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ABSTRACT

Convergence is a critical activity in group work that lays the foundation for shared understanding and the overall advancement of the group's task. However, convergence is time consuming and has been shown to be a slow and painful process for groups. The goal of this research is to derive a number of convergence performance criteria from field experiences with commonly used convergence thinkLets. Based on these insights, two new convergence thinkLets are proposed that were designed to overcome some of the limitations of existing thinkLets. To investigate the merits of these thinkLets, a program of study based on the design science paradigm is presented. Finally, the performance criteria are used to forward a selection guide for convergence thinkLets.

Keywords

Convergence, thinkLets, collaboration engineering, group support systems, collaboration, facilitation, design science.

INTRODUCTION

Collaboration and team work have become the organizational norm to innovate and create value (see e.g. Evans and Wolf, 2005; Munkvold and Zigurs, 2005; Nunamaker, Briggs and de Vreede, 2001). Organizational tasks have grown in complexity so that no single person has all the understanding, information, and resources to successfully complete them alone. A critical activity in group work concerns 'convergence,' where a group deliberates on and reduces the amount of information they have to work with (de Vreede and Briggs, 2005). Convergence lays the foundation for shared understanding and the overall advancement of the group's task (de Vreede, Fruhling and Chakrapani, 2005). However, convergence is time consuming and has been shown to be a slow and painful process for groups (Chen et al., 1994; Easton et al., 1990).

Researchers in the field of Collaboration Engineering (CE) originally considered convergence one of the five basic patterns of collaboration that can be used to model collaboration processes (Briggs, de Vreede and Nunamaker Jr., 2003). However, recent CE research distinguishes between six main patterns of collaboration: generate, reduce, clarify, organize, evaluate, and build consensus (Briggs et al., 2006). The second and third pattern, reduce and clarify, relate to convergence and the idea of a group moving from many ideas to fewer ideas worthy of more focused attention. In this paper, we will refer to 'convergence' as the overarching concept of 'reduction' and 'clarification.' Collaboration engineers have codified various thinkLets to accomplish convergence in groups. A thinkLet describes all information required to create a predictable, repeatable pattern of collaboration among people working together toward a joint goal (Briggs, de Vreede and Nunamaker Jr., 2003). In other words, a thinkLet is a repeatable facilitation technique that creates a particular pattern of collaboration or combination of patterns.

Studying convergence is important for three reasons. First, there is an abundance of literature on brainstorming and ideation (see e.g. Fjermestad and Hiltz, 1998/1999). However, very little research has been published about ways to help a group converge on the best idea among those generated in terms of processes and measurements (Briggs, Nunamaker Jr. and Sprague Jr., 1997). Second, facilitators and workshop participants often mention that it is easy to generate hundreds of ideas, yet they experience issues of information overload to process these hundreds of ideas (Briggs, Nunamaker Jr. and Sprague Jr., 1997). To develop better processes and systems to mitigate information overload issues, we need to better understand convergence. Finally, a better understanding of convergence may facilitate the transfer of facilitation skills and collaborative work practices. Specifically, a better understanding of convergence may lead to better approaches to train facilitators and collaboration process practitioners. Recent research has shown that convergence activities require the most facilitation skills (de Vreede, Fruhling and Chakrapani, 2005).

ThinkLets traditionally have been captured as existing best facilitation practices, in terms of the tools used, the configuration of these tools, and the script that the facilitator follows (de Vreede, Kolfschoten and Briggs, 2006). A better understanding of convergence will enable us to evaluate the different convergence thinkLets that have been captured to date. Moreover, a better understanding of convergence may also allow us to consciously design better convergence thinkLets than those currently available. This study uses a design science approach to propose measurement and evaluation approaches for

convergence in co-located groups working towards a joint goal in order to better understand and design better convergence thinkLets. Design science is an appropriate fit for this study because the focus of design science is on both the creation and evaluation of innovative and useful IT artifacts (Hevner et al., 2004). In this study the convergence thinkLets are the method, or IT artifact of interest, as we consider a thinkLet to represent a socio-technical system consisting of information technology (the tool and configuration part of the thinkLet), people and procedures (the script part of the thinkLet), see (Kolfschoten et al., 2006) for more details.

The next section introduces convergence and summarizes earlier approaches and experiences in the area of convergence. It also presents performance criteria that will guide the design and evaluation of convergence thinkLets. The subsequent sections present two new thinkLet designs to meet these criteria followed by a proposal to evaluate these and other convergence thinkLets. The final sections present a discussion followed by a summary and areas for future research.

BACKGROUND

Convergence

To converge has been defined as "to move from having many concepts to a focus on and understanding of a few deemed worthy of further attention" (de Vreede and Briggs, 2005). The goal of convergence is to reduce a group's cognitive load in order to address all concepts, conserve resources, have less to think about, and achieve shared meaning of the concepts.

In an explanation of CE, de Vreede and Briggs (2005) identify four aspects or sub-processes that can be combined in order to create useful variations in convergence activities. These include 1) judging, identifying which of the existing concepts merits further attention; 2) filtering, selecting a subset from a pool of concepts that will receive further attention; 3) generalizing, reducing the number of concepts under consideration through generalization, abstraction, or synthesis and then eliminating the lower-level concepts in favor of the more general concept; and 4) shared meaning, agreeing on connotation and establishing a shared meaning or understating about the labels used to communicate various concepts.

