A Design Approach for Collaboration Processes:

A Multi-Method Design Science Study in Collaboration Engineering

Gwendolyn Kolfschoten[1], Gert-Jan de Vreede[1,2]

[1]Faculty of Technology, Policy and Management

Delft University of Technology

The Netherlands

g.l.kolfschoten@tbm.tudelft.nl

[2]Center for Collaboration Science

University of Nebraska at Omaha

gdevreede@mail.unomaha.edu

Abstract

Collaboration Engineering is an approach for the design and deployment of repeatable collaboration processes that can be executed by practitioners without the support of collaboration professionals such as facilitators. A critical challenge in Collaboration Engineering concerns how the design activities have to be executed and which design choices have to be made to create a process design. We report on a four year design science study, in which we developed a design approach for Collaboration Engineering that *incorporates existing process design methods, pattern based design principles, and insights from expert facilitators regarding design challenges and choices. The resulting approach was evaluated and continuously improved in four trials with 37 students. Our findings suggest that this approach is useful to support the design of repeatable collaboration processes. Our study further serves as an example of how a design approach can be developed and improved following a multi-method design science approach.*

Keywords: Collaboration Engineering, Design science, Facilitation, GSS, Pattern language

1. Introduction

The adoption and sustained use of Information Systems (IS) remains a challenging issue, especially when the knowledge and skills involved in the operation and customization of complex systems need to be transferred to users to ensure sustained use. Recent research has shown that design patterns or best practice documentation can support users to successfully appropriate technology, see e.g. [1-4]. It is of particular importance that such design patterns focus on the work practices that involve the use of the technology rather than just the technology itself [5, 6]. To this end, this paper will describe the development and evaluation of a design approach that uses design patterns to create and transfer collaborative work practices that can be enabled by Group Support Systems (GSS).

Research and field experiences have provided evidence that suggests that support for collaboration processes such as facilitation and GSS technology can improve the efficiency and effectiveness of collaboration in organizations [7]. However, researchers have also argued that it is difficult to implement sustained collaboration support in organizations [8, 9]. First, a support facility for collaboration often does not support a core business process. Second, such a facility often has uncertain revenue [10]. Finally, it requires an extensive set of skills and competences that are difficult to develop and transfer [11]. Researchers, over the past few years, have developed and fielded Collaboration Engineering as an approach to address these challenges. Collaboration Engineering concerns designing and deploying high value recurring collaborative work practices that can be executed by practitioners by themselves without ongoing support from professionals [9, 12, 13]. A practitioner is an expert in the application domain of the collaborative work practice, but is not a collaboration professional such as a facilitator.

Collaboration Engineering can be considered to be a combination of a facilitation, design and training approach, that aims to create collaboration processes that can be supported with collaboration support tools such as GSS. The approach aims to foster sustainable collaboration support in the shape of transferable, reusable, and predictable collaboration process designs that can be used by practitioners in organizations. In Collaboration Engineering, a collaboration engineer designs an efficacious, acceptable, reusable, transferable and predictable collaboration process which is then transferred to a practitioner [14]. After this transition, which requires a (short) training [15], the practitioner is expected to be able to facilitate the collaboration process without any further support from a professional facilitator, and without having to learn extensive facilitation skills [9, 13]. Because practitioners normally lack extensive facilitation skills and experience, the design created by the collaboration engineer should be of higher quality and should be more robust than if the collaboration engineer were to execute the design himself. Therefore a key challenge in Collaboration Engineering research is to increase our understanding of how a collaboration engineer can design such a high quality recurring collaboration process.

This paper presents a pattern-based design approach for collaboration processes and explains how we derived and evaluated this approach. The design of a collaboration process has been described in the literature as a challenging yet critical activity to ensure that the process is executed productively, see e.g. [16-19]. The approach presented in this paper is based on existing IS design approaches and on best practices from the Collaboration Engineering field.

The contribution of our study will be threefold. First, the collaboration process design approach will (a) provide design guidance for (novice) collaboration engineers, (b) provide a definition of the iterative activities and techniques to design collaboration processes, (c) provide a basis for the creation of design support tools, and (d) provide a basis for the training of collaboration engineers. Second, in following the design science research strategy [20] our study will illustrate how the development and evaluation of a design approach can be undertaken as a scientific effort. Finally, as the collaboration process design approach presented in this paper has a strong foundation in pattern-based design, our study will attempt to show how a pattern-based perspective can facilitate the transfer of design knowledge to novice designers of information systems and the work practices they support.

The remainder of this paper is structured as follows. We first describe the foundation of the collaboration process design approach, which is grounded in a variety of problem solving and design methods. Next, we describe design science as our guiding research strategy and the methods we used within this strategy to develop and evaluate the design approach. Then, we present the collaboration process design approach in detail in terms of its steps and critical activities. Last, we present the results of an iterative evaluation of the design approach, followed by our conclusions and suggestions for further research.

2. Background

Regardless of domain, the act of designing involves creating something new: a solution to a problem, a new functionality for a system, or perhaps a new work of art. The verb ‘to design’ means to plan and fashion the form and structure of an object [21]. Engineering is the application of a systematic, disciplined, quantifiable approach to structures, machines, products, systems, or processes [22]. Both approaches aim to ‘structure an object’, yet the difference between ‘engineering’ and ‘designing’ is the use of a systematic approach while structuring the object. In this paper, the object of design or engineering is collaboration. Collaboration can be seen as a process or system. Collaboration envisioned as a process is a sequence of steps performed by a group to achieve a goal. Collaboration envisioned as a system is a group of people, interacting purposefully, possibly using technology and different communication modes.

System design or system engineering is an interdisciplinary approach and means to enable the realization of successful systems [23]. Process design or process engineering is discussed in several disciplines, of which the most closely related discipline is Business Process (Re)engineering. One of the founders of this domain, Thomas Davenport, defines it as “the envisioning of new work strategies, the actual process design activity, and the implementation of the change in all its complex technological, human, and organizational dimensions” [24].

Thus, collaboration process design should consist of a structured systematic approach to design purposeful interaction within the context of a sequence of steps which helps the group to achieve their goal. Several frameworks, models, and guidelines exist that support a facilitator in directing and encouraging purposeful, constructive interaction among of group of people. Examples include the guidelines from Schwarz [25], Butler [26], and the Circle model of Baldwin [27]. By following these guidelines, the facilitator is expected to be able to create a pleasant, 'fair' collaboration process. Schwarz [25], Forman and Selly [28] and Yoong [29] also offer approaches for the preparation of such a collaboration process. These steps give an overview of the design effort to be made by facilitators, but are still rather generic and provide little guidance for the actual steps that have to be followed and the choices that have to be made in the design of a collaboration process.

There are various studies that focus more explicitly on the choice of collaboration support tools in the context of meeting design. For example, Zigurs and Buckland [30] describe a model that allows the user to identify a fit between task and GSS tool to support the selection and use of appropriate GSS tools. Antunes [19] presents a tool that supports the choice of a GSS tool based on strategies for different group tasks. By matching the group task to the different options in the system, the tool proposes appropriate GSS tools. This tool might offer a first step in the choice for a tool, yet it does not help the designer in understanding how to use this tool in order to support the group in their task.

Wheeler and Valacich [31] and Dennis [32] describe how the appropriate use of GSS can support effective collaboration processes. They suggest that this appropriate use should be supported through facilitation, training, restriction, or guidance. 'Appropriate' is defined as "as intended by the designer." However, tools can be used very effectively for different purposes, other than what they are designed for, and vice versa, tools can be used highly ineffectively for purposes they are designed for [33]. Moreover, while one can argue that certain tools are more appropriate for a specific task than others, the successful execution of a task does not just depend on the tool selection. The tool does not offer predictive value on how a group will use it, see e.g. [33]. To this end, more detailed 'structuring tactics' are required, such as meeting agendas, process design modules, and facilitation actions [2].

