"...real, concrete facts about what works ...": Integrating Evaluation and Design Through Patterns

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ABSTRACT
Recent CSCW research has focused on methods for evaluating usability, rather than the more problematic evaluation of systems in use. A possible approach to the integration of use, design and evaluation is through the representation of evaluation findings as design-oriented models. A method is described for modeling computer-supported cooperative work and its context: a design patterns language, based on the principles of activity theory. The language is the outcome of an evaluation of the evolving use of tools to support collaborative information sharing, carried out at a global NGO.

Categories and Subject Descriptors
H.4.1 **[Information Systems Applications]**: Office automation – *groupware*. H.5.3 **[Information Interfaces and Presentation (e.g. HCI)]**: Group and Organization Interfaces - *computer-supported cooperative work, evaluation/methodology, organizational design, theory and methods*

General Terms
Documentation, Design, Theory

Keywords
Modeling computer-supported cooperative work, evaluation, activity theory, pattern languages, activity patterns

1. INTRODUCTION
The evaluation of collaborative systems has been seen as a crucial, but difficult problem in the field of Computer-Supported Cooperative Work (CSCW) [17]. In recent years progress has been made in developing practicable methods for evaluating the usability of the group-computer interface, for different genres of collaborative systems. However, the evaluation of systems in use, in their organizational context, remains problematic.

Another concern has been the need to develop methods that integrate evaluation and design [5]. Hughes *et al* have referred to the study of systems in use as the "*n*th phase" of requirements elicitation [23, p.22], as new requirements and the need for redesign emerge through use. The evaluation study which is described here was carried out with the objective of making recommendations that could inform the next phase of development of an in-house groupware project. It raised the problem of how the findings might be economically represented as potential design solutions, in a usable form. This effectively couples evaluation with the related problems of how cooperative work may be modeled and system requirements specified – issues which CSCW has tended to shy away from [33]. This paper focuses on the problem of representation, rather than looking more generally at a method for evaluating systems in use.

The evaluation was the final phase of a longitudinal study based at the International Secretariat (IS) of 'GreenFam'[1], a global, non-governmental organization (NGO) which campaigns for human rights [19]. The IS is located in London, UK; its job is to provide centralized support for the GreenFam movement. This work involves the direction of global campaign work and research into human rights issues, carried out by teams organized around either fixed term, single issue campaigns, or geographical regions and countries.

The motivation for the research project was to study the methods used by developers working on a long term, strategic groupware project. GreenFam's Information Technology Program (ITP), which is based in the IS, had been developing tools to support distributed teamwork since 1997, using the technology of LOTUS NOTES™ (Notes). Field research at GreenFam was carried out in two phases: participant observation over eighteen months during the initial stages of the Notes project (1997-1998); returning three years later (2001-2002) to evaluate several Notes databases as they had been appropriated by users over time, in order to produce design guidelines for future projects.

The empirical basis for this paper is mainly the evaluation phase of the project, although reference is made to the earlier research to verify the findings. Its objective is not to propose a novel evaluation method, but rather to describe an approach to integrating the activities of evaluation and design through the development of a tool for modeling CSCW, a design pattern language [2]. This is set in the context of a brief review of recent research into the evaluation of collaborative systems (Section 2), in order to draw attention to work that needs to be done. We also review research investigating the feasibility of patterns for modeling CSCW (Section 4.1). The theoretical foundation of the GreenFam study is activity theory [7,13]: the pattern language we propose differs from other approaches to patterns by embodying the principles of activity theory. In Section 3 we describe the origins of the patterns in the GreenFam evaluation, including a field study vignette, which is the basis for the patterns which illustrate our approach. In Section 4 we discuss the process by which the pattern language was developed and its foundation in

[1] Names have been changed in order to protect the identities of the research partner and the people working there.

activity theory. Finally, Section 5 outlines some conclusions from the study and proposals for further research.

2. EVALUATION IN CSCW

2.1 Development of evaluation methods

The program for research seeking to evaluate, or to develop methods for the evaluation of CSCW, has been set by two influential papers. Grudin identified that a barrier to progress was the failure to learn from actual implementations of groupware, saying that - "We fail to learn from experience because these complex applications introduce almost insurmountable obstacles to meaningful, generalizable analysis and evaluation" [17, p.86]. He pointed out the qualitative differences from evaluation of single-user applications: the difficulty of recreating authentic group interaction in a laboratory setting, especially as this is something that unfolds over an extended period; the long timescales required in field studies, with implications for practicality and costs; and the many variables that can be observed, making the factors influencing 'success' or 'failure' difficult to attribute.

Bannon [5] emphasized the critical role of evaluating systems in use in an iterative design process, challenging the traditional system development life-cycle approach that treats them as distinct activities carried out at different stages. Like Grudin, Bannon identified field studies as an appropriate method for evaluating systems in context. He questioned how the results of ethnographic studies might be made more usable for designers, but did not pursue this issue.

Scriven, the godfather of evaluation research, distinguished between "evaluation proper" and "process studies" [34, pp.49-52]. We have adopted this distinction and have not included field studies of systems in use in our review of the main trends in evaluation research. Many field studies are implicitly evaluative, but we have concentrated on research which explicitly addresses the problem of evaluation methodology. Table 1, below, summarizes a selection of research which suggests that CSCW may be getting to grips with what Neale *et al* go so far as to call the "evaluation crisis" [26, p.112].

