Chapter 8
Conclusions

As I mentioned in the beginning of this thesis, the aim of this research is to explore the respects in which EM can provide an alternative and potentially a better conceptual framework for groupware development that accommodates the dynamic nature of the context of group work that the groupware aims to support. This thesis consists of three sections. The first section (chapter 2 and 3) reviews research into groupware and the approaches to its development. The second section (chapter 4, 5, and 6) explores EM and its potential in collaborative modelling. The last section (chapter 7) puts EM into the context of groupware development, arguing that the potential of EM in collaborative modelling can be exploited in groupware development. Chapter 7 also argues that such orientation potentially yields a better conceptual framework that gives a holistic account of groupware development from the emergence of conception to its eventual disposal.

8.1 Research summary

In chapter 2, I stated that the groupware development is challenging due to: i) the socio-technical issues surrounding its development (cf. §2.2.2), and ii) the difficulties that typical software development faces (because groupware is a species of software)(cf. §2.2.3). These issues are intertwined and are often hard to infer from the formal description of the group activities (especially the work practices) so that they cannot easily be addressed independently. To expose and address these issues, contemporary groupware development is usually iterative, ethnographical, and participatory (cf. §2.3). Due to the evolving nature of the group activities, successful groupware has to co-evolve with the human/group activities that it supports (cf. §2.4). One promising way to alleviate these problematic issues is to adopt a human-centred focus for the development process, as this takes the evolving and situated nature of human activities into account (cf. §2.5.1). However, contemporary

systems development approaches do not respect human-centred design principles entirely, though participatory approaches (e.g. PD) come closest (cf. Gasson, 2003). Furthermore, the need for evolution in groupware development also leads to a conceptual disorientation in respect of the perceived contexts of development and use for the groupware – the increased user participation alone does not resolve this conceptual disorientation properly (cf. §2.5.2). For this reason, I endeavour to establish a unified organic process view of groupware development – efficacious groupware development – which does not distinguish contexts and roles (cf. §2.5.3). This view is influenced by the notion of *efficacious disposition* – Jullien's interpretation of the ancient Chinese philosophical notion of *shi* in seeing the propensity of things (also cf. Jullien, 1995).

The analysis in chapter 2 indicates that conceptual issues surrounding participation are at the centre of efficacious groupware development. For this reason, chapter 3 is devoted to a deeper examination of the issues surrounding participation. I argue that the contexts of development and use, the roles of stakeholders (in particular developer and user), the nature of participation (natural to the roles of participants) are interdependent concepts. These concepts are intertwined: re-conceptualising one of them may result in the need to re-conceptualise the rest. In short, chapter 3 argues:

i) a high degree of user participation problematizes the perceived contexts and roles (cf. §3.4);

ii) the roles of the participants begin to shift as they become deeply engaged in the development process (cf. §3.3);

iii) user participation may cause a tension between stakeholders because of the imbalance of influence over the construction of the artifact (cf. §3.1); and

iv) reconceptualising the conception of roles is not trivial (§3.2).

Human-centred development promotes a high degree of user participation that is close to *genuine participation*. In fact, the nature of participation is arguably *genuine participation* when the contexts and roles are conflated, which is the case in efficacious groupware development. In closing chapter 3, I made seven suggestions for facilitating *genuine*

participation (cf. §3.5).

In chapter 4, I discussed EM principles (§4.1), the philosophical outlook of EM compared with some key ideas in philosophy of science (cf. §4.2), and the practical tool support for EM (§4.3). EM is a modelling approach which is based on experience, interaction, observation, and experimentation. The idea behind modelling through observation is similar to the idea of theory building through observation in philosophy of science (§4.2.1), and the idea of an experience-based approach shares a similar perspective with James's Radical Empiricism. The key elements in an EM model are the observable, dependency, and agent (cf. §4.1.1). The EM process is open and flexible. In contrast to traditional systems development, the EM process does not necessarily follow a pre-defined path or goal. Central to the EM process are two important concepts: modelling *state-as-experienced* and *modelling with definitive scripts* (MwDS) (cf. §4.1.2). The meaning of an EM model (or artifact) cannot be apprehended through the examination of the artifact itself – its meaning is closely associated with the possible interactions and possible experience it offers to its observer. These qualities are always open for new interpretation and subject for change in response to continuous observation throughout the EM process. In the sense of Gooding's construal, EM artifacts are provisional, situated, tacit, interactive, and ostensive (cf. §4.1.3). In section 4.3, I discussed how the EM principles and modelling process are currently supported, though far from perfectly, by the principal tool (viz. tkeden).