Other frameworks for the design of a collaboration process include the Divergence-Convergence model from Kamer et al [34], the Habermas model from Sheffield [35], and various checklists such as provided in [36-38]. While these approaches offer some helpful guidelines, they offer only a high level overview of a process rather than a detailed insight in the design choices between similar but slightly different collaboration techniques. Studies by Santanen et al. [39] and Shepherd et al. [40] showed that small variations in the collaboration technique can have significant effects on the outcomes of a collaboration process.

Process design, i.e. creating a sequence of steps, is an approach used especially in workflow design [41], business process change [42, 43] and system analysis and design methods [44]. The key phases of such an approach have been labeled variously as “design”, “decision-making”, “creativity”, or “problem solving” and usually include [45-52]:

- Identification of the issue, where the problem or challenge is identified and the scope determined.
- Analysis, in which the situation, context, different aspects and processes involved are rigorously examined and modeled or other ways captured and simplified to gain insight in the problem and to determine constraints to the process.
- Finding (and evaluating) alternatives, where different solutions and ideas are derived through a creative process and where these solutions are further analyzed to enable precise comparison.
- Choice, where based on some set of criteria the different solutions are compared and the best one(s) are identified.
- Implementation, where the chosen solution is realized and embedded in its context.

We used this sequence of steps as a basis for the design approach for collaboration processes. We tailored the approach to make it useful for the design of a transferable collaboration process prescription that can be instantiated across many different instances of a collaborative task. Before presenting the details of the design approach, we will first discuss the research method of our study and then discuss in more detail how the design approach was developed.

3. Research Method

Design as an approach and perspective on inquiry has recently evolved in Design Science where design is proposed as a research strategy to gain knowledge and understanding about the object under construction. Design science can be used to research not just instantiations (prototypes or systems) but also constructs (symbols, vocabulary), models (abstractions and representations) and methods (algorithms and practices) [20]. Design science provides seven guidelines for research with a design component. These guidelines call for addressing the innovative artifact that is to be designed, the problem it solves, the evaluation criteria for success, the research contribution, the rigor of the research methods used, the design approach itself, and the communication of findings [20].

In this study, the object of design is an approach to design collaboration process prescriptions. The problem addressed is to 'increase the quality of collaboration' both in terms of process quality and the quality of the outcome of the collaboration process. Quality of collaboration is a highly relevant organizational and societal phenomenon as collaboration is now seen as the most critical production factor of organizations [53]. For the evaluation of collaboration engineering efforts, a distinction can be made between process and outcome factors, and between an organizational perspective (e.g. efficiency, effectiveness, productivity) and a participant perspective (e.g. satisfaction, commitment, adoption). For most of these factors, theories [54-56] and empirical findings [18, 57, 58] have been studied and reported for over two decades.

The research contribution of this paper is to present and validate a pattern-based collaboration process design approach, which is identified by Hevner as a key contribution of design science studies [20]. In order to develop, validate, and improve the design approach, we used a multi-method research approach (see figure 1). First, the collaboration process design approach was based on existing design approaches, theories, and frameworks as discussed in the previous section. Next, a survey was organized among facilitators to explore the challenges of collaboration process design [59]. Finally, a number of expert facilitators were interviewed to get a deeper understanding of their process design choices [60]. The results of the survey and interviews are discussed in more detail in the next section. These results were used to develop the first version of the collaboration process design approach. The design approach was then applied in a series of trials in which it was evaluated and improved iteratively.

Figure 1: Research approach.

4. Deriving a collaboration process design approach

In this section we describe how the first version of the collaboration process design approach was developed. As the approach aims to design collaboration processes as a sequence of patterns, we first address the use of a pattern language as a basis for design. Next, we discuss facilitation design practices and the information facilitators use in their design effort to further inform the collaboration process design approach. Finally, we report on a series of interviews with facilitators from which criteria for the selection of facilitation techniques were distilled. These combined insights lead to the first version of the collaboration process design approach, which provided the starting point for further improvements in a number of evaluation trials.

4.1 Pattern based design

A key ingredient of our design approach is the use of design patterns as our building blocks for the development of a collaborative work practice. Designers in various domains have adopted the use of design patterns to exchange reusable methods and best practices, to foster mutual learning, and to make design efforts more effective and efficient. A related set of design patterns can be defined as a pattern language. Pattern languages were originally proposed by Alexander [61] in the domain of architecture, and later adopted in software engineering [62] from which it spread to various other disciplines including workflow design [41] and virtual project management [1]. An important implication of using patterns in a design approach is that rather than designing a solution in all its details, the designer can focus on selecting and combining a number of appropriate patterns from a library.

In the field of Collaboration Engineering, design patterns are used as well. These patterns are called thinkLets [63]. A thinkLet is a 'best facilitation practice': it describes all relevant information to create a pattern of collaboration in a group of people working together towards a common goal [9]. ThinkLets were first conceptualized to serve as design patterns but were then further developed to serve also practitioners [63, 64]. Field experiences have shown that thinkLets represent transferable, reusable, and predictable building blocks for the design of collaboration processes, see e.g. [13, 65-67].

4.2 Survey: Facilitators' design practices

One of the sources of design expertise that we used to develop the design approach is the expertise of seasoned facilitators. To understand how facilitators design collaborative work practices and the design choices they make, we developed a survey on facilitation design practices. Almost 200 facilitators completed this survey in response a request through the International Association of Facilitators' (IAF) mail group and website [68] and the Grp-Facl listserv on group facilitation [69]. Although the survey questions were aimed to be as generic as possible to accommodate all types of group facilitation, some facilitators had difficulties answering all questions.

Questionnaires that contained multiple incomplete parts were excluded. As a result, 89 questionnaires were eventually taken into account. Some questions were answered by fewer facilitators (as they were not applicable to some facilitators).

The respondents represented a broad range of styles, methods, and work experience in many different environments. Most facilitators used non-GSS tools and methods to support their groups. Some respondents explained their work situation, to provide the context for their answer. Of the 89 respondents, 39 reported that they had facilitated more than 100 sessions. We deemed these to be expert facilitators. Table 1 presents the results regarding which design tasks expert facilitators executed when they prepare for a facilitated workshop, evaluated using a checklist of facilitation design tasks.

Workshop design activity	**Experts (n=39)**	
1 Analysis of task/problem	90%	35
2 Analysis of group and context	97%	38
3 Define tasks/steps	87%	34
4 Choose techniques	95%	37
5 Create agenda	100%	39

Table 1. Percentage and number of expert facilitators that perform specific design tasks.

The results show that expert facilitators perform each of the identified design tasks. This implies that the collaboration process design approach should at least incorporate these tasks. Further, since the collaboration process design approach needs to result in a process prescription that is highly predictable, one additional task is required: Although using thinkLets as design patterns may increase the predictability of the separate facilitation steps in the collaboration process, it does not guarantee that the collaboration process prescription as a whole is predictable as well. Therefore, a validation task has to be include in the design process. This task is done before the documentation tasks that captures the process prescription for transfer to practitioners.

4.3 Interviews: Facilitators' design challenges

We found that while the survey gave insight in the high level steps of a design approach, it did not give us detailed insight into the design choices and challenges that facilitators face. We therefore held a number of interviews to learn more about the design task of a facilitator. During a series of interviews, a number of facilitators were presented with a concrete and specific case description and asked to design a collaboration process that a practitioner had to execute [60]. In particular, they were asked to choose facilitation techniques and verbalize their thinking process while doing so. The interviews followed the guidelines of Verbal Protocol Analysis [70]. VPA 'has been used extensively as an effective method for in-depth examination of cognitive behaviors' [71]. The verbal reports generated using this method are a valuable and reliable source of information about cognitive processes [70].