A concern of a number of studies [16,31,4,30] has been to respond to the impracticality of carrying out detailed field studies, particularly in the early stages of design before established use can be observed, by developing "discount methods" [27]. Methods that are low-cost and rapid to carry out are needed in commercial projects, to make feasible early and frequent evaluation of prototypes. A major focus has been the development of methods for groupware usability evaluation, using heuristics [16,4], scenarios [31], frameworks [31,4] or group task models [30]. Some of these approaches adapt techniques from Human-Computer Interaction (HCI) for usability evaluation of single-user systems, by founding them on principles that are appropriate for groupware. An example is the "mechanics of collaboration" [31,4], a definition of generic collaborative actions that groupware systems should support, that has been expressed as heuristics [4].

An alternative to heuristics is to represent group work in the form of scenarios [35,31,30,20] or group task models [30], and use them as evaluation criteria. A unit of analysis of traditional HCI is the *task*, a set of interactions between a single user and the system, performed to accomplish a goal. Groupware evaluation must extend this to focus on *teamwork*, defined by Pinelle and Gutwin as "[…] the actions that group members must carry out in order to complete a task as a group" [30, p.456]. Scenarios are concrete descriptions of collaborative interaction, which include information about the context which impacts on the adoption of systems [35,20].

The last two studies in Table 1 address the issue that usability is only one aspect of evaluation of CSCW. Neale *et al* [26] list the different variables, including usability for both single-users and groups, the social and organizational impact, and the context of use. Their approach is to develop a multi-facetted model, based

Table 1. Summary of studies about the development of groupware evaluation methods

Ref.	Methods/techniques	Unit of analysis/framework	Evaluation object and goals
[35]	Cooperation scenarios	Single user, group, organizational context	Integrating evaluation and design in early design process; identifying and validating requirements; communicating with users
[16]	Discount method - heuristic evaluation	Teamwork; groupware heuristics derived from *Locales Framework*	Usability of groupware to support synchronous and asynchronous teamwork
[31]	1) Usage evaluation - field research 2) Laboratory inspection using scenarios	Groupware usability principles – "mechanics of collaboration" (p.126)	Usability of groupware to support synchronous and asynchronous teamwork
[4]	Discount method - heuristic evaluation	Groupware heuristics based on mechanics of collaboration	Usability of distributed real-time, shared-workspace groupware
[30]	Groupware walkthrough - inspection method using scenarios	Teamwork scenarios, group task model; mechanics of collaboration	Usability of groupware prototype
[20]	Scenario-based evaluation – scenarios of actual and envisioned (required) use	"Situated instance of the task in context" (p.94)	Assessing support for groups; organizational benefits of multi-featured collaborative work environment
[26]	Conceptual framework – the Activity Awareness Model	Variables derived from concept of "activity awareness" (p.115)	Systems to support distributed teamwork
[32]	PETRA – multi-methods framework including heuristic evaluation, interaction analysis, participatory prototyping	Collaborative activity; single user interaction with tools	Computer-mediated communication and coordination mechanisms; usability; integrating evaluation and design

on the concept of "activity awareness" (*ibid*, p.115). Ross *et al*'s PETRA framework [32] – standing for participatory evaluation through redesign and analysis – addresses this complexity through a multi-methods approach, which incorporates theoretical perspectives for understanding interaction, with design-focused usability evaluation and participatory prototyping. They are motivated by the need to integrate evaluation and design, as are Stiermerling and Cremers [35] who use "cooperation scenarios" to identify and validate requirements. Haynes *et al* [20] also use scenarios as a design tool, eliciting "envisioned scenarios" [*ibid,* p.96], which represent support required by users, but not currently delivered by the system.

2.2 Integrating evaluation and design

The studies cited above have gone some way to addressing the problems identified by Grudin [17]. It seems that progress is being made in developing low-cost, practicable methods for evaluating groupware usability, particularly in the course of systems development. However, holistic evaluation of systems in use still remains a problem. Twidale *et al* [36] questioned the validity of an approach that evaluates the interface without reference to the work practices that will emerge and evolve as a result of its implementation. They concluded that "[…] evaluation work will need to focus increasingly on the examination of the relationship between the system, existing work and organizational practices, and the re-design of both" [*ibid*, p.450].

If evaluation in groupware development is viewed as a formative activity, integral to the process of design and redesign, this raises the question of how findings should be represented. This is more of a problem for studies of systems in use, due to the rich, descriptive and ambiguous character of qualitative data from field studies. Of the studies reviewed here, those using the technique of scenarios to model group interactions in context [35,20] come closest to representing the evaluation results in a way that is oriented to design. Scenarios are useful in identifying requirements, in scoping out the design problem space and supporting reflection on design. But they are not a tool that generates design solutions: Bodker says that scenarios are best described as "springboards" or "thinking tools" that facilitate discussion about solutions [9, p.220].