However, we propose to remove 'judging' from this list as the other three sub-processes all involve some element of 'judging.' For example, when a group is selecting a subset of concepts (filtering), they are judging which concepts merit further attention. When a group is abstracting or synthesizing concepts (generalizing), they are judging which concepts bear sufficient similarity. When a group is establishing shared meaning, they are judging and agreeing on particular interpretations of concepts. Therefore, a convergence activity may involve filtering, generalizing, and/or establishing shared meaning as constituent sub-processes.

Previous Research

Group Support Systems (GSS) include a number of functionalities that can improve the performance of groups. Many GSS provide brainstorming functionality, allowing participants to diverge and contribute ideas, as well as read the ideas of others in order to elaborate and improve the overall results. A significant amount of research has studies GSS and EBS, however, researchers have argued that because there is so much research on divergence activities more research should explore other patterns of collaboration as it is through these patterns that groups create value by processing the 'raw concepts' from the divergence activity (Briggs, Nunamaker Jr. and Sprague Jr., 1997; Hengst and Adkins, 2007).

Previous research has argued that convergence activities in group work are complicated due to a variety of reasons. These reasons include information overload at the start of a convergent task, the cognitive effort that is required for convergent tasks, and the need for a higher granularity of meeting ideas to be stored (i.e. meeting memory) for future decision making and analysis (Chen et al., 1994). To address these issues, GSS researchers have argued about the most effective mode and means of communication for convergence issues. For example, Dennis and Valacich (1999) propose that face-to-face, or verbal communication, is best suited for group members to converge and establish shared meaning. Verbal communication is mostly recommended for efficiency, because it provides the fastest feedback. Other researchers argue for combining electronic and verbal communication modes during convergence: participants can benefit electronic tools during convergence due to the fact that key concepts can be identified and represented with a minimum of cognitive load on the group members (de Vreede and Briggs, 1997). These insights have been consolidated in media synchronicity theory (MST) which suggests that individuals would prefer highly synchronized communication media (i.e. face-to-face) for convergence communication, which relate to shared understanding, and less synchronized media (e.g. email) for conveyance communication, which relates to facts or alternatives (DeLuca and Valacich, 2006). Furthermore, MST argues that decision making tasks require convergence before proceeding to the next task as well as the conveyance of specific information (e.g., facts or alternatives) (Dennis, Wixom and Vandenberg, 2001).

In contrast to the research that addresses convergence issues from the group members' perspective, recent research from a facilitator's perspective has shown that facilitators find convergence to be one of the least demanding patterns of collaboration, behind divergence (Hengst and Adkins, 2007). Yet, the same study found building consensus to be the most demanding pattern of collaboration and the authors suggest that building consensus is most often done with convergence and organization sub-processes.

In conclusion, a review of previous research suggests there is little structural attention on the topic of convergence. Moreover, there is very limited, detailed guidance available how to best structure convergence activities in groups, or how to assess interventions that guide groups through convergence tasks (Briggs, Nunamaker Jr. and Sprague Jr., 1997; Hengst and Adkins, 2007). Below we propose a set of criteria that can be used as a basis for the evaluation and design of convergence thinkLets .

Performance Criteria for Convergence thinkLets

To better understand convergence thinkLets and to establish a way to evaluate their comparative merits and limitations, we surveyed a small number (5) of experienced facilitators regarding a number of convergence thinkLets. We asked each facilitator to reflect on the strengths and weaknesses of each convergence thinkLet. The results are presented in table 1. Based on these results, we derived a number of performance criteria for convergence thinkLets. We propose that such success criteria fall into two categories: results oriented and process or experience oriented. The first category of results oriented success criteria includes the following:

- *Speed*: Previous research has argued that the longer groups spend in divergence tasks the greater amount of time is needed for convergence tasks (Pendergast and Hayne, 1995). Therefore, speed is an important performance criterion for convergence activities; if more productive brainstorming techniques are devised, their effectiveness should not be offset by overly time-consuming convergence techniques. This also explains why Dennis and Valacich (1999) argue for the use of face-to-face interactions or verbal communication for convergence tasks in order to get the fastest feedback. In some cases, the results of a convergence thinkLet can be considered successful if they are reached quickly.
- *Level of comprehensiveness*: During a convergence activity, the group often determines which concepts are to be considered further. To assess the quality of this activity, an assessment has to be made about the appropriate inclusion or exclusion of every concept in the results of the activity. The convergence activity can be considered optimally comprehensive if it can be established that the group indeed selected all concepts that it needs to further consider to successfully complete its task. Therefore, in some cases, the level of comprehensiveness will be an important performance criterion.
- *Level of shared understanding*: Studies of MST relate convergence to the shared understanding of information, which is critical for group members to converge (DeLuca and Valacich, 2006). Pendergast and Hayne (1995) present shared understanding in the form of a shared context model which puts boundaries around what the group is focusing on during a meeting. The shared context helps the group focus on their context of interest and allows for higher group performance. Additionally, this shared understanding provides the group members with the ability to discuss, evaluate, and re-propose solutions before advancing, which is important for establishing shared meaning. Furthermore, Pendergast and Hayne (1995) argue that it is less difficult for group members to establish a shared understanding when using a GSS because it is the ideas and comments generated by group that form the mental picture of the group's understanding of a particular problem at hand. Either way, in some cases it is necessary for a group to reach a minimum level of shared understanding from a convergence thinkLet in order for the process to be considered a success.
- *Level of reduction*: Research has suggested that idea generation performance increases with group size (Dennis, Valacich and Nunamaker Jr., 1990). For many tasks, a group has very limited time available. So it becomes imperative that they only continue their collaborative efforts with a manageable subset of the original brainstorming results. Since electronic brainstorming tasks produce so many ideas, convergence tasks become more difficult as there are so many alternatives for the group to focus on (Easton et al., 1990). Therefore, for the results of a convergence thinkLet to be considered a success, in some cases, a maximum percentage of the convergence input should equal the convergence outcome.
- *Level of refinement of outcomes*: In many group tasks, the results of a convergence activity must represent the intermediate or final deliverables that are reported back to the task owner. This implies that the group has to produce polished, refined outcomes. Therefore, in some cases, the results of a convergence thinkLet can be considered successful if they are sufficiently refined, i.e. in a final version and not draft form.