A total of 16 facilitators were interviewed. The facilitators worked privately or in Dutch universities and research institutes. The length of each interview ranged from 30 to 120 minutes. Each interview was transcribed and then analyzed. We coded both the reasons for choosing a technique and the outcomes that were sought or expected by using the technique. Examples of reasons for selection were "(I chose technique x because…) it is required for the task, to make the deliverable, but also fits the group, it motivates people to see a broad perspective." And "… so with this concern I will choose a method that will let me manage information overload…"

From the coding results we identified a number of tradeoff dimensions that inform the choice of facilitation techniques. We then clustered the coded results among the tradeoff dimensions. If the coded results could not be clustered we revised the tradeoffs to increase their completeness. From the analysis we found that facilitators appear to create and adjust a collaboration process design in three key phases: (1) Negotiation of the assumptions and requirements to the design, (2) Choice of facilitation techniques, tools and methods, and (3) Instantiation, customization and adjustment of the design during validation and execution. In each of these phases, the facilitator has to balance tradeoffs in three key dimensions: (a) Achieving the group's goal, (b)

Efficient use of available resources (time, effort, knowledge, tools), and (c) inclusion, participation, and acceptance of the stakeholders. Additionally the facilitator needs to consider the limitations in the ability of the practitioner executing the design. These design challenges are visualized in figure 2.

Figure 2. Design challenges.

The following limitations regarding the above analysis should be noted. First, a number of the interviewed facilitators had similar backgrounds which could have resulted in more similar results than with a broader sample. Second, the resulting model depicted in figure 2 was not verified with an independent data set. Finally, the coding was done by two researchers and not verified by independent parties.

5. An approach for collaboration process design

Based on the foundations and insights presented in sections 2 and 4, we developed the approach for collaboration process design. An overview of the approach is depicted in figure 3.

Figure 3. Overview of a collaboration process design approach for Collaboration Engineering.

The approach consists of five steps. The first step concerns an analysis of the collaborative task that the group has to execute. Also the characteristics of the group and the stakes involved in the outcome are part of this step. In the next step, the group's collaborative task is decomposed into a number of activities that can be performed using collaboration process design patterns, i.e. thinkLets. This decomposition provides the basis for the next step in which available thinkLets are matched to the constituent activities. Next, the agenda for the collaboration process is build using the results from the previous steps. Finally, the design of the process is validated to test whether it is likely to yield the desired results. Documentation of the collaboration process design occurs at each of the five steps.

We will present each of the design process' steps below in more detail. It is important to note that the design process as described may appear to represent a linear "waterfall" approach. However, as in software engineering, it is clear that these steps cannot be executed sequentially, but are likely to be iterative and incremental in nature [72]. Insights and choices in every step can affect past and future steps and choices [73]. For instance, choices of facilitation techniques affect the choices made in the decomposition, and validation results might lead to revisions of the requirements, and thus result in changes in the sequence of activities. While we acknowledge this iterative nature of the design process, the process will be discussed as a linear sequence of steps to keep the description straightforward.

5.1 Step 1: Task diagnosis

Design is an evolving process that starts with the initial conversation with the stakeholders involved in the collaboration process to diagnose the relevant requirements and constraints. In this conversation the collaboration engineer determines, adjusts, and negotiates the requirements and constraints on the collaboration process with respect to the task, the stakeholders involved, the resources available, and the facilitator(s) or practitioner(s). Each of these sub steps is elaborated below in terms of purpose, activities, and resulting documentation. To support the overall task diagnosis step the checklist in appendix A can be used.

Task analysis

The task analysis sub step covers the definition of the collaboration process' goals and deliverables and the establishment of the stakeholders' commitment with respect to these goals and deliverables. A goal can be defined as a desired state or outcome [74]. The goal and deliverables of the collaboration process are the cornerstones of the design. If the process creates the wrong deliverables or achieves a different goal than the stakeholders had in mind, the process will not be successful. Thus, the facilitator or practitioner will have to gain commitment from the group with respect to the goal and deliverables.

The goal and deliverable often represent a solution, decision, or analysis. However, a collaboration process can also have "experience goals", for example the objective to create awareness of a problem among the participants. Goal setting theory describes that a goal should be specific and challenging enough for the participants in order to evoke productivity [75].

The deliverables represent the tangible output of the process, for example, a detailed solution, a ranking of preferences, or a list of options. It has to be to established what will happen with the deliverables after they have been created: How will they be used, will the participants get them, should they be elaborated in more detail, or will the decision be implemented.

Depending on how a result will be used, some characteristics of the deliverable can be established. For example, a proposal that needs to be judged by the management of a large organization should not be a 100-page document, but a concise management summary, while an evaluation report might require more length and detail. A good way to get an understanding of the deliverables is to ask the stakeholders to give an example of a deliverable. The list of adjectives depicted in table 2 can be used to guide the discussion with the stakeholders about the characteristics of the deliverables. This list was derived from the analysis of the designs made by the facilitators in the interview study (see section 3).

Amount of concepts	Consistency	Preciseness

Balanced	Creativeness	Representative
Breadth	Deliberated	Richness
Certain	Depth	Scrutiny
Clarity	Detailed	Shared/Joint
Coherence	Feasible	Supported
Completeness	Important	Variety
Consent/Agreement	Level of abstraction	Well understood

Table 2. Adjectives to describe a collaboration process deliverable.

In conclusion, the documentation of the task analysis sub step will consist of the following: A definition and description of the collaboration process' goal and deliverables and a description of what will be done with the deliverables after they have been created.

Stakeholder analysis

The next sub step is the stakeholder analysis. The purpose of this sub step is to gain a deeper understanding of the group that will execute the collaboration process in terms of their roles, interrelationships, and individual interests. Aspects such as group size, participants' age, sex, culture, educational background, or organization level are useful to customize the collaboration process design. For example, it can help to determine the tone of the script (formal/informal), or identify the best composition of sub-groups. It is especially important to determine whether the stakeholders have congruent or conflicting interests. When the facilitator or practitioner is unaware that there are different or conflicting interests, the execution of the collaboration process design can be a challenge. It may, for example, be difficult to interpret the signals from the group and to manage discussions, misunderstanding, and conflict.

An effective way to perform the stakeholder analysis is to consider the group's history, and determine for each stakeholder involved:

- What are their individual stakes in the process and results?
- What are their reasons for participation and their expectations?
- What can they contribute?
- Are they committed to the group goal?
- Will they accept the results?
- Will they accept the process?
- Will they commit the required resources (time, budget, materials)?
- Will they be motivated to make an effort and to share knowledge?

The collaboration process design should accommodate the individual interests as much as possible to increase commitment of resources (knowledge and effort) and acceptance of the process and results. To this end, it may be useful to give different stakeholders different roles in the process. For example, the problem owner can follow the instructions for all participants, but will have an additional responsibility during the introduction and conclusion of the process.

The documentation of the stakeholder analysis sub step will consist of the following: (a) A definition of the relevant history of the group and interests, motivations, and intentions of the individual participants, and (b) a definition of which stakeholders will represent which roles in the collaboration process.

Resource analysis

The purpose of the resource analysis sub step is to determine what are the available resources for the collaboration process design and how they can be expended. In discussion with the organization, the timeframe, facilities, technology, and budget need to be determined.

The timeframe within which the collaboration process design has to be completed can vary for different instances of the process. For example, a risk assessment workshop for an engineering project might follow a specific design and sequence of steps, and yet take more time to complete for a small scope engineering project than for a large scope project. Therefore setting a timeframe for the collaboration process design might be challenging. The facilities and technologies that are available or required to support the process need to be defined as well. It has to be considered that technology is not necessarily reliable (think of power-black-out or equipment failures). If the availability of reliable facilities and technology is a concern, the process can be designed in such a way that it includes instructions for the facilitators or practitioners on how they can implement the design with different resources (for example GSS-based or pen/paper-based). Finally, the person hours and monetary resources that have to be committed by the organization have to be agreed on and budgeted. These can be used as benchmark to set deadlines for designing an early pilot version of the process and a final version that can be deployed into the organization.

The documentation for this sub step will include the minimum requirements for the facilities, time, and technology that are needed to execute the collaboration process, in relation to its scope and the different settings in which the collaboration process design has to be executed. It will also cover a planning for the design process in terms of required time and monetary resources.

Facilitator/Practitioner analysis

The purpose of the last sub step is to determine a profile of the professionals that will execute the collaboration process design so that the design can be attuned accordingly. This profile may include the facilitators' or practitioners' skills, experience, domain expertise, or personality.