There are many different forms of collaborative modelling (CM), different degrees of engagement, different relationships between modellers and agents, different modes of interaction (cf. §5.1). In section 5.2, I argue that Sun's (1999) Distributed Empirical Modelling (DEM) framework has limited capacity for collaborative modelling. This can be attributed to the fact that DEM was developed for structured organisations rather than collaborative work which is typically dynamic and situated, and often involves changing and diverse modes of interaction, communication, and structure. I argue that EM has in fact more potential for facilitating the heterogeneous nature of collaborative modelling (cf. §5.3).

In chapter 6, I investigated how EM can be practiced in collaborative modelling contexts through four case studies, namely, i) virtual electronic laboratory; ii) distributed jugs, iii)

collaborative Sudoku, and iv) the cricket project. These case studies are meant to cover a broad range of collaborative modelling scenarios, from a pair of modellers to not more than a dozen modellers, from asynchronous to synchronous collaborations, from unstructured to structured goals for the modelling. The case studies firmly support the potential of an EM approach to collaborative modelling. In addition, the case studies reveal that collaborative EM facilitates some key properties that we are looking for in supporting the notion of genuine participation and human-centred development: supporting different degrees of engagement (cf. §6.1, §6.2, §6.3, and §6.4), conflation of contexts (cf. §6.1, §6.2, and §6.3), conflation and shifting of roles (cf. §6.2 and §6.3), modelling through experimentation (§6.2), supporting dialogical and diverse interaction (cf. §6.2), co-evolution between the modellers understanding and the artifact (cf. §6.3), integrating diverse perspectives (cf. §6.4), and learning through co-construction (cf. §6.4).

Drawing on the discussions from previous chapters, chapter 7 argued that EM is potentially a conceptual framework better-suited for guiding efficacious groupware development. In order to show the potential of practising an EM approach in groupware development, firstly (cf. §7.1), I view groupware development as a collaborative modelling process that co-constructs a shared understanding of the group activity (i.e. a conceptual model) through construction of the groupware (i.e. the actual artifact). Through the lens of efficacious groupware development, such a modelling process is in fact a co-evolution without a pre-defined *end product*. Secondly (cf. §7.2), I argued that EM is potentially suited to providing the two prerequisites for efficacious groupware development: human-centred development and genuine participation. This claim is justified by the potential fulfilment of the seven recommendations that were set out in chapter 3 and the human-centred design principles discussed in chapter 2. Thirdly (cf. §7.3), I proposed a *GroupPIE* framework that allows EM to be practised in the groupware development context through practising EM for collaborative modelling in the way I discussed in chapter 5 and 6. Instead of giving precise step-by-step guidelines on how EM is practised (as EM does not encourage a preconceived path for modelling), the GroupPIE framework sketches the plausible scenarios when EM is introduced into the groupware development context at three levels: **P**articipatory, **I**nteraction, and **E**volution. Fourthly, I discussed the limitations of the GroupPIE framework (cf. §7.4).

Finally (cf. §7.5), I sketched a vision, the potential issues and obstacles in realising efficacious groupware development with EM.

8.2 Further work

In this thesis, I have shown how EM could be practised in a collaborative modelling context. Although I only justify its potential in the groupware development context, the potential of EM is in principle more far-reaching than the scope of this thesis. In this section, I sketch a few possible directions for further work based on the research described in this thesis.