thinkLet	Description	Purpose	Strengths	Weaknesses
FastFocus	Each participant browses a subset of brainstorming ideas. Participants take turns proposing an idea from the collection to be added to a public list of ideas deemed worthy of further consideration. Group discusses meaning, but not merits of the proposed idea. Facilitator add concise, clear version of the idea to the public list.	Filtering Generalizing Shared meaning	• Exhaustive • Fosters shared understanding • Fosters support for resulting list • Inclusive as participants can add what can argued to be important • Produces clear, clean, non-redundant, relevant contributions at a useful level of abstraction	• Relatively slow • Takes a lot of facilitator and participants' energy • Tendency for participants to focus on value of ideas rather than on meaning • Inexperienced facilitators find formulating a concise description challenging • Inexperienced facilitators find managing the group discussion challenging
OneUp	Group browses a collection of brainstorming ideas. First participant adds an idea to the public list. For each subsequent addition, the proposer argues why the new idea is better than those already on the list. Facilitator writes a concise, clear version of the idea on the public list. Facilitator also keeps a list of the criteria used by the participants.	Filtering Generalizing Shared meaning	• Side product: List of criteria • Inclusive as participants can add what can argued to be important • Fosters shared understanding • Stimulates active engagement • Reduced cognitive load, as group only deals with best ideas • Produces clean, clear, non-redundant ideas at a useful level of abstraction	• Slower than polling-based and association-based convergence thinkLets • Participants may have evaluation apprehension • Not completely exhaustive as some worthy ideas may be left behind because no participant argues for them • If single most critical idea is mentioned first, other key ideas may not be added to the list
BucketBriefing	Categories with ideas are assigned to subgroups and the subgroups clean up the ideas before reporting back to the entire group.	Filtering Generalizing Shared meaning	• Fairly fast • Fairly easy for facilitator due to limited discussion guidance • Easy for participants as they only focus on a subset of the ideas	• Risk of lack of agreement on idea clean-up between subgroups • Risk of limited shared understanding between subgroups • Subgroup bias may filter out good ideas • Facilitator cannot filter out vague, poorly worded, irrelevant, ideas nor frame them at a useful level of abstraction
DimSum	Individual members generate candidate statements. Group members identify words and phrases that they like from those statements. Group and facilitator work together to draft a statement from selected words and phrases. If word-smithing breaks out, process is repeated with current draft as a starting point.	Filtering Shared meaning	• Inclusive as each participant can identify critical elements • Fosters joint ownership • Faster than conventional oral discussions	• Inexperienced facilitators find managing the group discussion challenging • Inexperienced facilitators find proposing draft statements challenging • Only useful for converging on the wording of a single statement. Not good for converging to a list of ideas.
Pin the Tail on the Donkey	Group members browse a collection of ideas, often from a Brainstorming session. Group members place a mark by the ideas that they want to continue focus everyone's attention on. Marked ideas are discussed in a plenary activity.	Filtering Shared meaning	• Fast • Easy for facilitator • Easy for participants	• Limited comprehensiveness • Inexperienced facilitators find managing the group discussion challenging • Does not eliminate redundancy • Does not produce clean, readable statements • Does not eliminate irrelevant contributions • Does not reframe ideas at a more useful level of abstraction
BroomWagon	Brainstorming ideas are selected in order to identify the ones that are worthy of further attention.	Filtering	• Fast • Democratic • Easy for facilitator • Easy for participants	• Requires non-redundant list of ideas, so some clean up may have to be done before the activity starts • Not exhaustive, eliminates all but most popular