The collaboration engineer has to ensure that the facilitators or practitioners will have enough time allocated to be trained and to execute the collaboration process in practice. Also, practitioners should already be, or soon become, experts in the domain that the collaboration process is part of. The analysis of the facilitator or practitioner can be done in one of two ways. First, if the individual facilitators or practitioners are known, then the collaboration process design can be adjusted to them. If the individuals are not known, a profile can be created based on the collaboration process design so that individuals may be recruited and selected based upon this profile.

The chances for a successful transition of the collaboration process may increase if the facilitators or practitioners have certain skills or competencies. For example, when someone has some experience in working with groups, for example in the role of teacher or manager, the role of practitioner might be easier for him or her. Furthermore social skills, listening skills, and analytical/focus skills will be useful [11, 76]. Also, experience with leadership or a natural disposition for authority could help a person to feel more comfortable in the role of group leader. If GSS technology is used, some affinity or experience with such technology is useful.

The documentation for this last sub step will include the definition of the profile of the facilitators or practitioners that will execute the collaboration process, in terms of skills, experience, domain expertise, or personality as relevant for their projected leadership role and technology use.

5.2 Step 2: Task Decomposition

When the constraints and requirements concerning the collaboration process are clear, the initial sequence of steps for the collaboration process needs to be determined. For this purpose, the collaborative task has to be decomposed, i.e. the task's constituent activities have to be determined. There are three possible scenarios to decompose the collaborative task. First, it may be that the organization already has a standard way for performing the task (collaboratively). If this is the case, and if this standard is functional, then it can be used as a starting point to define the constituent activities. Second, if the organization has no task standard yet, then the literature has to be searched for industry standards that might provide a starting point for the activity decomposition. Finally, if the task is a first of its kind, then a new process for the task should be defined from scratch. The following steps are required to outline a process from scratch:

1. Elicit the task's deliverables. A task must have a deliverable, and a deliverable must serve a goal. There might be requirements to the deliverable that describe how it is captured and used in a next phase. The goal of the task might also set requirements to the deliverable, such as for example the level of detail or consensus among the team members.

2. Define activities for the deliverables. Each deliverable will require a collaborative activity to accomplish it. This activity should be defined as a step in the collaboration process.

3. Name & sequence the activities. Finally, once the activities are defined, they must be named and sequenced, e.g. activity 1 has to precede activity 2 so that the output of activity 1 serves as input for activity 2.

Using these three steps an outline of the collaboration process and description of the deliverables is created. The next step is to further decompose this process into smaller steps. There are two approaches to this next decomposition: pattern decomposition and result decomposition. Both can be used in combination iterating from both ways towards the critical choices in decomposition. We explain each separately below.

Pattern Decomposition

Pattern decomposition concerns determining for each activity which pattern of collaboration is required to be evoked in the group so that they can execute the activity. There are six patterns of collaboration [12, 77]:

- Generate: Move from having fewer to having more concepts in the pool of concepts shared by the group.
- Reduce: Move from having many concepts to a focus on fewer concepts that the group deems worthy of further attention.
- Clarify: Move from having less to having more shared understanding of concepts and of the words and phrases used to express them.
- Organize: Move from less to more understanding of the relationships among concepts the group is considering.
- Evaluate: Move from less to more understanding of the relative value of the concepts under consideration.
- Build consensus: Move from having fewer to having more group members who are willing to commit to a proposal.

Some patterns can be evoked in parallel, while some need to be done sequentially. Some activities may require more than one pattern to be evoked. It is important to consider carefully which patterns are required to keep the sequence of activities proceeding smoothly. For example, is it required to organize certain concepts before the next activity, is clarification needed, is consensus needed about a decision, etc.

Result Decomposition

Decomposition based on results is based on a further analysis of the deliverables to come up with the elementary activities to create the deliverables. Decomposition should lead to a level of activities where deliverables of each activity cannot be decomposed any more. Decomposition depends on the requirements defined in the first main step including:

- Time: If little time is available for the task one might choose to strive for less detail in the deliverables, requiring less discussion activities.
- Project embedding: It might be possible to assign participants to do preparation tasks before and “homework” after the collaboration process.
- Task complexity: Depending on the cognitive capacities of the group members, further decomposition of activities might be required to reduce task complexity.
- Technology: Certain GSS may for more efficient data processing and faster input generation than others or than a manually supported process.

- Practitioner skills: A practitioner that is experienced in working with groups can guide more complex activities than an inexperienced facilitator.

To perform a results based decomposition, first the collaboration process' deliverables are defined in detail, using the checklists of the task diagnosis. In addition, the inputs required to create these deliverables should be envisioned. The following classification of results of collaborative work can be used as a basis for results decomposition:

- Input. There are four types of input that can be distinguished: creative input such as ideas and solutions, informative input such as facts and experiences, visionary input such are future requirements, visions, scenarios and trends, and reflective input such as comments, preferences and opinions.
- Structure. Concepts can be ordered using the following types of structures: a cluster of related concepts, a ranking of concepts based on some criterion, a model in which more complex relations can be indicated, and a sequence in which the timely relationship of concepts is indicated.
- Focus. Results in this category include a selection where only a few concepts are chosen by the group, a summary in which concepts with similar meaning are integrated without removing unique input, a scope in which the boundaries for a collection of constructs are formulated, and a direction in which concepts that fit a specific cause of action are taken into account.
- Shared understanding. There are several types of shared understanding that a group can strive for. First, shared knowledge followed by shared

meaning about the knowledge available in the group. Next, mutual learning when participants might learn from each other and advance both their own knowledge and the group's knowledge. Last, mutual differences and disagreements can be revealed to gain an understanding of different types of conflicts.

- Commitment. One type of commitment is a decision, which can be made based on majority or on other decision making rules. Another type of commitment is an agreement, for instance to spend an amount of resources or to create a specific deliverable. A last type of commitment is a consensus, in which all critical stakeholders commit to a proposal [56].
- Empathy. Empathy results include respect for other stakeholders, consideration when participants take other's stakes into account, shared stakes when participants accommodate the interests of others among their own, and a team bond in which mutual goals are pursued.

The documentation for the task decomposition step consists of the definition of a logical sequence of process steps. Each step involves a named activity that generates a defined deliverable that contributes to the overall goal of the collaborative process.

5.3 Step 3: ThinkLet choice

In this step after the decomposition, the individual activities are matched to thinkLet design patterns so that each activity is specified in terms of a method to execute it. The choice of a thinkLet is a complex task. Many factors influence the fit of a thinkLet to a task. There are ways to reduce the complexity of this choice:

1. Use an overview of all available design patterns, to ensure consideration of all possible thinkLets.

2. Each design pattern comes with a set of guidelines for the scope and context of its use. In the thinkLet pattern language, information is provided describing the features of the thinkLet and the situations in which it is applicable. Information is also provided regarding the problems that can occur when using the thinkLet and situations in which it cannot or should not be used. Finally, an example or success story is provided to describe a useful illustration of the thinkLet in action.

3. ThinkLets can be classified based on the patterns of collaboration they create and on the type of results they produce. Therefore, the patterns of collaboration and activity results that were identified in the decomposition step can be used as a starting point to consider specific thinkLets that create the required pattern or result.

4. Apart from the fit with the activity it support, a thinkLet should also fit in combination with the preceding and subsequent thinkLet. In other words, the output of the preceding thinkLet should be useful as input for the thinkLet chosen for the current activity.

To support the thinkLet choice two supporting maps were developed. One is a classification map of thinkLets based on results or patterns of collaboration. The other is a choice map that offers insight in the usefulness of thinkLet combinations when the output of one thinkLet is used as input for the next thinkLet. An example of both is given in figure 4. In the choice map, the thinkLets displayed horizontally follow the thinkLets displayed vertically, e.g. the inverted cell indicates the combination FreeBrainstorm followed by OnePage. The symbol in each cell indicates whether the combination is good ('*'), possible but tricky ('^'), or impossible ('-').