Although there is acceptance in CSCW research that abstraction and representation are essential tools for design, there is also a well-founded scepticism of reductive models of collaborative work embodied in the design of systems [33]. If, until recently, there has been a lack of methods for evaluation, there is an even greater lack of methods for modeling and specifying CSCW. This was apparent at GreenFam where developers were very conscious of a lack of appropriate methods. They lacked the resources to prototype each Notes application in a user-centred development process, but "rolling out" generic template applications did not meet the specific needs of different groups. The developers needed what they articulated as "a new kind of analysis" and tools that would help to capture configurable, reusable design solutions. Throughout the study we identified a lack of adequate resources to support the project work, and particularly to support communication of design ideas between members of the development team, and between developers and users. It was this which motivated the investigation into appropriating patterns as a tool for modeling collaborative work in context, which we will discuss in the following sections.

3. THE GREENFAM FIELD STUDY

It is beyond the scope of this paper to describe the GreenFam field study in full. The purpose of this section is to describe the empirical background to Section 4, which discusses how the findings from the evaluation might be represented as design-oriented models. This section gives a brief overview of the evaluation and its methodology, and presents an illustrative vignette, the basis for the patterns discussed in Section 4.

3.1 GreenFam's vision for Notes

The evaluation was carried out some four years after the first phase of Notes development, the rollout of Notes email at the IS. Notes had been adopted to realize a vision of more collaborative way of working at GreenFam, where it would be used as -

"[…] an in-house tool for the initial stages of campaign planning; […] as a key platform for planning and coordinating the development of the campaign; as a central forum for the exchange of ideas, problems and planned activities; as a resource in the implementation of the campaign; and as an important resource for the final evaluation." [2]

It was planned to decentralize some of the work of the London centre to field offices throughout the world, by using Notes to provide access to information for distributed teams. Underlying the Notes vision was the idea that information should be a shared resource. Achieving this would involve weaning the workforce away from the well-established practice of using email to coordinate and talk about work. The organizational view was that email was a barrier to the ideal of information-sharing, because "[…] the collective knowledge that messages represent remains locked in the mailboxes of individuals".

Several reviewers of this paper noted, with surprise, the lack of apparent differences between an NGO and the business organizations which are the more usual subject of CSCW research. Although we found that there were striking parallels between the IT strategy of a global NGO and a business, these similarities are largely superficial, with very different underlying motives. GreenFam's move to decentralization and distributed teamworking was motivated by the aspiration of democraticizing the movement, making its work more effective, rather than profitability. Being seen to be an effective and well-managed organization was an important factor in the recruitment of members, fund-raising and establishing GreenFam's moral authority to speak on human rights issues. To some extent there is competition between large charities and NGO's when it comes to recruitment and donations [22, p.178].

In another parallel with business cases, the Notes vision was by no means shared by all of GreenFam's London staff. The objective of collaborative information sharing contradicted a predominantly individualistic work culture. Orlikowski [29] found an apparently similar culture in the global consultancy she studied with "[…] few norms around cooperating or sharing knowledge with peers" (*ibid*, p.367). She concluded that this individualistic and competitive culture did not support the premises underlying groupware technologies and was a barrier to the adoption of the new technology. The individualistic culture of

[2] Excerpts are from the Notes project initiation document, an internal GreenFam report.

teams at GreenFam had very different sources, based not in competitiveness, but in taking responsibility for work and seeing through cases. This was in many ways a positive culture that contributed to achieving good, rapid outcomes. The researchers in the IS also dealt with information that was politically sensitive and needed to safeguard the security of some of their sources. However, this culture was, just as Orlikowski found, a barrier to the adoption of groupware and realization of the Notes vision.

3.2 Objectives of the evaluation

The impetus for the evaluation came when GreenFam reviewed its campaign work in 2001, deciding to adopt a new, more decentralized model. The movement would focus on long-term campaigns on strategic human rights themes, which would bring together staff and activists from throughout the GreenFam movement. Groupware systems were seen as central to the success of these collaborative structures. The ITP set up the evaluation project to inform the development of computer support for the campaign networks. The brief, from the Director of the ITP, was to "[…] conduct a thorough evaluation of these [*i.e. Notes*] projects in order to get some real concrete facts about what works and what doesn't work for GreenFam. I think that would be tremendously helpful in trying to develop a template for future collaborative spaces." [Private email, July 2001.] Three Notes "collaborative spaces" that provided models for the kind of computer support that would be needed were selected for evaluation. These were two spaces to support existing campaign work: the worldwide *Youth and Student Network*, and the major, fixed term *Campaign Against Torture*. The other Notes database, *Mokili Ya Afrika*[3], supported the work of the four sub-regional teams of the Africa Program, which were mainly based in the IS, but also distributed in several field offices in France and Africa.

The focus of the evaluation was to gather "real concrete facts about what works", through an investigation of how the collaborative spaces had been appropriated by users. The criteria first had to be established for assessing what could be said to work (or not) in terms of GreenFam's objectives. This was done by talking to those responsible for the spaces – the people who had set them up, or who administered them. The objectives were similar in all three cases and had a dual character. The spaces were intended to provide an accessible, shared repository of official documents, other information and reusable resources, such as images and graphics. They were also intended as spaces to support "[…] the transformation of information into action" as Nick, the administrator of *Mokili*, expressed it. This meant encouraging the active participation of the database users in discussions, and in posting information and comments, rather than them merely being passive consumers of information. It indicated that it was important to investigate the quality and degree of participation in the databases, as one of the indicators of success in meeting their objectives.