thinkLet	Description	Purpose	Strengths	Weaknesses
			• Converges to most popular ideas • Can be used to converge to a list of a pre-determined length	ideas • Good ideas may be left out because they are poorly understood
GoldMiner	Group members browse a collection of ideas, often from a brainstorming activity. Group members move "gold nugget" that they like to a new location for future discussion.	Filtering	• Fast • Easy for facilitator • Easy for participants	• Risk of insufficient filtering • Does not eliminate redundancy • Does not produce clean, readable statements • Does not eliminate irrelevant contributions • Does not create shared meaning • Does not eliminate ambiguity • Does not reframe ideas at a more useful level of abstraction
ExpertChoice	An expert is selected to condense and summarize a set of ideas and presents the finalized set to the entire team.	Filtering Generalizing	• Fast for participants • Easy for facilitator • Easy for participants • Produces a clean, non-redundant list of relevant contributions at a useful level of abstraction.	• Difficult to create shared understanding • Single expert may not have all requisite insight for filtering and generalization • High cognitive load for expert. • Participant interests may not be accommodated because of facilitator's and assistant's unawareness
GarlicSqueezer	The facilitator works with assistant to condense the list of brainstorming ideas by selecting contributions that represent the highlights. Each person starts at a different end of the list and works to the middle so that all but the key ideas are squeezed out.	Filtering	• Fast for participants • Easy for participants	• Risk of leaving key ideas out that the participants consider critical • Difficult for participants to assess results as they are unaware of rationale behind selections • High cognitive load for facilitator and assistant • Participant interests may not be accommodated because of facilitator's and assistant's unawareness
ReviewReflect	The group reviews and comments on the existing content first. Next, the group discusses the restructuring and rewording of the content.	Shared meaning	• Democratic • Allows participant interests to be taken into account	• Slow • Unlikely to reduce
RichRelations	Group reviews a collection of ideas. Facilitator asks the group to identify ideas that are related in some way. Group and facilitator negotiate the wording of the relationship and subsume the related statements.	Shared Meaning Filtering Generalizing	• Creates shared meaning of ideas that are discussed • Exhaustive • Produces non-redundant list	• Slow • Shared meaning is only established for the ideas that are reduced • Risk of over-convergence. People continue to abstract until they get down to vague generalizations • Does not eliminate irrelevancy • Does not eliminate ambiguity • Does not necessarily produce a useful level of abstraction

Table 1. Existing thinkLets for Convergence

The second category of convergence performance criteria includes the following process or experience oriented success criteria:

- *Acceptance by Participants*: Research suggests that groups enjoy divergence processes more than convergent processes (Dennis, Valacich and Nunamaker Jr., 1990; Easton et al., 1990). Some researchers have argued that this may be because the divergent process is performed in parallel, while the convergent task is performed in serial (Pendergast and Hayne, 1995). Regardless of the exact cause of acceptance, groups that are unwilling to accept a collaborative process are less likely to accept the outcomes of this process (de Vreede and Bruijn, 1999). Therefore, for a convergence thinkLet to be considered successful, the participants need to be accepting of the process.
- *Ease of Use for Facilitator*: Due to the fact that facilitation is a key success factor for GSS, the ease of use of a thinkLet for a facilitator is critical (Hengst and Adkins, 2007). A convergence thinkLet may be very effective, yet groups may not experience the benefit if facilitators are reluctant to use it because they find it hard to use. Therefore, for a convergence thinkLet to be considered successful, the facilitator should find the thinkLet easy to execute.
- *Ease of Use for Participants*: In a study of decision making and consensus building using two different electronic tools, participants with fewer brainstorming ideas were more likely to reach consensus because they had fewer ideas to deal with (Easton et al., 1990). Since there was less to deal with, participants were able to concentrate on just a few ideas and then find one that satisfied everyone in the group. In other words, if a collaboration process is too difficult for participants to execute, they may not successfully complete their task. Therefore, for a convergence thinkLet to be considered successful, the participants should find the thinkLet easy to execute.
- *Satisfaction with ThinkLet by Facilitator*: Research has argued that support for facilitators will result in wider use and acceptance of GSS (Hengst and Adkins, 2007). We believe this extends to thinkLets as well. Therefore, if facilitators are not satisfied with a convergence thinkLet, they are less likely to accept and use it. Therefore, for a convergence thinkLet to be considered successful, facilitators should be satisfied with the thinkLet.
- *Satisfaction with ThinkLet by Participants*: Researchers have argued that if participants are dissatisfied with a GSS experience, they are less likely to participate in future such efforts (see e.g. Reinig, 2003). Since GSS workshops can be perceived as a sequence of thinkLets (Kolfschoten et al., 2006), participants' satisfaction with the thinkLets employed in a process is critical. Therefore, for a convergence thinkLet to be considered successful, the participants should be satisfied with the process of the thinkLet.

The next sections present a design of two new convergence thinkLets to better meet these criteria than the thinkLets presented in table 1, followed by a proposal for a concerted effort to evaluate these and other convergence thinkLets.

DESIGN OF CONVERGENCE THINKLETS

As mentioned earlier, this study uses a design science approach to propose measurement and evaluation approaches for convergence in co-located groups working towards a joint goal in order to design better convergence thinkLets. Design science is an appropriate fit for this study because the focus of design science is on both the creation and evaluation of innovative and useful IT artifacts (Hevner et al., 2004). Design science research aims at improving practice (Hevner et al., 2004; Vaishnavi and Kuechler, 2006). The use of the design science methodology is often referred to as "improvement research" (Vaishnavi and Kuechler, 2006). This label emphasizes the problem solving and performance improving nature of the methodology. In an effort to improve practice, design science research aims to "produce and apply knowledge of tasks or situations in order to create effective artifacts" (March and Smith, 1995).