Pattern: Generate	**Result: Input**
FreeBrainstorm	FreeBrainstorm
OnePage	OnePage
Comparative	Comparative
LeafHopper	LeafHopper
DealersChoice	DealersChoice
PlusMinus	PlusMinus
TopFive	TopFive
BranchBuilder	BranchBuilder
TheLobbyist	TheLobbyist
DimSum	DimSum
PointCounterPoint	PointCounterPoint
	StrawPoll
	MultiCriteria
	CheckMark
	StakeholderPoll
	BucketVote

ThinkLet combination: Good= * Tricky = ^ Impossible = -	**FreeBrainstorm**	**OnePage**	**Comparative**	**LeafHopper**	**DealersChoice**	**PlusMinus**	**TopFive**	**BranchBuilder**	**TheLobbyist**
Workshop kickoff	*	*	*	*	*	-	-	*	-
FreeBrainstorm	-	-	*	^	-	^	-	^	*
OnePage	-	-	^	^	^	*	-	*	*
Comparative	-	-	-	^	^	^	-	^	*
LeafHopper	-	-	-	*	*	*	-	^	*
DealersChoice	-	-	-	*	*	*	-	^	^
PlusMinus	-	-	-	^	^	^	-	^	*
TopFive	-	-	-	-	-	^	^	^	*
BranchBuilder	-	-	-	-	-	^	-	^	*
TheLobbyist	-	-	-	-	-	-	-	-	-

Figure 4. Pattern and Result classification and Choice Map example.

The documentation for the thinkLet choice transfers the sequence of activities into a sequence of thinkLet design patterns to prescribe how to perform each of the activities listed, and how to accomplish the indicated deliverables.

5.4 Step 4: Agenda building

A sequence of thinkLets by itself does not yet represent a collaboration process design. Additional planning of activities and definition of specific questions and instructions for each of the activities is required. This is captured in the process' agenda. The agenda should, besides activities to accomplish the group goal, specify breaks, presentations, and any other activities that need to be performed by the group. Also, the time required for each activity and time management guidelines should be included. Finally, the specific questions or assignments to the group needs to be formulated. Posing the right questions or the right instruction for the group is one of the most vital steps in a collaboration process design. The questions and instructions should be:

- Clear and unambiguous to focus effort.
- Not too complex, ensuring the optimal use of the available cognitive capacity in the group.
- Specific about the envisioned results (e.g. “Write a detailed description of possible solutions”, or “State a possible solution in one sentence”)
- Appropriate to ensure that the outcomes generated can be used as input in the next activity.
- Detailed by specifying the key information regarding issues such as the categories, voting criteria, voting scale, topics, prompts, and the (GSS) tools used.

Finally, the agenda can be represented using a specific format or using a Facilitation Process Model. Therefore the documentation of the Agenda building step consists of a formatted agenda and FPM of the collaboration process design.

Agenda Format

The agenda format specifies all required information for each thinkLet or activity. An example of a formatted agenda is given in table 3.

	Activity	**Question/Assignment**	**Deliverable**	**ThinkLet (Pattern)**	**Time**
	Introduction Explain goal of session, program and scope	Goal: gain insight in the Dutch goals with respect to the environment. Deliverable: short list of goals and instruments	Commitment to the goal, understanding GSS, knowing each other		10.00
1	Brainstorm goals	Which Dutch environmental goals need to be taken into account in the EU policy.	Broad list of goals	FreeBrainstorm (Diverge) EBS	10.30
2	Select among goals and clarify them	Please identify and reformulate the most important goal on your sheet	Complete but short list of specific, clear, measurable goals	FastFocus (Reduce & Clarify) EBS and Categorizer Criteria: Clear, Concrete, Measurable, Specific	10.50
3	Prioritize selection of goals	Please indicate the priory of each of these goals on a 5 point scale.	Ranking of the goals based on priority	StrawPoll (Evaluate) Vote Criteria: Priority of the goal, 5 point scale, low-high priority of the goal	11.30

Table 3. Example of the agenda format of a collaboration process design.

Facilitation Process Model

A Facilitation Process Model (FPM) can be used to depict the collaboration process flow [13]. An FPM focuses attention on the logic of the flow of the process from activity to activity. Additionally, to link the FPM to the agenda and to the design pattern documentation, it should contain the step number, the activity, and the thinkLet name. In summary, a FPM contains the following elements (an example is given in figure 5):

- The sequence of activities.
- Decisions that influence the flow of the process, criteria for the decisions, and alternative process flows.
- The pattern of collaboration that will occur from the activity and the result.
- The starting time for each activity and the estimated duration.
- Step number.
- Activity name.
- ThinkLet name.

Figure 5. Symbols in a Facilitation Process Model and an example (based on Vreede et al. 2005).

5.5 Step 5: Validation

In the final step in the design approach, the collaboration process design is validated. This can be done in the following ways:

- Pilot Testing. A pilot is a simple, small scale implementation of the collaboration process which helps to assess the quality of the process. This validation will reveal whether the process can be successfully executed with the given resources, stakeholders, process leader and whether it will accomplish high quality results.
- Walk-Through. A walk-through of the process the problem owner, prospective practitioners, and possibly a few participants can reveal pitfalls and difficulties for facilitation, the likeliness of acceptance by stakeholders, the expected quality & efficaciousness of the results, and the reusability.
- Act It Out (Simulate). By simulating the process, the collaboration engineer tries to answer the questions that would be posed to the participants, and considers if these answers can be used in the next activity. The collaboration engineer also has to consider questions such as: Can the intended participants also perform these activities? Is all information available, and do the participants have expertise to answer questions asked? Will the result be instrumental to the group goal? Can the practitioner perform this activity? This validation tests the logic of the design. A simulation can be done using role-playing.
- Expert Evaluation. As each collaboration engineer may have his or her own style, each will have different solutions for a collaboration challenge. Discussing the collaboration process design with colleagues may help to find alternative or better solutions for difficult activities and different thinkLets or methods for a certain challenge. This may help to identify inefficient parts of a

design. A colleague can offer alternative approaches and verify the expected outcomes.

The validation of the design is usually not documented separately, but changes made based on the validation should be adjusted in the other collaboration process documentation.

6 Evaluation of the design approach

To validate the design approach and the support offered in each step of the design process, a group of students were invited to design a collaboration process based using the approach. We documented the design approach in a design support booklet, i.e. a manual to design a collaboration process prescription. The booklet contained the following information:

- An introduction to explain how to use the booklet.
- A description of the requirements of a high quality collaboration process design.
- A step-by-step explanation of the design approach with a running example for each step.
- A list of design guidelines and tips and tricks.

To evaluate the design approach we investigated if the design booklet was in fact supporting the users in their efforts to design a collaboration process. We surveyed the students for their perception on the extent to which the design booklet offered effective and efficient support in designing a collaboration process through following on the following dimensions:

- Use. The extent to which they used the various parts of the design booklet.
- Usefulness. The extent to which they found the various parts of the design booklet useful.
- Time saving. The extent to which they felt the various parts of the design booklet saved them time.
- Improvement. The extent to which they felt that parts of the design booklet were in need of improvement.

Over the course of four years, a total of 37 students at the University of Nebraska at Omaha (32) and Delft University of Technology in the Netherlands (5) participated in the evaluation. The group was a mix of graduate and undergraduate students that participated in an annual course on Facilitation with GSS offered at both universities. The students received the design booklet and a set of thinkLet descriptions. They were tasked to design a collaboration process based on a case description. The case was a real project description of a GSS session run in the Netherlands by facilitators of Delft University of Technology, but the name of the organization involved was changed. The case involved an interdisciplinary law enforcement organization that faced challenges to meet internal and external expectations regarding the number of cases they were handling. For this organization, a collaboration process had to be designed that could be used on a regular basis to identify, elaborate, and agree on a collection of cases that could be worked on in the near future.

After finishing their design, the 37 students volunteered to fill out a questionnaire to collect their perceptions of the design assignment and the design approach. After the students received their grade, they participated in informal evaluation sessions, where they were asked to offer suggestions for improving the design approach and booklet.

6.1 Versions of the design approach and booklet

After each group of students finished their design assignment and reflections, the design approach and booklet were improved based on their feedback. This resulted in a total of four versions of the design approach and booklet. As an illustration, the first round of evaluations revealed the suggestions for improvement listed in table 4.