[3] *Mokili Ya Afrika*, in the words of Nick, information officer for the Africa Program, means the following: "It's Lingala, a Central African language, and means 'The world is Africa' or 'Africa the world'; world (just as in English) having both a personal and a geographical context." [Private email.]

3.3 Evaluation methodology

It is not intended to present the evaluation method as being in any way novel or groundbreaking. We carried out a qualitative field study, working under a number of constraints. The two researchers involved volunteered their time: in the author's case this was motivated by her interest in GreenFam in the context of her wider research project, where the evaluation is described in full [19]. Users of the spaces to support the *Campaign Against Torture* and the *Youth and Student Network* were located throughout the world. As there were no resources for travel around 160 distributed users were surveyed by an email questionnaire, consisting mainly of open-ended questions. 25% of the questionnaires were returned and fortunately many respondents replied in detail, giving a fairly full picture of how they used the spaces in their work. Contextual interviews were carried out with the administrators of the spaces and the more accessible users based in London. The interpretation of the data was helped by the author's involvement in researching the Notes project since its beginning; findings from the earlier phase of the research program helped to validate those from the evaluation.

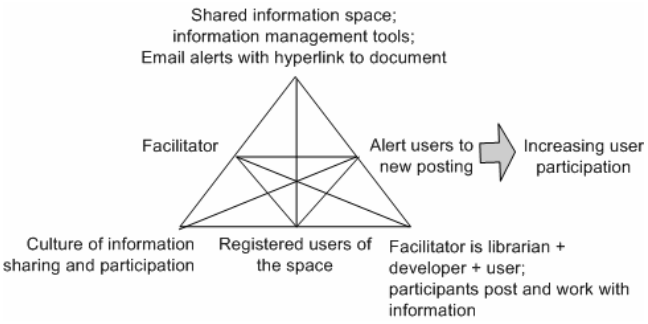


Figure 1. The role of the facilitator

The unit of analysis for the evaluation was drawn from activity theory [7,13]. Activity is defined as a system of tool-mediated actions carried out by an individual or collective subject, organized around a communal object of work and motivated by a desired outcome. The context of the actions is a community, mediated by a division of labor and a shared culture (sometimes termed rules). An activity system may conventionally be represented as a triangular model [13] showing these elements; an example modelling the role of a collaborative space facilitator in context is shown in Figure 1, above.

Activity is a hierarchical concept: an activity is realized through the concrete, goal-directed *actions* performed by collaborating subjects which, in turn, are composed of simple tool-mediated *operations* [24]. In Table 2 these hierarchical levels of activity are illustrated by examples from GreenFam.

Table 2. Levels of activity with examples from GreenFam

Level	Example
Activity	*E.g.* Running a campaign; researching a country
↑ ↓	↑ ↓
Action	*E.g.* Posting a news article in the collaborative space; writing an email alert message
↑ ↓	↑ ↓
Operation	*E.g.* Clicking a hyperlink to open a document or an action button to send an email

Bodker [8], in the tradition of activity theory, uses the terms system, medium and tool, to denote the different perspectives on how a computer artifact mediates the work of collective and individual subjects. These are useful concepts to distinguish the different aspects of an artifact that have to be evaluated. The systems perspective is the artifact perceived from an organizational viewpoint – how it contributes to the realization of organizational goals. The tool perspective emphasizes how it is experienced by the individual subject carrying out his work, while "[…] the media perspective emphasizes the human engagement with other human beings through the computer application. Thus, a medium mediates the relation between the acting subject and the community of practice surrounding the subject and the activity." (*Ibid*, p.154). The collaborative spaces were evaluated from the three perspectives of system, medium and tool – how well they contributed to achieving the organizational vision and goals; how effectively they were used to mediate the collaborative work of the team or community; and how adequately they supported the individual using them to carry out scenarios of both real and envisioned use (the conventional usability perspective).

Another tool from the methodology of activity theory is the concept of contradictions [7,13]. Contradictions are defined as structural tensions which emerge over time within and between activity systems. An example is when a new tool is introduced into a cultural context that has developed around other tools, disrupting the existing work practices. In activity theory contradictions are seen as immanent tendencies that drive change and development. Development occurs when an accumulation of contradictions and incremental adjustments eventually leads to qualitative change. The evaluation focused on contradictions in the activity systems mediated by the collaborative spaces; identifying the barriers to change, and emerging new ways of working that had the potential to resolve contradictions and bring about the development that GreenFam had envisioned.

3.4 Example: the emerging role of facilitator

In this section we describe the emergent new role of encouraging and facilitating use of the collaborative spaces, which was observed throughout the course of the study. The objective is to show the empirical basis for the patterns discussed in Section 4.

The Notes collaborative spaces had to compete with a well-established practice of using email to share information and hold group discussions. There were other barriers that had to be overcome – the individualistic culture of some teams and reluctance to adopt new, collaborative ways of working though the spaces has been described in Section 2.2. Team members rationalized this by reference to the increasing amount of information they had to deal with, leading to the experience of information overload. Putting information in common in the Notes spaces was felt, by many, to be the final straw.

