this research was to investigate the development of software systems for the support of BPR. However for software system development itself (or software engineering), EM is potentially applicable to this research area and the relevant research connecting EM with software development is ongoing in this group. For example, the support by EM for situated problem-solving activity in requirements engineering, and reengineering the user interfaces through exploring statecharts (Beynon et al., 1999). Further work may include the detailed investigation of the difference between EM and other development methods (such as OO or Harel's statecharts), especially in their different modelling philosophy. The evaluation of computer-mediated interaction among participants through the distributed nature of EM models, instead of traditional face-to-face interaction, is another direction for investigation of EM in software development, especially to identify how participative process modelling can contribute in this area.

The second is the investigation of the linkage of different spheres relevant to BPR in which EM may make a contribution. For example, as pointed out in chapter 6, EM's emphasis on the process of model construction can address many of the significant issues raised by Warboys et al. (1999) such as the modelling of software and organisational processes or evolutionary design of software systems. Applied to human-computer interaction (HCI), EM has the potential for applications in scenario-based design which include system development, object-orientation and process modelling. EM may also have potential in decision support systems which can provide an environment for the learning of modellers through the modelling process, rather than merely providing several alternatives. EM can contribute in this area because decision-making in an organisation is always influenced by the context, which involves people with different perceptions and interests. One clue for investigating how the EM approach will be applied to these areas is through the concept of 'participative' modelling which was the core of this thesis.

In addition, the systems thinking and the evolutionary paradigm for system development are also reference points for further work of EM. Apart from system development or BPR, the further development of EM should be emphasised in taking the holistic view to include the environment of the applications developed. In this perspective, the open-ended and situated characteristics of EM show its potential for application in many different disciplines.

A major issue for the use of EM in serious system development is the problem of scalability for large, realistic applications. This has been identified as a key issue in previous theses (e.g. Ness, 1997 and Sun, 1999). This thesis has made more detailed proposals for a unified development approach (cf. subsection 5.3.1) and we have outlined in the final paragraph of subsection 6.4.3 one aspect of how a 'frozen' EM model may be optimised for local efficiency. It may be that there will be a trade-off between the extent of such local optimisations and the adaptability of the original EM model. Current models (e.g. the case studies of the digital watch and the warehouse in chapter 7) are of the order of several hundreds definitions. There is clear need for further work to explore the scalability and management issues with models using several thousand definitions.