Offer thinkLet memorization support	*Add further explanation of the requirements to the design documentation and models*
Explain the task thinkLet choice; explain differences between thinkLets, similarities, strengths of each thinkLet and weaknesses	*Explain elements of high quality design in a consistent way and with explanation on how they affect the quality of collaboration*
Add better explanation of the patterns of collaboration	*Add tips on how to get started, an introduction for the novice*
Elaborate on the thinkLet choice with respect	Offer videos of successful and failed thinkLet

to appropriation and efficiency	implementations with tips and guidelines
Add further support for the validation and simulation of design with checklist and visualization	*Add step by step explanation of the design approach especially on thinkLet task choice and decomposition, with examples, learning checkpoints, and a small exercise*
Add a template for the design	*Add examples*

Table 4. Suggestions for improving the design approach and booklet.

The italicized improvements in table 4 were made in version 2. In this version we added a running example, as this was suggested by many students. Additionally, we added an introduction on how to use the booklet, describing the purpose of each part, and extended and updated the descriptions of the approach and documentation requirements. Last, we added an explanation of the criteria for a high quality design. In version 3 we updated the design approach explaining its iterative nature. Furthermore, we added a preliminary checklist for the analysis. The explanation of choosing thinkLets for activities was extended in this version as well, as were the requirements to the agenda documentation. The suggestions for improvement based on this version were very limited and mostly addressed the need to further explain how some part of the booklet should be used. We also implemented some improvement suggestions from version 1.

In the final version, version 4, we further updated the quality of the design description. We also extended the checklist for analysis, explained the quality trade-offs for the choice among thinkLets from a facilitation perspective and explained how choice and decomposition can affect each other. Next, we added classifications of the thinkLets based on results and patterns, and the choice map. We also updated the documentation requirements. Furthermore, we extended and updated the design guidelines. At the conclusion of this final update, the design booklet had grown from 20 pages in the first version to 60 pages in version 4.

6.2 Evaluation Results

In Table 5 we present the results of the survey among students for the four versions. For all questions the scale was 1-5, (1) being strongly disagree and (5) being strongly agree, unless indicated otherwise. Please note that the 5 Dutch students worked with versions 2 (1), 3 (3), and 4 (1).

Question	**v1**	**v2**	**v3**	**v4**
	N=14	N=5	N=5	N=13
I found the design exercise difficult	3.90	3.00	2.80	3.08
I found the design exercise took me a lot of effort	4.00	4.20	2.00	3.46
Average time spend in hours	5.95	11.30	9.30	7.31
Average grade (scale 1-10, 1=lowest, 10=highest)	7.90	7.80	7.90	8.51

Table 5. Students perceptions on effort of the design exercise and grade.

Table 5 shows that it became less difficult to design a process with the new versions of the booklet. However, the time spent on the design and the effort required for the exercise varied. The students' feedback suggested a possible explanation: while we improved the booklet in each iteration, the amount of information in the booklet increased. This presented a tradeoff: more support might be helpful but also increases the workload of the task as the students have more material to read, use, and incorporate in their design decisions. This effect is also visible in the average grade of the students, which remained stable in the beginning, indicating that the information overload pressed on the performance of the students. Based on the feedback we received, the increased grade and decreased time spent on the design in version 4 was most likely due to the updated design guidelines and thinkLet choice support that were introduced in this version. We envision further addressing the issue of information overload in future research by developing a computer aided collaboration engineering tool in which parts of the design choices and routines can be supported and automated.

Design approach step-wise description	**v1**	**v2**	**v3**	**v4**	**total**
	N=14	N=5	N=5	N=13	N=37
I used this information	4.14	4.60	4.80	3.83	4.19
I found this information useful	4.07	4.60	4.60	3.92	4.17
This information saved me time	3.57	4.20	4.80	3.83	3.92
This information should be improved	3.54	2.00	1.80	2.58	2.76

Table 6. Design approach evaluation.

Facilitation process model	**v1**	**v2**	**v3**	**v4**	**total**
	N=14	N=5	N=5	N=13	N=37
I used this information	4.36	4.80	4.40	4.38	4.43
I found this information useful	4.14	4.60	4.20	4.23	4.24
This information saved me time	4.14	4.60	4.40	4.08	4.22
This information should be improved	2.64	2.50	3.60	2.31	2.64

Table 7. Facilitation process model evaluation.

Agenda format	**v1**	**v2**	**v3**	**v4**	**total**
	N=14	N=5	N=5	N=13	N=37
I used this information	4.14	5.00	4.25	4.75	4.49
I found this information useful	4.07	4.80	4.00	4.42	4.29
This information saved me time	3.71	4.80	4.00	4.17	4.06
This information should be improved	3.36	2.00	2.75	2.17	2.71

Table 8. Design format evaluation.

Design guidelines	**v1**	**v2**	**v3**	**v4**	**total**
	N=14	N=5	N=5	N=13	N=37
I used this information	3.50	3.60	3.80	4.15	3.78
I found this information useful	3.64	4.40	4.20	4.31	4.05
This information saved me time	3.50	4.25	3.60	3.85	3.72
This information should be improved	3.36	2.00	2.40	2.77	2.89

Table 9. Design guidelines evaluation.

Tables 6-9 present the evaluations of the different design booklet elements. The results show that overall the students were most positive about the second version of the booklet. The scores for the third and fourth version appear to indicate that the further improvements did not yield considerably more positive perceptions. Feedback from the students suggested the same reason that was mentioned earlier: For each refinement of the approach and supporting booklet, the amount and complexity of the information increased. This made it harder for the students to process and apply all information. Another reason may be the comparatively small sample size of the students that used versions 2 and 3.

The results in tables 6-9 further show that compared to the first version, the final version was perceived more positively than the first version on all dimensions except for the design approach description. Overall, it can be stated that the various design booklet elements received positive scores in terms of usefulness and the need for improvement. Notwithstanding these positive survey results, the students did offer various useful suggestions for modification and expansion of the booklet during the informal feedback sessions as described in section 6.1.

7 Discussion and conclusions

This paper presented a pattern based design approach for Collaboration Engineering. The approach was developed during a four year design science study that incorporated insights from existing process design methods, from pattern based design, and from a survey and interviews with expert facilitators regarding challenges and design choices. The resulting design approach was evaluated in four iterations with 37 students during which data was collected to improve the approach and related guidelines. The experiences provide evidence that suggests that this approach is useful to support the design of repeatable collaboration processes. However, as the design support and documentation of the approach increased in size and quality, it also made the approach more time consuming.

The contribution of our study extends beyond the Collaboration Engineering research area. It can also serve as an example of how a design approach can be developed and evaluated within a design science framework. By incorporating insights from reference design disciplines and best practices from expert designers in a particular domain, a first version of a design approach can be created. This can then be iteratively applied in a series of trials in which a number of subjects use the approach while researchers collect observations and feedback. Through these trials, continuous enhancements can be made, resulting in a more refined design approach.

Several limitations have to be considered concerning the results of this study. First, the students participating in the trials came from different cultural backgrounds, educational programs, majors, and levels of education. However, none of the students had followed other courses that addressed the design or facilitation of group work. Second, as this was a four year study, it may have been difficult to maintain consistency in the grading of the students. Our perception of what makes a high quality collaboration process design has developed over the years, and this might have affected both our teaching and grading. However, in anticipation of this effect we developed and consistently applied a grading template for each assignment. Finally, it cannot be claimed that the fourth iteration of the design approach represents a stable, final version. For this purpose, more applications are required. For example, the approach should be tested with expert collaboration engineers and facilitators rather than with novice designers such as our students. Also, the approach should be applied to a variety of case situations.