When looking at the Notes spaces that had been more successful in becoming integrated into the work of a team or campaign group, we found that this development was always associated with an enthusiastic and skilful individual who acted as a 'facilitator'. This person took on the responsibility of posting information to the database and making team members aware of it. This finding is backed up by several other CSCW studies that have documented the importance of human mediators in the successful adoption of new collaborative tools [*e.g.* 6,28]. Crucial to the role of the facilitator was the ability to make use of email, the tool of choice of most users, to alert them to documents in the space. Facilitators promoted use of the space by sending users a hyperlink ('doclink' in Notes jargon) to new postings in an email message. When clicked the link took the recipient directly from their mailbox to the document in a seamless way. We first observed this use of the 'email alert' message when the ITP manager used a Notes database to coordinate work in the early stages of the project [19]. He recognised the contribution this made to getting members to use the tool, and spread the word about the practice.

Facilitators played a key role in overcoming some of the barriers – or contradictions – to the use of the collaborative spaces. By taking on much of the work of managing information in the space they protected users from the overhead of information sharing. Pushing targeted information to interested users through the tool of the email alert and doclink also helped to overcome the perception of information overload. By encouraging use of the space they contributed to a gradual change in team culture and more positive attitudes as team members began to discover the benefits of having "[…] information in one place" – something that we found was valued by the majority of users.

4. FROM EVALUATION TO PATTERNS

GreenFam had asked, as an outcome of the evaluation, for "[…] real, concrete facts about what works". The ITP intended to use the findings as a template for the design of tools and work practice in the next phase of groupware development. In the absence of any established methods for modeling cooperative work we presented them with a long, wordy evaluation report. This included design guidelines generalizing the most significant, recurrent findings. Work following the evaluation has investigated better ways of representing these findings as more immediately usable design-oriented models. In doing this we are attempting to address those issues raised by Grudin [17] and Bannon [5]: the related problems of producing generalizable results from the analysis and evaluation of collaborative systems, and presenting qualitative data in a form which is usable for developers.

4.1 Patterns in CSCW

The inspiration for the development of patterns in computing is Christopher Alexander's pattern language for the built environment [2,3]. For a comprehensive review of the work of Alexander and the different domains of computing which it has influenced see the forthcoming paper by Dearden and Finlay [12]. Their review concentrates on the use of patterns in HCI, where the experience is more mature than in CSCW. The HCI patterns community has identified several general problems and questions – such as what principles should determine the structure of a pattern language, and how to identify true patterns, as opposed to guidelines. There is a growing body of research in CSCW: workshops have been held at recent conferences, namely CSCW 2002 and ECSCW 2003. Patterns seem to have obvious potential as a modeling technique for CSCW. There is a clear analogy with Alexander's architectural pattern language, where the concept of "scale" is used to structure dependencies between patterns that cover everything from regional and town planning (CITY COUNTRY FINGERS), whole buildings (FARMHOUSE KITCHEN) down to the design of details for rooms (WINDOWS WHICH OPEN WIDE) [2]. Alexander's approach is based not on reductive abstraction and decomposition of complexity, as traditional systems engineering

methods are, but on modeling concrete patterns of different scale. Large scale patterns are no less or more 'abstract' than small scale ones. Patterns of all scales are integrated in a holistic pattern language of related patterns. Similarly models in CSCW should be able to represent the entirety of computer-mediated work, from its organizational context to the design of tools, in a concrete rather than overly abstract way.

Patterns in CSCW were first motivated by Erickson [14] when he proposed that patterns could be used to describe and design organizational features of workplaces, functioning as repositories of shared, reusable design knowledge captured in workplace studies. Erickson presents a case for patterns in CSCW based on their concreteness; their grounding in the social; their generative power – *i.e.* the selection of a relevant subset of patterns from a pattern language to configure a solution to fit a specific problem; and the fact that a pattern language supports incremental and iterative development. This last feature indicates the suitability of patterns as a tool to integrate design, use and evaluation. Erickson also argues that pattern languages can be used to generate *lingua francas* for the "communicative aspect of design" [15, p.357] – a shared language for the diverse actors who need to talk to each other in specific design projects.

Closely related to Erickson's first proposal [14] has been the development of patterns of "cooperative interaction" by researchers based in Lancaster University, UK [25]. The Lancaster approach is to find patterns, retrospectively, in the CSCW corpus of workplace studies that can be generalized across sites. Their patterns depart somewhat from Alexander's definition of a pattern as "[…] a rule which establishes a relationship between a context, a system of forces which arise in that context, and a configuration which allows these forces to resolve themselves in that context." [3, p.253.] The stated purpose is to develop a new way of presenting the findings from ethnographic field studies in order that they can be made accessible and communicable to designers. Similarly, one motivation for the development of a GreenFam pattern language is to disseminate the most significant findings from the research project in an accessible way.