The design science paradigm attempts to produce an artifact in the form of a construct, a model, a method, or an instantiation (Hevner et al., 2004; March and Smith, 1995). As mentioned earlier, in this study the convergence thinkLets are the method, or IT artifact of interest. Furthermore, we propose an instantiation to comprise of the physical implementation of the thinkLet in a collaboration technology and the specification of the script in terms of exact prompts and parameters for the situation in which it is used (de Vreede, Kolfschoten and Briggs, 2006).

Based on the strengths and weaknesses of the thinkLets presented in table 1 and the various performance criteria, we propose two new convergence thinkLets: FastHarvest and FocusBuilder. The details of each are depicted in table 2.

thinkLet	Description	Purpose	Strengths	Weaknesses
FastHarvest	Participants form subgroups that are responsible for a particular aspect or category that relates to the brainstorm ideas. Taking a subset of all brainstorm ideas at a time, each subgroup extracts concise and clear versions of ideas that relate to their aspect or category. Every time the subgroup is done with a subset of ideas, the process another subset until they have considered all brainstorming ideas. When all subgroups are done, each subgroup presents their findings to the whole group and clarifies the meaning (not merit) of their extractions if necessary.	Filtering Generalizing Shared meaning	• Fast • Easy for facilitator due to limited discussion guidance • Easy for facilitator due to limited involvement in concise formulation of ideas • Easy for participants as they only focus on a subset of the ideas • Engaging for participants because they have to stay active • Exhaustive • Inclusive as participants can add what can argued to be important • Produces clear, clean, non-redundant, relevant contributions at a useful level of abstraction • Foster fair level of shared understanding	• If subgroups are not able to produce concise and clear ideas, quality suffers • Difficult for facilitator to monitor quality until plenary presentations by subgroups • Does not work well if subgroups do not understand the concept (e.g. action item) that the resulting ideas need to describe • Facilitator needs to monitor that subgroups filter and synthesize ideas, rather than just copy ideas verbatim • Risk of limited shared understanding between subgroups • Subgroup bias may filter out good ideas
FocusBuilder	All brainstorm ideas are divided into as many subsets as there are participants. Each participant receives a subset of brainstorm ideas and is tasked to extract the critical ideas. Extracted ideas have to be formulated in a clear and concise manner. Participants are then paired and asked to share and combine their extracted ideas into a new list of concise, non-redundant ideas. If necessary, the formulation of ideas is improved, i.e. the pairs focus on meaning, not merit. Next, pairs of participants work together to combine their two lists into a new list of concise, non-redundant ideas. Again, the formulation of ideas is improved if necessary. The pairing of lists continues until there are two subgroups that present their results to each other. If necessary, formulations are further improved. Finally, the two lists are combined into a single list of non-redundant ideas.	Filtering Generalizing Shared meaning	• Very fast • Immediate focus on critical ideas • Fosters shared understanding • Easy for facilitator due to limited discussion guidance • Easy for facilitator due to limited involvement in concise formulation of ideas • Easy for participants as they only focus on a small subset of the initial ideas • Continuous growth of subgroup size may mitigate risk of poor idea formulation by individual participants • Engaging for participants because they have to stay active • Inclusive as each participant can initially add what (s)he considers important • Produces clear, clean, non-redundant, relevant contributions at a useful level of abstraction • Foster fair level of shared understanding	• Important ideas may be left behind if none of the participants in first round includes them • Difficult for facilitator to monitor quality until plenary presentations by subgroups • Does not work well if participants do not understand the concept (e.g. action item) that the resulting ideas need to describe • Facilitator needs to monitor that participants filter and synthesize ideas, rather than just copy ideas verbatim • Participant bias may filter out good ideas

Table 2. New thinkLets for Convergence

Both FastHarvest and FocusBuilder represent convergence thinkLets that aim to support filtering, generalizing, and creating shared understanding. Each of them builds on the strengths of other thinkLets that support these three convergence subprocesses, such as FastFocus, OneUp, and BucketBriefing. The key design guideline for these thinkLets was to distribute responsibility for converging on a subset of the brainstorm ideas to a subset of the whole group. This enables the participants to work in parallel (speed). FastHarvest offers comprehensive results as each brainstorm ideas is considered by a team of participants. Both thinkLets foster shared understanding and stimulate refinement as extracted ideas can be clarified and re-formulated during the process. Finally, both thinkLets can greatly reduce the number of ideas that the group has to consider; the FocusBuilder leads to a higher reduction rate than FastHarvest.

Both thinkLets have been piloted in about half a dozen facilitated workshops. In these pilots, groups performed an after action review on an operational risk management (ORM) process. The FastHarvest was used to converge on promising ways to improve the efficiency of the ORM process during its different phases. Subgroups were assigned a phase and then extracted unique and concisely formulated improvement ideas for their phase. The FocusBuilder was used to converge on key lessons regarding the effective use of a devil's advocate in ORM workshops. Both thinkLets were readily accepted by the participant. Both the participants and facilitator involved were satisfied with the thinkLets and felt there were easy to use. However, more field data has to be collected to assess whether FastHarvest and FocusBuilder represent a worthwhile addition to the collection of convergence thinkLets.