Approaches / Characteristics	Empirical Modelling	Participatory Design
i. Development strategy	Growing incrementally through continuous observation	Iterative, design-by-doing (Bødker 1987, Greenbaum and Kyng)i
ii. Problem solving	Bottom-up	Bottom-up
iii. Integrating diverse perspectives	Encourages diverse perspectives through different modes of observation	Enables workspace democracy and takes account of diverse perspectives of all stakeholders
iv. Diverse interaction	Does not presume a particular mode of interaction	Multiple channels (Mambrey and Pipek, 1999})
v. Participation	Encourages genuine participation	Workspaces democracy through active and direct user participation
vi. Structural constraints	None, but encourages genuine participation	None, at least not during the PD project

Table 8.1 – Similarities between Empirical Modelling and Participatory Design

Participatory design and distributed participatory design

Participatory design (PD) is a body of practices, techniques, methodologies, policies, and philosophy that advocates a high degree of workspace democracy through active and direct user participation. In chapter 2, I briefly discussed participatory design in the context of groupware development. Due to the scope of this thesis, the full potential of EM for PD has yet to be explored in the broader context. Although there is so far no direct connection between EM and PD, previous research has already hinted at the potential of EM in participative systems development (cf. Sun, 1999, Chen, 2001, Wong, 2003). As I argued in chapter 7, EM potentially facilitates the notion of *genuine participation* (cf. chapter 3) – a degree of participation (and collaboration) that transcends the notion of *genuine user participation* as advocated in PD (cf. Bødker et al., 2004). Furthermore, as shown in table

8.1, EM and PD share a number of similar characteristics. This potentially means that EM can be elaborated to support PD activities in the wider context.

Distributed participatory design (DPD) is an emerging field of research that is dedicated to the distributed challenge in PD projects (cf. Danielsson et al., 2006; 2008a; 2008b). Gumm (2006) suggests that DPD projects are distributed in three dimensions: physical, temporal, and organisational. The distributed challenge in DPD, thus, can be thought as *to maintain workspace democracy through active and direct user participation in highly distributed settings*. As the case studies (cf. chapter 6) revealed, EM facilitates different degrees of engagement and diverse modes of interaction in a collaborative modelling context. With proper tool support, it is possible to transform EM principles and the GroupPIE framework into principles and frameworks that can be used to inform DPD projects.

Collaborative software development

With the ongoing trend of globalisation, members of a software development team are usually spread across the world. Collaborative software development (CSD) is a growing research field that often utilises groupware technologies and research from research fields such as CSCW and HCI. CSD faces a similar challenge as does DPD in coping with distributed work. However, being more inclined towards the traditional software engineering paradigm, CSD puts its focus on facilitating the collaboration and coordination of larger developer teams over the Internet rather than promoting active and direct user participation (cf. Hildenbrand et al., 2008). So far in this thesis, I have only considered collaborative modelling and groupware development with EM in relation to small groups having no more than a dozen of participants (or modellers). With the emerging need to collaborate over the Internet and the recent development in *Web EDEN* – a web-based support tool for EM developed by Richard Myers (2008), it is worthwhile to explore how the work in this thesis can be further developed to cope with larger scale collaborative modelling over the Internet.

Collaborative modelling tool support

As I mentioned earlier in this thesis (cf. §5.2.2 and §6.3.5), there are at present a number of problematic issues in the EM tool support for collaborative modelling.

Firstly, the current collaborative modelling (CM) tool support does not allow switching between modes of interaction (cf. §5.1.3) – any reconfiguration of the modelling environment means restarting the collaborative modelling session. Although it is possible to mimic different modes of interaction by exploiting existing modes supported by the modified tool (cf. §6.2, §6.3, and §6.4), it is possible that the modellers would like to *formalise* a set of ritualised and situated modes of interaction that emerged during the collaborative modelling process. Due to the situatedness of the group dynamics, it is not possible to prescribe a generic universal set of modes of interaction. One plausible way of improving the collaborative modelling environment is to develop a definitive notation which enables the modellers to *grow* and experiment with the appropriate utilities for support *in situ* – similar to the 'little helper agent' grown out of the modellers' needs in respect of communication and collaboration discussed in section 6.3.5 (cf. figure 6.14 on page 203).

Secondly, the transition between private and public workspace is not without issues. Throughout the collaborative modelling case studies, it became clear that some form of basic awareness support is necessary. This is an issue in the user interface of the tool support. A good starting point is to integrate tool support models, such as the dependency viewer (EMPA: dmtHarfield2006) and visual symbol table (EMPA: vstKing2005), into the collaborative modelling environment.