Recent work in the development of patterns based on ethnographic fieldwork has gone a step further towards design. Crabtree *et al* [10] use an adapted patterns framework to "[…] identify generic patterns of social interaction […] and embedded technology usage from the minutiae of ethnographic studies of the home" (*ibid*, p.265). The motivation for this project is the search for design techniques that are suitable for designing domestic technologies, rejecting traditional work-oriented IT methods with their inappropriate abstractions.

The use of patterns which is closest to this study is that proposed by Herrmann *et al* [21]. They describe a pattern language for groupware applications, where patterns describe the whole of the "socio-technical system" - the organizational context, roles and tasks of users, and the technical components. For Alexander it is tried and tested architectural design solutions that have "the quality without a name" [3] that provide the basis for his patterns, and for Herrmann *et al* it is successful implementations of systems. In this way their concept of groupware patterns embody the "[…] experience and wisdom of practitioners" [21, p.351], just like Alexander's patterns. They use the Alexandrian pattern template [2], which is formatted as follows: *Name* of the pattern; *Picture* of an actual instantiation of the pattern; *Introduction*, linking the pattern to its related, larger scale patterns which are its context; *Concise statement* of a design problem; *Full statement* of the problem illustrated by empirical examples; *Solution*; *Diagram* of the solution; and *Conclusion*, linking the pattern to the smaller scale patterns which contribute to its realization. By explicitly stating the related larger and smaller scale patterns in the introduction and conclusion, a network of patterns is defined – this is the pattern language. Herrmann *et al* illustrate their discussion with several patterns developed through the study of knowledge management systems. They discuss the basis for defining the structure of a groupware pattern language, usefully suggesting a number of different types of relationship, but no general principles for ordering the patterns.

4.2 Modeling patterns of activity

It is not intended to critique the diverse body of work on CSCW patterns reviewed above, but to describe our approach to developing a pattern language based on the GreenFam study [18,19]. It differs from those above in that the patterns are based on the principles of activity theory, as briefly outlined in Section 3.3. In many ways Alexander is a rather strange bedfellow for activity theory and, like other people who have appropriated patterns, we do not adopt his philosophy wholesale. However, in our view there are several good reasons for bringing together patterns and activity theory:

- Activity theory provides an analytic framework for conceptualizing computer mediated collaborative work in its organizational context. The elements of this unit of analysis can be represented as related patterns without losing the unity of the whole.
- Activity theory is, like pattern languages, systemic. The concept of levels of activity (see Table 2) provides a principled basis for structuring the relationships between patterns which is analogous to Alexander's concept of scale.
- Alexander's definition of a pattern as a "three-part rule, which expresses a relation between a certain context, a problem and a solution" [3, p.247] is consistent with activity theory. Patterns are not abstract solutions to problems, but are situated in a conjunction of specific historic, technological and social conditions.
- Alexander's definition of a problem in context as being caused by a system of forces which arises in that context [3, p.253] resonates with the concept of contradiction in activity theory.

The unit of analysis of activity theory is not something that can be decomposed; it is a dynamically related, integral system. A pattern language preserves the unity and integrity of the activity system through the relationships between the patterns, its discrete elements. Patterns can be written to represent any aspect of the unit of analysis – for example, the design of artifacts; the actions of an individual or collective (*i.e.* group or team) subject; cultural aspects such as organizational policy and procedures; the roles within the division of labor or community of the workgroup. However, each pattern is related to the larger patterns it helps to complete, and the smaller patterns that complete it.

Figure 2 shows a subset of patterns from the GreenFam pattern language, which represents findings from the evaluation and field study. We have selected those patterns which model the actions and tools of a facilitator, as described in Section 3.4. The key role played by facilitators is set in the context of GreenFam's

envisioned information policy INFORMATION AS COMMON PROPERTY, and one of the patterns that helped to realize it, putting INFORMATION "IN ONE PLACE". Relevant features of the groupware architecture are modeled in patterns 7 and 8: we found that integration of email was crucial to the success of GreenFam's collaborative spaces, providing SEAMLESS ACCESS between users' email and the space. One of the tool mediated actions of facilitators, alerting users to new postings in the space, is modeled by the related patterns EMAIL ALERTS and EMAIL HYPERLINK. Finally, we found that facilitators made it difficult for users to avoid using the spaces by posting critical information, such as meeting agendas and minutes, rather than circulating these as email attachments, as had been done in the past. Figure 3 shows the EMAIL ALERTS pattern, in order to illustrate the pattern form and to show how the dependencies between higher and lower level patterns are defined.