EVALUATION OF CONVERGENCE THINKLETS

To evaluate the new convergence thinkLets that were presented in the preceding section, we can follow Hevner et al.'s (2004) proposal for methods to evaluate design science research outcomes. An overview of these methods is given in Table 3.

1. Observational	Case Study Field Study
2. Analytical	Static Analysis Architecture Analysis Optimization Dynamic Analysis
3. Experimental	Controlled Experiment Simulation
4. Testing	Functional (Black Box) Testing Structural (White Box) Testing
5. Descriptive	Informed Argument Scenarios

Table 3. Design Evaluation Methods, based on (Hevner et al., 2004)

The evaluation of convergence thinkLets according to the methods in Table 3 will take the form of a program of research as no single method will be sufficient to comprehensively demonstrate the strengths and weaknesses of a given convergence thinkLet. Below we outline how each method that is considered applicable, could be employed to evaluate the design convergence thinkLets, followed by an example of related completed research:

- *Observational – Case study*: Each time the new convergence thinkLets are used in a real life workshop, qualitative and quantitative data on its use can be collected. This would include the actual workshop results (e.g. information at the beginning and conclusion of the thinkLet), feedback by participants and the facilitator from a questionnaire that addresses each of the performance criteria, and observational data on the performance criteria. The execution of the thinkLets may also be videotaped for further behavioral analysis. An example of this type of observational research is a study on usability testing using a CE process approach (de Vreede, Fruhling and Chakrapani, 2005). The study relied on direct observation, interviews, questionnaires, and actual session data as sources of data for analysis.
- *Observational – Field study*: The qualitative and quantitative data from a series of case studies can be compared and contrasted in a cross-case analysis to gain deeper insights into persistent patterns regarding the performance of the convergence thinkLets. Such a comparative field study will yield findings that may be less situation-specific, i.e. more generalizable. In a study of 15 years of GSS research, thinkLets were not used, however, the study shows how a

comparison across different organizations can be used to identify patterns and overall strengthen the study of the phenomenon of interest (de Vreede et al., 2003).

- *Analytical – Static analysis*: To examine the structure of the designed convergence thinkLets, their documentation can be presented to a panel of expert facilitators and collaboration engineers. Each of them can be invited to provide an assessment of the thinkLet's strengths and weaknesses with respect to the various performance criteria. Based on their experience, the panelists can also be invited to give an assessment of the overall feasibility of the thinkLet in the field. To date there is no research of thinkLets that utilizes static analysis, which makes this a good candidate for future research.
- *Analytical – Architecture analysis*: The fit of a designed convergence thinkLet to a technical IS architecture can be demonstrated by defining the specific capabilities of the GSS platform on which the thinkLet is implemented. Proof by demonstration can be provided through showing the exact functionality selection and configuration that is required to implement the thinkLet on a specific GSS, such as GroupSystems.com, WebIQ, MeetingWorks, or Facilitate.com. A study from Tarmizi et al. (2006) has demonstrated that various thinkLets (included the BroomWagon convergence thinkLet) can be successfully implemented in an enterprise web environment, specifically Groove.net.
- *Analytical – Dynamic analysis*: The evaluation of the dynamic qualities of the convergence thinkLets extension lies at the heart of the observational and experimental methods listed in this overview. This type of method would be a good candidate for future research because to date there is no dynamic analysis research of convergence thinkLets that we are aware of.
- *Experimental – Controlled experiment*: Laboratory experimentation is the most popular evaluation method in GSS research (Fjermestad and Hiltz, 1998/1999). To assess the performance of convergence thinkLets, a carefully crafted experiment could be very insightful. A key consideration in the design of such an experiment is the nature and scope of the task. Does the task start with a divergence activity followed by a convergence activity on the generated ideas, or does the task start with a convergence activity that uses a pre-defined set of ideas as input? Lab experiments can also be used to test different physical implementations of the new convergence thinkLets for the same task.
- *Experimental – Simulation*: Simulation techniques may be used to support laboratory experiments by reducing the number of subjects needed (Hilmer and Dennis, 2000/2001; Satzinger, Garfield and Nagasundaram, 1999). For example, a simulator may give a subject the impression of working with others in a group by automatically submitting predefined contributions at predefined moments in the process. The use of simulators can also be explored in the convergence phase of the experimental task, e.g. by letting a simulator based on AI techniques (Orwig et al., 1997) suggest generalizing keywords that describe a subset of the contributions.
- *Testing – Functional (black box) testing*: Prototype designs of convergence thinkLets can be tested in a pilot group of (student) subjects to uncover design flaws and fine tune the different thinkLet elements. A study of two student groups and one group of professionals were used to test and refine a prototyped CE process design for putting together an incident response plan (Kamal et al., 2007). The various pilot studies allowed the researchers to identify flaws and fine tune the process a couple of times before finalization.

We considered analytical optimization and structural (white box) testing not applicable to evaluation the design of convergence thinkLets. In light of the other evaluation methods available, we consider descriptive methods as described by Hevner et al. (2004) not powerful enough for assessing thinkLet designs.