Based on our findings and limitations we suggest a number of directions for future research on a design approach for Collaboration Engineering. First, it would be useful to extend the documentation of the pattern language, i.e. the thinkLets, with the explicit description of alternative patterns for each pattern and how each alternative might impact the quality of the resulting collaboration process design. Second, more research is required in the area of design guidelines that could inform all steps in the approach. For example, how can design guidelines be used to validate a the collaboration process design? It would be possible, for example, to check whether sufficient design patterns are included that support group discussion in a process where group commitment is an important outcome. Third, more research is required to explore whether the approach proposed in this paper can only be applied to design organization specific collaboration processes, or can also be used to design processes that are industry specific, for example an industry standard on collaborative software engineering project post-mortems. Fourth, efforts can be made to develop tools to support the automatic generation of design documentation such as facilitation scripts, slides to introduce and guide the collaboration process, and an agenda format or FPM. Further, given the prescription of capabilities within the design patterns, it should be possible to create an interface with a GSS to configure it for a specific process design.

Finally, the current design approach and design patterns already contain many design restrictions and guidelines that could be implemented in a more intelligent design support system. A next step in our research will be the creation of a tool that supports a collaboration engineer in selecting, sequencing, and instantiating thinkLets to design a collaboration process according to the approach. With such tool the guidelines and checklists are systematically offered to the designer at the appropriate moment, which is expected to reduce information overload. This in turn will hopefully increase the efficiency and quality of the design effort, while containing or further decreasing the cognitive effort involved.

References

1. Khazanchi, D., and Zigurs, I. Patterns for effective management of virtual projects: Theory and evidence. International Journal of E-Collaboration, 2, 3 (2006), 25-48.

2. Niederman, F., Vreede, G.J. de, Briggs, R.O., and Kolfschoten, G.L. Extending the Contextual and Organizational Elements of Adaptive Structuration Theory in GSS Research. Journal of the Association for Information Systems, 9, 10 (2008).

3. Zigurs, I., and Khazanchi, D. From Profiles to Patterns: A New View of Task-Technology Fit. Information Systems Management, 25, 1 (2008), 8-13.

4. Kolfschoten, G.L., Duivenvoorde, G.P.J., Briggs, R.O., and Vreede G.J., de. Practitioners vs Facilitators a Comparison of Participant Perceptions on Success. Hawaii International Conference on System Science, Waikoloa: IEEE Computer Society Press, 2009.

5. Steinhauser, L., Read, A., and Vreede, G.J. de. Studying the Adoption of Collaborative Work Practices Using the Value Frequency Model. In, Germonprez, M., and Iversen, J., (eds.), Midwest United States Association for Information Systems, Eau Claire, Wisconsin, 2008.

6. Deokar, A.V., Kolfschoten, G.L., and Vreede, G.J. de. Prescriptive Workflow Design for Collaboration Intensive Processes Using the Collaboration Engineering Approach. Global Journal of Flexible Systems Management, 9, 4 (2008), (in press).

7. Fjermestad, J., and Hiltz, S.R. A Descriptive Evaluation of Group Support Systems Case and Field Studies. Journal Of Management Information Systems, 17, 3 (2001), 115-159.

8. Agres, A., Vreede, G.J. de, and Briggs, R.O. A Tale of Two Cities: Case Studies of GSS Transition in Two Organizations. Group Decision and Negotiation, 14, 4 (2005), 256-266.

9. Briggs, R.O., Vreede, G.J. de, and Nunamaker, J.F. jr. Collaboration Engineering with ThinkLets to Pursue Sustained Success with Group Support Systems. Journal Of Management Information Systems, 19, 4 (2003), 31-63.

10. Post, B.Q. A Business Case Framework for Group Support Technology. Journal Of Management Information Systems, 9, 3 (1993), 7-26.

11. Clawson, V.K., Bostrom, R., and Anson, R. The Role of the Facilitator in Computer-Supported Meetings. Small Group Research, 24, 4 (1993), 547-565.

12. Briggs, R.O., Kolfschoten, G.L., Vreede, G.J. de, and Dean, D.L. Defining Key Concepts for Collaboration Engineering. Americas Conference on Information Systems, Acapulco, Mexico: AIS, 2006.

13. Vreede, G.J. de, and Briggs, R.O. Collaboration Engineering: Designing Repeatable Processes for High-Value Collaborative Tasks. Hawaii International Conference on System Science, Los Alamitos: IEEE Computer Society Press, 2005.

14. Kolfschoten, G.L., Vreede, G.J. de, Briggs, R. O., and Sol, H.G. Collaboration Engineerability. In, Kersten, G.E., and Rios, J., (eds.), Group Decision and Negotiation conference, Mt Tremblant: Concordia University, 2007.

15. Kolfschoten, G.L., Vreede, G.J. de, and Pietron, L. A training approach for the transition of repeatable collaboration processes to practitioners. Group Decision and Negotiation, Working paper (2009).

16. Hayne, S.C. The Facilitator's Perspective on Meetings and Implications for Group Support Systems Design. DataBase, 30, 3-4 (1999), 72-91.

17. Clawson, V.K., and Bostrom, R.P. The Importance of Facilitator Role Behaviors in Different Face to Face Group Support Systems Environments. Hawaii International Conference on System Sciences, Los Alamitos: IEEE Computer Society Press, 1995, pp. 181-190.

18. Nunamaker, J.F. Jr., Briggs, R.O., Mittleman, D.D., Vogel, D., and Balthazard, P.A. Lessons from a Dozen Years of Group Support Systems Research: A Discussion of Lab and Field Findings. Journal Of Management Information Systems, 13, 3 (1997), 163-207.

19. Antunes, P., Ho, T., and Carriço, L. A GDSS Agenda Builder for Inexperienced Facilitators. In, Ackermann, G.V.a.F., (ed.), 10th Euro GDSS Workshop, Copenhagen, Denmark: Delft University of Technology, 1999, pp. 1-15.

20. Hevner, A., March, S., Park, J., and Rahm, S. Design Science Research in Information Systems. Management Information Systems Quarterly, 28, 1 (2004), 75-105.

21. Dictionary.com. design. (n.d.). Dictionary.com Unabridged (v 1.1). 2007.

22. IEEE. IEEE Std 610.12 Glossary of Software Engineering Terminology. IEEE Standard (1990).

23. INCOSE. What is Systems Engineering? , 2007.

24. Davenport, T.H. Process Innovation: Reengineering Work through Information Technology. Boston: Harvard Buisiness School Press, 1993.

25. Schwarz, R.M. The Skilled Facilitator. San Francisco: Jossey-Bass Publishers, 1994.

26. Butler, C.T.L., and Rothstein, A. On Conflict and Consensus; A Handbook on Formal Consensus Decision Making. Takoma Park: Food Not Bombs Publishing, 2004.

27. Baldwin, C. Calling the Circle : The First and Future Culture. New York: Bantam, 1994.

28. Forman, E.H., and Selly, M.A. Decision by Objectives. World Scientific, 2001.

29. Yoong, P. Assessing Competency in GSS Skills: A Pilot Study in the Certification of GSS Facilitators. SIGCPR (1995).

30. Zigurs, I., and Buckland, B. A Theory of Task/Technology Fit and Group Support Systems Effectiveness. Management Information Systems Quarterly, 22, 3 (1998), 313-334.

31. Wheeler, B.C., and Valacich, J.S. Facilitation, GSS and Training as Sources of Process Restrictiveness and Guidance for Structured Group Decision Making an Empirical Assessment. Information Systems Research, 7, 4 (1996), 429-450.

32. Dennis, A.R., Wixom, B.H., and Vandenberg, R.J. Understanding Fit and Appropriation Effects in Group Support Systems Via Meta-Analysis. Management Information Systems Quarterly, 25, 2 (2001), 167-183.

33. DeSanctis, G., and Poole, M.S. Capturing the Complexity in Advanced Technology Use: Adaptive Structuration Theory. Organization Science, 5, 2 (1994), 121-147.

34. Kamer, S., Lind, L., Toldi, C., Fisk, S., and Berger, D. Facilitator's Guide to Participatory Decision-making. Gabrolia Island: New Society Publishers, 1996.

35. Sheffield, J. The Design of GSS-Enabled Interventions: A Habermasian Perspective. Group Decision and Negotiation, 13 (2004), 415-435.

36. Hunter, D., Bailey, A., and Taylor, B. The Art of Facilitation: How to Create Group Synergy. Auckland: Tandem Press, 1992.

37. Rees, F. The Facilitator Excellence Handbook: Helping People Work Creatively and Productively Together. San Francisco: Jossey-Bass, 1998.