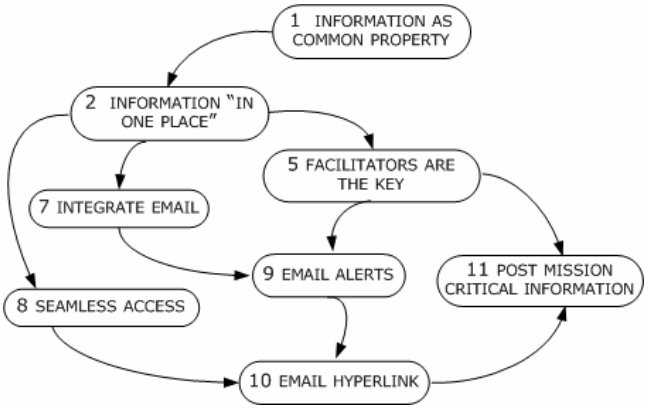
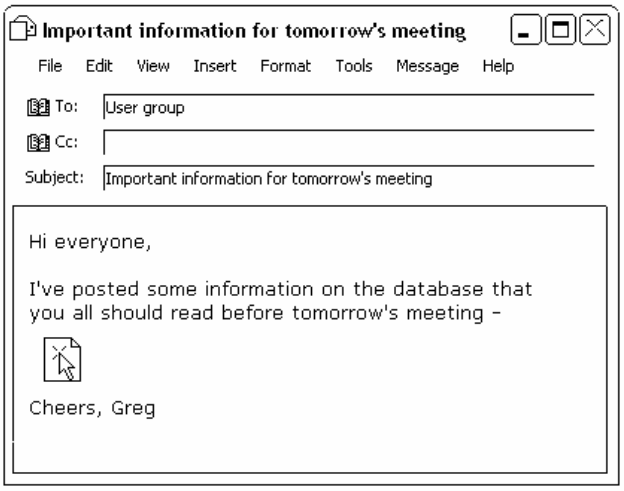


Figure 2. Map of a subset of the GreenFam pattern language

9 EMAIL ALERTS **



… Where organizations want to change from an email paradigm to a shared information paradigm and put INFORMATION "IN ONE PLACE" (2) with tools which INTEGRATE EMAIL (7), FACILITATORS ARE THE KEY (5) to encouraging users to adopt the new way of working.

❖ ❖ ❖

It can be difficult to get users to change from using email to communicate information, to placing it in a shared information space where everybody can access it. Facilitators need the right tools to involve users and encourage participation.

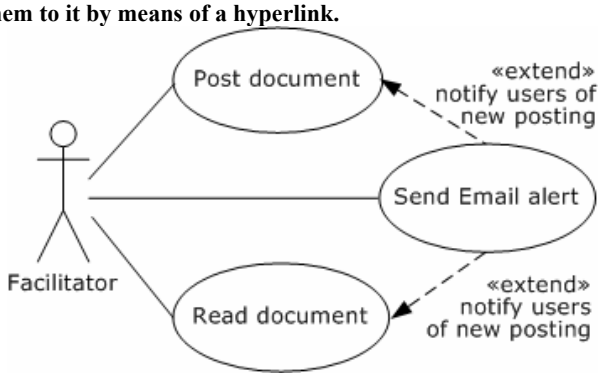
Email is a tool used to coordinate work and communicate information that is generally popular with users. It has the drawback that email messages are stored in personal mailboxes where the information cannot be shared. When new tools for collaborative information sharing are introduced to organizations they will have to compete with tried and tested ways of communication such as email, which are embedded in the culture and practice of the workplace and which are easy and quick to use.

If email is integrated in the information space the facilitator can easily send a message to users after she has posted a new document in the space, especially if it contains mission critical information that they need to read. Or maybe she has just read an interesting document that someone else has posted and wants to draw it to the attention of one or more users, who may not yet have got into the habit of checking the space regularly for new information.

Users who are accustomed to using email in their day to day work will read the message and, by means of a hyperlink to the document, go directly to the shared information space. By the means of email alerts users are accustomed to the space, which gradually becomes more widely used.

Therefore:

Make a virtue of the popularity of email by using it to alert users about new information on the database and directing them to it by means of a hyperlink.



Use cases for EMAIL ALERTS

❖ ❖ ❖

The email message contains an EMAIL HYPERLINK (10): a mouse click on the hyperlink icon takes the user directly to the relevant document in the database …

Figure 3. Pattern modelling one of the mediated actions of a facilitator

The patterns shown in Figure 2 have not only been validated through the longitudinal GreenFam study, but also through informal observation of another groupware system, a collaborative learning environment used at our university. This tool does not integrate with our normal email system or allow hyperlinks to be made to documents. We have found that in this

case would-be facilitators lack crucial tools that would allow them to promote the use of the system.

As discussed in Section 4.1, the question of the principle for defining relationships between patterns in a pattern language has been raised in both HCI and CSCW. In 'activity patterns' the unit of analysis provides one basis for defining the relationships; the concept of the hierarchical levels of activity is another. Patterns can be written for different levels of activity (see Table 2); the relationships between patterns once again preserve the unity of the system. The patterns shown in Figure 2 are partly structured according to the different levels of activity they represent. For example, pattern 1 defines the organizational culture for the whole activity system; pattern 5 describes the role of an individual subject within the system, who carries out actions represented in patterns 9 and 11. EMAIL HYPERLINK defines a pattern at the level where an action could next be modeled at the operational level, specifying user interaction with the tool, the point at which our model interfaces with an HCI pattern language – or potentially, groupware usability patterns.

The GreenFam patterns use the same basic Alexandrian template as Herrmann *et al* [21]. However, we reconceptualise Alexander's notion of a design problem as a contradiction, as defined in Section 3.4, giving the following formula -

An activity pattern is a three-part rule which establishes a relationship between a context, a contradiction that arises in that context, and its resolution, which takes it from its current state to a more developed one.