DISCUSSION

In this paper, we presented an assessment of the strengths and weaknesses of various documented convergence thinkLets. This assessment was based on field experiences with each thinkLet. Furthermore, we derived a set of performance criteria in terms of the results of convergence thinkLet and the perceived process/experience for the stakeholders involved. We propose that these insights can be as the basis for a selection guide for convergence thinkLets. We have included that guide in table 4. In table 4, a '+' means that a thinkLet satisfies the performance criterion well, while a '-' means that it does not satisfy the performance criterion. A '□' is used to show that the thinkLet only provides some limited fit to the performance criterion. Please note that the fit of a thinkLet for a particular group activity may also depend on other criteria, such as the nature of the input and output of the convergence activity (e.g. a single clean statement that all participants understand vs. a list of critical concepts that the group selected from a larger set).

	Results Oriented					Process/Experience Oriented				
ThinkLet	**Speed**	**Comprehensive**	**Shared Understanding**	**Reduction**	**Refinement of Outcomes**	**Participant Acceptance**	**Facilitator Ease of Use**	**Participant Ease of Use**	**Facilitator Satisfaction**	**Participant Satisfaction**
FastFocus	□	+	+	+	+	□	–	□	□	□
OneUp	□	□	+	+	+	□	–	–	□	□
BucketBriefing	+	□	□	+	□	+	+	+	□	+
DimSum	□	+	+	–	+	+	□	+	+	+
Pin the Tail on the Donkey	+	–	□	+	–	+	□	+	+	□
BroomWagon	+	□	–	+	–	□	+	+	+	+
GoldMiner	□	□	–	+	–	+	+	+	+	+
ExpertChoice	+	□	□	+	+	□	+	+	□	□
GarlicSqueezer	+	–	–	+	–	□	–	+	□	□
ReviewReflect	□	+	+	–	+	+	□	□	□	+
FastHarvest	+	+	+	+	+	+	+	+	+	+
FocusBuilder	+	□	+	+	+	+	+	+	+	+

Table 4. Selection Guide for Convergence thinkLets

CONCLUSION, LIMITATIONS, AND FUTURE RESEARCH

Convergence is a critical activity in group work. Many techniques are available to make a group productive during brainstorming activities, yet raw brainstorming results are not immediately useful as final deliverables. Convergence takes raw brainstorming results to create focus, shared understanding, and clarity. In this sense, convergence is a critical phase in the overall advancement of the group's task. Yet, experiences in research and practice suggest that convergence is time consuming and often a painful process for groups. Although some best practices regarding facilitated convergence have been captured as thinkLets, a better understanding of convergence patterns is required. This insight will help explain why certain convergence thinkLets perform better than others and how better convergence thinkLets might be designed.

To this end, this paper makes a number of contributions. First, it exposes a framework of convergence performance criteria based on field experiences with a collection of convergence thinkLets. Second, it proposes two new convergence techniques that are specifically designed to build on the strengths of existing thinkLets and overcome some of their limitations. Third, it proposes a program of design science research to evaluate the quality of both new and existing convergence thinkLets. Finally, the paper proposed the first iteration of a selection guide for convergence thinkLets. Future research will have to validate the selection guide through a structured, in-depth evaluation of each thinkLet along the criteria presented in this paper. Future research is also required to understand the causalities that underlie the performance characteristics of the various convergence thinkLets. Only when we better understand why certain thinkLets perform better on various dimensions, we can hope to design even more useful thinkLets.

Within the CE research domain, this paper is one of the first to follow the design science paradigm. This appears to hold promise to further the study of CE related phenomena, yet its value will have to be assessed in further studies.

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REFERENCES

1. Briggs, R. O., de Vreede, G.-J. and Nunamaker Jr., J. F. (2003) Collaboration engineering with thinkLets to pursue sustained success with group support systems, *Journal of Management Information Systems*, 19, 4, 31-64.
2. Briggs, R. O., Kolfschoten, G. L., de Vreede, G.-J. and Dean, D. L. (2006) Defining key concepts for collaboration engineering, in *Proceedings of the 12th Americas Conference on Information Systems*, August 4-6, Acapulco, Mexico
3. Briggs, R. O., Nunamaker Jr., J. F. and Sprague Jr., R. H. (1997) 1001 Unanswered research questions in GSS *Journal of Management Information Systems*, 14, 3, 3-21.