Thirdly, there is no doubt that the modelling environment is not yet stable enough. However, improving the stability of the modelling environment is challenging without sophisticated knowledge about how and why the tool has been built in the way that it has – in Naur's (1985b) sense, it is challenging because the original authors of the tool left with the "theory" of the tool.

Indeed, the collaboration tool support features that I mentioned above is not unique. To some extent, contemporary collaboration tools have addressed these issues, e.g. (Sonnenwald et al. 2003).

Activity theory

Sun's (1999) Distributed Empirical Modelling (DEM) framework is draws on ethnomethodology and distributed cognition. As I argued in chapter 5, distributed cognition

may not be fully compatible with the need for flexible structure and interactions in collaborative modelling due to its emphasis on fluent cognitive function (or operation) in structured organisation (or teams). Recently, another social theory, *activity theory*, has received much attention in the CSCW and HCI community. Activity is the basic unit of analysis in activity theory:

> *"Activity is considered the most basic category; analysis of activities opens up a possibility to properly understand both subjects and objects [of the activity]. This idea may appear counter-intuitive. Traditional analytical thinking, typical, for instance, of natural sciences, would assume that to understand an activity it is necessary to understand the subject and the object separately and then make an inference about their interaction. Activity theory challenges this assumption. It claims that this apparently flawless logic can be misleading." (Kaptelinin and Nardi, 2006, p.31)*

Since activity theory focuses on the relationship between the subject and the object and the possibilities for changes, activity theory potentially gives a better account of the co-evolution between participants' understandings and the evolving artifact in the collaborative modelling process (in the sense as described in §5.1.1). So far in this thesis, I have only drawn on activity theory in explaining the evolving nature of human activity (cf. §2.4), but have yet to establish firm connections with activity theory.

Activity theory has a long history that originated from Vygotsky's historical and cultural psychology (cf. Kaptelinin and Nardi, 2006). It would be interesting to know whether activity theory can inform the collaborative modelling process when it is practised using an EM approach and to identify the main points of contact between EM and activity theory. However, there are many varieties of activity theory (Rogers, 2008). It is not clear, at this stage, which strand of activity theory this work should attach to. Moreover, although there seems to be a natural fit for activity theory in explaining collaborative modelling (as an activity), it seems that activity theory conceptualises human agency differently from EM, as Kaptelinin and Nardi (2006) write:

> *"Activity theory conceptualizes the potency of human agency in part through the principle of mediation: tools empower in mediating between people and the world ... things have agency, because if they did not, they could not act as mediators." (ibid, p.248)*

For this reason, further research is necessary before any strong links to activity theory can be made.

8.3 Concluding remarks

This thesis argues that Empirical Modelling (EM) potentially offers a better conceptual framework for groupware development that accommodates the dynamic nature of the group work it supports. The main conclusions of this thesis can be summarised as follow:

1. The entire lifecycle of groupware should be conceived as a continuous development process. This is because groupware, unlike other species of software, has to co-evolve with the context for the group work it supports. This means that, viewed from a holistic perspective, the development never terminates. There is so far no evidence that computer artifacts can evolve themselves according to human needs – the evolution of a computer artifact involves human agency.

2. The *efficacious groupware development* perspective provides a unified organic process view of groupware development consonant with Jullien's interpretation of ancient Chinese philosophy in "*The Propensity of Things*".

3. EM promotes a high degree of participatory development and potentially facilitates *genuine participation*. EM also potentially fulfils the human-centred design principles. This makes EM potentially better suited for human-centred groupware development when practised in the *GroupPIE* framework.

4. The *GroupPIE* framework provides a promising foundation for practising an EM approach to groupware development. It potentially fosters the notion of *efficacious groupware development*.

As I pointed out in chapter 7 (cf. §7.5), there are a number of factors, both technical and

social, that may hamper the realisation of *efficacious groupware development*. These include, amongst other things, the limitations of the current tool support for collaboration using EM, the difficulties of motivating genuine participation, and the economic culture. These issues are not trivial to tackle and, arguably, the latter two go beyond the scope of the computer science discipline. In order to tackle these issues properly, interdisciplinary research is required – but "true" interdisciplinary research is not easy to achieve (Rogers et al., 2003).