Alexander's definition of a pattern is, as we have seen, a rule about how to resolve a "system of forces" which always arise in a given context. Alexander defines a number of different kinds of forces relevant to the built environment such as psychic, psychological, social, economic, structural, natural, political and ecological forces [3, p.248-249]. His understanding of a force is very different from the understanding of contradiction in activity theory, as the force that drives development and change. In activity patterns the problem/solution statement at the heart of the pattern is conceived as a contradiction to the realization of the aims of the activity system, which is found – in that specific context - to be resolved by the pattern. Patterns are identified, in the field, by observation of recurrent contradictions or barriers to progress, and emergent new practices that tend to resolve them.

By embodying the principles of activity theory in patterns, we have been able to address some of the problems that have been identified in HCI and CSCW research. The unit of analysis and hierarchical concept of activity provide a principled way of structuring the relationship between patterns, which can represent different levels of activity, or different elements of tool mediated collaborative work. The concept of a pattern as expressing a resolution to a contradiction in the design space, provides a basis for the identification of patterns which are orientated towards the design of developmental solutions.

5. DISCUSSION AND CONCLUSIONS

In the introduction to this paper we stated several objectives: investigating ways of representing evaluation findings in a form that was useful for developers; addressing the need for generalizable solutions that could be communicated to others working in design; looking at ways of integrating use, evaluation and design through design-oriented models. In conclusion we will assess the potential of an activity pattern language to meet these objectives.

It has already been shown that patterns, in CSCW, are a good method of communicating recurrent findings from field studies [25]. They are an economical way of representing qualitative data, containing enough information about the context of the problem and its solution to be communicated across boundaries. This does not necessarily mean that they will be found to be a useful or usable tool by designers, although the experience in the fields of software engineering and HCI [12] suggests that there will equally be potential for patterns in groupware design and development. However, little research has been done as yet to test the concept as a practicable method in groupware projects.

The generalizability of patterns is also an issue that needs to be addressed. The GreenFam patterns were the outcome of a longitudinal research project and were observed recurring in several instances: we therefore have confidence in their validity within the GreenFam context. We have been able to verify several of the patterns by reference to other research in CSCW, where similar observations have been made, or by informally testing the patterns in other situations. Examples of this were put forward in Section 3.4 and 4.1. However, our definition of a pattern emphasizes context, and the situatedness of both the contradiction and its resolution represented in the pattern. In Section 3.1 we pointed out that some of the apparent similarities between GreenFam and other CSCW case studies were largely superficial, with very different underlying causes. This suggests that patterns derived from the study of one organization are not necessarily generalizable to another similar-looking situation, but where different forces may be at work. The generalizability of a specific pattern is a question that can only be resolved through the dissemination of pattern languages, and their application and testing by a community of users.

Our main objective was to investigate ways of integrating evaluation and design, and to address a gap in CSCW evaluation research. Vygotsky, writing about the development of a method adequate to explain the nature and development of psychological processes, talks about method as something that is "[…] simultaneously prerequisite and product, the tool and result of the study" [37, p.65]. One of the qualities of a pattern language is that it evolves continuously as it is put to use. The language can be easily changed, by amending, deleting or writing new patterns: in this way it can evolve as the field of design changes. It is both a *tool* that is applied in projects and an *outcome*, as what is learned from the project is fed back into further development of the language. Patterns are not only a way of representing "real, concrete facts about what works", but also a method that can effectively integrate the activities of use, evaluation and design.

This last feature puts a slightly different emphasis on the use of patterns. They are more usually presented as a tool for representing designers' expertise or findings from workplace studies, in order that this can be disseminated. For us, investigating the method of applying patterns is a more interesting problem for future research than solely writing patterns that might capture generalizable solutions. What has emerged from the fairly small community of CSCW patterns researchers reviewed in Section 4.1 is a diversity of approaches, and we feel that this is a strength. It suggests that the pattern language concept is flexible enough to lend itself to being appropriated and adapted to fit the

specific needs of researchers – exactly what is also required in tools for designers and developers [18]. However, focusing on a pattern language as a practicable method that can be used in design projects raises a number of additional questions.

Unlike architectural patterns [1], reports of experiences of using design patterns for HCI or CSCW in real-world projects are lacking. Erickson backs his case in favor of pattern languages for *lingua francas* with an example from architecture. He acknowledges that, in HCI, the work is just beginning [15, p.366]. Dearden *et al* [11] have made progress in evaluating patterns as a method for involving users in the participatory design of systems. They emulate Alexander's intention for his pattern language, that it should be a tool to support and empower the people who live in towns and buildings to shape their own environment. They report on an experiment to involve users in the participatory design of a web site, but although much was learned this was a trial rather than a real project. Dearden *et al* identify a number of interesting practical issues, including how accessible the form of their patterns was to users, and how projects might be facilitated. Both Erickson and Dearden address the issue from the perspective of HCI research: in CSCW little research has, as yet, been reported on the process of applying patterns in design projects. The research reported in this paper is no exception. Our work on patterns was carried out after the field research had ended. Although the patterns themselves can be validated through the findings of the longitudinal study, the patterns method has not yet been tested or systematically evaluated in practice. In conclusion, we would like to suggest this is a possible direction in which CSCW patterns research might go.

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