4. Chen, H., Hsu, P., Orwig, R., Hoopes, L. and Nunamaker Jr., J. F. (1994) Automatic concept classification of text from electronic meetings, *Communications of the ACM*, 37, 10, 56-72.
5. de Vreede, G.-J. and Briggs, R. O. (1997) Meetings of the Future: Enhancing Group Collaboration with Group Support Systems, *Journal of Creativity and Innovation Management*, 6, 2, 106-116.
6. de Vreede, G.-J. and Briggs, R. O. (2005) Collaboration engineering: Designing repeatable processes for high-value collaborative tasks, in *Proceedings of the 38th Annual Hawaii International Conference on Systems Science*, Los Alamitos.
7. de Vreede, G.-J. and Bruijn, H. D. (1999) Exploring the boundaries of successful GSS application: Supporting inter-organizational policy networks, *The Data Base for Advances in Information Systems*, 30, 3/4, 111-131.
8. de Vreede, G.-J., Fruhling, A. and Chakrapani, A. (2005) A repeatable collaboration process for usability testing, in *Proceedings of the 38th Hawaii International Conference on System Sciences*.
9. de Vreede, G.-J., Kolfschoten, G. L. and Briggs, R. O. (2006) ThinkLets: A collaboration engineering pattern language, *International Journal Computer Applications in Technology*, 25, 2/3, 140-154.
10. de Vreede, G.-J., Vogel, D. R., Kolfschoten, G. and Wien, J. S. (2003) Fifteen Years of GSS in the Field: A Comparison across Time and National Boundaries, in *Proceedings of the 36th Hawaiian International Conference on System Sciences (HICSS)*, Los Alamitos, CA.
11. DeLuca, D. and Valacich, J. S. (2006) Virtual teams in and out of synchronicity, *Information Technology & People*, 19, 4, 323-344.
12. Dennis, A. R. and Valacich, J. S. (1999) Rethinking Media Richness: Towards a Theory of Media Synchronicity in *Proceedings of the 32nd Hawaii International Conference on System Sciences*, 1017.
13. Dennis, A. R., Valacich, J. S. and Nunamaker Jr., J. F. (1990) An experimental investigation of the effects of group size in an electronic meeting environment, *IEEE Transactions on Systems, Man and Cybernetics*, 20, 5, 1049-1057.
14. Dennis, A. R., Wixom, B. H. and Vandenberg, R. J. (2001) Understanding fit and appropriation effects in group support systems via meta-analysis, *MIS Quarterly*, 25, 2.
15. Easton, G. K., George, J. F., Nunamaker Jr., J. F. and Pendergast, M. O. (1990) Using Two Different Electronic Meeting System Tools for the Same Task: An Experimental Comparison, *Journal of Management Information Systems*, 7, 1, 85-101.
16. Evans, P. and Wolf, B. (2005) Collaboration Rules, *Harvard Business Review*, 7, 1-11.
17. Fjermestad, J. and Hiltz, S. R. (1998/1999) An assessment of group support systems experimental research: Methodology and results, *Journal of Management Information Systems*, 15, 3, 7-149.
18. Hengst, M. d. and Adkins, M. (2007) Which collaboration patterns are most challenging: A global survey of facilitators, in *Proceedings of the 40th Annual Hawaii International Conference on System Sciences*, January, 17.
19. Hevner, A. R., March, S. T., Park, J. and Ram, S. (2004) Design science in information systems research, *MIS Quarterly*, 28, 1, 75-105.
20. Hilmer, K. M. and Dennis, A. R. (2000/2001) Stimulating Thinking: Cultivating Better Decisions with Groupware Through Categorization, *Journal of Management Information Systems*, 17, 3, 93-114.
21. Kamal, M., Davis, A. J., Nabukenya, J., Schoonover, T. V., Pietron, L. R. and de Vreede, G.-J. (2007) Collaboration engineering for incident response planning: Process development and validation, in *Proceedings of the 40th Annual Hawaii International Conference on System Sciences (HICSS-40)*, January 3-7, Waikoloa, Hawaii.
22. Kolfschoten, G. L., Briggs, R. O., de Vreede, G.-J., Jacobs, P. H. M. and Appelman, J. H. (2006) Conceptual foundation of the thinkLet concept for collaboration engineering, *International Journal of Human Computer Science*, 64, 7, 611-621.
23. March, S. T. and Smith, G. F. (1995) Design and natural science research on information technology, *Decision Support Systems*, 15, 251-266.
24. Munkvold, B. E. and Zigurs, I. (2005) Integration of e-collaboration technologies: Research opportunities and challenges, *International Journal of e-Collaboration*, 1, 2, 1-24.
25. Nunamaker, J. F., Briggs, R. O. and de Vreede, G.-J. (2001) From information technology to value creation technology, in Gary W. Dickson and Gerardine DeSanctis (Eds.), Information technology and the new enterprise: New models for managers: Prentice Hall.
26. Orwig, R., Chen, H., Vogel, D. R. and Nunamaker Jr., J. F. (1997) A Multi-Agent View of Strategic Planning Using Group Support Systems and Artificial Intelligence, *Group Decision and Negotiation*, 6, 1, 37-59.
27. Pendergast, M. and Hayne, S. C. (1995) Alleviating convergence problems in Group Support Systems: The shared context approach, *Computer Supported Cooperative Work*, 3, 1, 1-28.
28. Reinig, B. A. (2003) Toward an Understanding of Satisfaction with the Process and Outcomes of Teamwork, *Journal of Management Information Systems*, 19, 4, 65-84.

29. Satzinger, J. W., Garfield, M. J. and Nagasundaram, M. (1999) The creative process: the effects of group memory on individual idea generation, *Journal of Management Information Systems*, 15, 4, 143-160.
30. Tarmizi, H., Payne, M., Noteboom, C., Zhang, C., Steinhauser, L., de Vreede, G.-J. and Zigurs, I. (2006) Technical and Environmental Challenges of Collaboration Engineering in Distributed Environments, in *Proceedings of the CRIWG*, 38-53.
31. Vaishnavi, V. and Kuechler, W. (2006, January 18). Design Research in Information Systems. from http://www.isworld.org/Researchdesign/drisISworld.htm