38. Tropman, J.E. Making Meetings Work: Achieving High Quality Group Decisions. Thousand Oaks: Sage Publications, 1996.

39. Santanen, E.L., Vreede, G.J. de, and Briggs, R.O. Causal Relationships in Creative Problem Solving: Comparing Facilitation Interventions for Ideation. Journal of Management Information Systems, 20, 4 (2004), 167 -197.

40. Shepherd, M.M., Briggs, R.O., Reinig, B.A., Yen, J., and Nunamaker, J.F. Jr. Social Comparison to Improve Electronic Brainstorming: Beyond Anonymity. Journal of Management Information Systems, 12, 3 (1996), 155-170.

41. Aalst, W.M.P van der, Hofstede, A.H.M. ter, and Kiepuszewski, B. Workflow Patterns. Distributed and Parallel Databases, 14 (2003), 5-51.

42. Grover, V., and Kettinger, W.J. Business Process Change; Reengineering Concepts, Methods and Technologies. Harrisburg: Idea group Publishing, 1995.

43. Kettinger, W.J., and Teng, J.T.C. Business process change: a study of methodologies, techniques and tools. Management Information Systems Quarterly, 21, 1 (1997), 55-80.

44. Marca, D.A., and McGowan, C.L. SADT: Structured Analysis and Design Technique. New York, NY: McGraw Hill, Inc., 1987.

45. Simon, H.A. The New Science of Management Decision. New York: Prentice Hall, 1960.

46. Mitroff, I.I., Betz, F., Pondly, L.R., and Sagasty, F. On Managing Science In The Systems Age: Two Schemas For The Study Of Science As A Whole Systems Phenomenon. TIMS Interfaces, 4, 3 (1974), 46-58.

47. Drucker, P.F. The Effective Executive. London, 1967.

48. Brady, R.H. Computers in Top-Level Decision Making. Harvard Business Review (1967), 67-76.

49. Ackoff, R.L. The Art of Problem Solving. John Wiley & Sons, 1978.

50. Couger, J. D. Creative Problem Solving and Opportunity Finding. Danvers, Mass: Boyd And Fraser, 1995.

51. Checkland, P.B. Systems Thinking, Systems Practice. Chichester: John Wiley & Sons, 1981.

52. Simon, H.A. The Structure Of Ill Structured Problems. Artificial Intelligence, 4 (1973), 181-201.

53. Frost, and Sullivan. Meetings Around the World: The Impact of Collaboration on Business Performance. Frost & Sullivan White Papers, 2007, pp. 1-19.

54. Briggs, R.O., Reinig, B.A., and Vreede, G.J. de. Meeting Satisfaction for Technology-Supported Groups: An Empirical Validation of a Goal-Attainment Model. Small Group Research, 37, 585-611 (2006).

55. Briggs, R.O. The Focus Theory of Team Productivity and its Application to Development and Testing of Electronic Group Support Systems. Tucson, 1994.

56. Briggs, R.O., Kolfschoten, G.L., and Vreede, G.J., de. Instrumentality Theory of Consensus. First HICSS Symposium on Case and Field Studies of Collaboration, Kauai, 2006.

57. Fjermestad, J., and Hiltz, S.R. An Assessment of Group Support Systems Experimental Research: Methodology and Results. Journal Of Management Information Systems, 15, 3 (1999), 7-149.

58. Pervan, G.P., Bajwa, D.S., Lewis, F.L., and Lai, V. The adoption and use of collaboration information technologies: International comparisons. Journal of Information Technology, 20 (2005), 130-140.

59. Kolfschoten, G.L., Hengst, M. den, and Vreede, G.J. de. Issues in the Design of Facilitated Collaboration Processes. Group Decision and Negotiation, 16, 4 (2007), 347-361.

60. Kolfschoten, G.L., and Rouwette, E. Choice Criteria for Facilitation Techniques: A Preliminary Classification. In, Seifert, S., and Weinhardt, C., (eds.), International Conference on Group Decision and Negotiation, Karlsruhe: Universtatsverlag Karlsruhe, 2006.

61. Alexander, C. The Timeless Way of Building. New York: Oxford University Press, 1979.

62. Gamma, E., Helm, R., Johnson, R., and Vlissides, J. Elements of Reusable Object-Oriented Software. Addison-Wesley Publishing Company, 1995.

63. Vreede, G.J. de, Briggs, R.O., and Kolfschoten, G.L. ThinkLets: A Pattern Language for Facilitated and Practitioner-Guided Collaboration Processes. International Journal of Computer Applications in Technology, 25, 2/3 (2006), 140-154.

64. Kolfschoten, G.L., Briggs, R.O., Vreede, G.J., de, Jacobs, P.H.M., and Appelman, J.H. Conceptual Foundation of the ThinkLet Concept for Collaboration Engineering. International Journal of Human Computer Science, 64, 7 (2006), 611-621.

65. Vreede, G.J. de, Koneri, P.G., Dean, D.L., Fruhling, A.L., and Wolcott, P. Collaborative Software Code Inspection: The Design and Evaluation of a Repeatable Collaborative Process in the Field. International Journal of Cooperative Information Systems, 15, 2 (2006), 205-228.

66. Bragge, J., Merisalo-Rantanen, H., and Hallikainen, P. Gathering Innovative End-User Feedback for Continuous Development of Information Systems: A Repeatable and Transferable E-Collaboration Process. IEEE Transactions on Professional Communication, 48, 1 (2005), 55-67.

67. Harder, R.J., Keeter, J.M., Woodcock, B.W., Ferguson, J.W., and Wills, F.W. Insights in Implementing Collaboration Engineering. Hawaii International Conference on System Science, Los Alamitos: IEEE Computer Society Press, 2005.

68. International Association of Facilitators. IAF Website. 2004.

69. Schuman, S. Grp-Facl. 2006.

70. Ericsson, K.A., and Simon, H.A. Protocol Analysis: Verbal Reports as Data. Cambridge: MIT Press, 1993.

71. Schenk, K.D., Vitalari, N.P., and Davis, K.S. Differences Between Novice and Expert Systems Analysts: What Do We Know and What Do We Do? Journal Of Management Information Systems, 15, 1 (1998), 9-50.

72. Boehm, B.W. Software Engineering Economics. New-York: Prentice-Hall, 1981.

73. Lehman, M.M. Uncertainty in Computer Applications and its Control trough the Engineering of Software. Journal of Software Maintenance, 1, 1 (1989), 3-28.

74. Locke, E. A., and Latham, G. P. Building a Practically Useful Theory of Goal Setting and Task Motivation: A 35-year Odyssey. American Psychologist, 57 (2002), 705-717.

75. Locke, E.A., and Latham, G.P. A Theory of Goal Setting and Task Performance. Englewood Cliffs: Prentice Hall, 1990.

76. Niederman, F., Beise, C.M., and Beranek, P.M. Issues and Concerns about Computer-Supported Meetings: The Facilitator's Perspective. Management Information Systems Quarterly, 20, 1 (1996), 1-22.

77. Briggs, R.O., Kolfschoten, G.L., and Vreede, G.J. de. Toward a Theoretical Model of Consensus Building. Americas Conference on Information Systems, Omaha, 2005.

Appendix A. Task diagnosis checklist.

Task	**Resources**
Goal	How much time is available
Deliverables	What resources are available
Level of detail	What is the date and time
Quality criteria to results	Who will create invitations
What will happen with the results	Does location meet requirements
‘experience goals’	Organize catering
What will participants take home	Will there be a welcome talk
Stakeholder	Will there be a content introduction
Who will attend	Will there be presentations on content
Age, sex	**Self assessment**
Education level	Are you motivated
Expertise, experience	Do you have the required skills
What are individual stakes	Do you have the required knowledge
What are reason(s) for participation	Will the group accept your support
What can participants contribute	Are you impartial
Will they commit to the group goal	
Will they accept the results	
Will they accept the process/task	
Will they commit the required resources	
Whether they will be motivated	
What are expectations	
Do they have decision power	
Is there conflict	
How are participants related	
Do participants know each other	