Participant-Driven Collaborative Convergence

Joel H. Helquist
Utah Valley State College
joel.helquist@uvsc.edu

John Kruse
The MITRE Corporation
john@kruser.org

Mark Adkins
AK Collaborations
mark@akcollaborations.com

Abstract

Traditional GSS workflow leverages the abilities of an expert facilitator to lead groups through the convergence activities. This dependence on a facilitator creates a bottleneck that is difficult to resolve in asynchronous and distributed groups. This paper presents a new framework, participant-driven convergence, which enables the participants to perform the convergence work in parallel. The goal of this approach is to enable each participant to work in parallel and anonymously to drive the group toward some level of convergence consensus.

1. Introduction

Considerable research has investigated and documented the benefits of group collaboration through Group Support Systems (GSS). A meta-analysis of over fifty field studies found that in 86.5 percent of the studies, the users of GSS experienced performance improvements [1]. These improvements include such things as savings in man hours and calendar time [2, 3].

Group work provides many advantages as the individuals within the group are able to share information, generate ideas, make decisions, and review the effects of the decisions [4]. The collaborative efforts leverage the knowledge and experience of the team members to develop innovative ideas and increase participant buy-in for decisions [5].

However, high-level collaboration is difficult to achieve (1) with distributed and asynchronous participation, (2) through lean computer-mediated communications, and (3) with larger groups [6]. These conditions create difficulties for the group to effectively coordinate and collaborate. This paper seeks to improve the ability of groups to collaborate effectively by further examining and refining the processes by which groups converge on potential solutions to problems or consolidate brainstorming ideas.

This paper is organized as follows. The next section presents an overview of the basic classification of collaborative activities. This classification is presented as a means to understand the general patterns of collaboration within a collaborative GSS session. Section three extends the discussion of the patterns of collaboration by further examining the various activities associated with convergence. This section highlights the difficulties associated with this collaborative stage and the limitations faced by existing GSS tools and approaches. Section four presents the new, participant driven, approach to accomplishing the convergence activities. Finally, specific modules or subcomponents in this approach are presented and discussed.

2. Collaboration patterns

Collaborative decision support processes can be classified into five core collaborative activities or patterns [7, 8]. Briggs et al define these five patterns of collaboration as follows:

- Generate: Move from having fewer concepts to having more concepts
- Converge: Move from having many concepts to focusing on a few concepts deemed worthy of further attention
- Evaluate: Move from less understanding of the value of concepts for achieving a goal to more understanding of the value of concepts for achieving a goal
- Organize: Move from less understanding to more understanding of the relationships among concepts
- Build Consensus: Move from having less agreement among stakeholders to having more agreement among stakeholders.

Of these five core activities, three are overt and indispensable in the collaborative workflow: diverge, converge, and evaluate. The other two are necessary, but can be affected through the three primary collaboration patterns.

Divergence is commonly achieved through groups brainstorming ideas in parallel to generate a wide variety of potential solutions or alternatives. The objective of the divergence phase is to generate a variety of solutions that cover as much of the solution space as possible. Brainstorming in parallel increases the cognitive bandwidth of a meeting by allowing the participants to work simultaneously, exchanging and developing ideas for the group. Considerable research has focused on brainstorming and how to improve the results from brainstorming sessions [9-13].

The ideas generated in the divergence activity are then grouped into logical clusters or topic threads through convergence activities.

This synthesizing activity requires the group to develop some level of consensus as to the logical organization of the brainstorming ideas.

The group then evaluates the ideas and the threads to identify the most important elements that are worthy of further attention. This evaluation often takes the form of standard polling mechanisms where participants are able to anonymously register their vote.

This collaborative workflow is illustrated in Figure 1. This figure illustrates the group generating ideas in the divergence stage, converging the ideas into relevant threads, and evaluating the threads that merit further attention by the group.

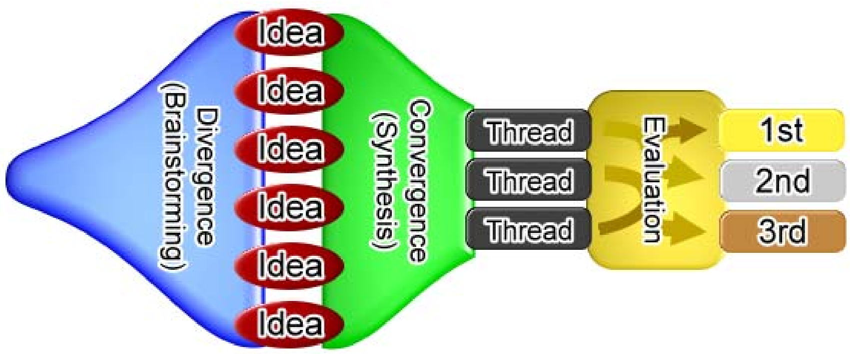

Figure 1 - Collaboration process

The challenge to collaboration decision support lies primarily in the convergence activities. Humans are born to synthesize ideas into rich threads. This is, however, difficult to do in a group process where multiple opinions and ideas have to be balanced. The convergence process becomes a bottleneck as typically an expert facilitator is used to guide the group through the convergence process. The facilitator is able to discuss the themes and ideas with the participants to help them identify the logical groupings or threads.

The convergence process, then, becomes less collaborative and more serial in nature, as the work is constrained by the facilitator. The ability of the group to converge is hindered greatly when the group is collaborating in a distributed, asynchronous environment, even with the use of an expert facilitator. This paper seeks to further examine the convergence activities to improve the process and refine the activities in a collaborative workflow, enabling improved convergence in distributed environments.

Research by Nunamaker et al [3] posits that there are three levels of group work: individual, coordination, and group dynamics. Individual is compared to a group of sprinters, each exerting effort but in an uncoordinated, individual manner. Coordination is a level of collaboration where the work is coordinated but done independently. This level of group work is synonymous with the "divide and conquer" approach to group tasks. Nunamaker et al compare this level of group work to a relay team at a track event. The members of the team each work together to an extent for the good of the team but each member is still working on an individual basis. The highest level of collaborative group work is the group dynamics level. This is collaboration where the members of the group work in a concerted effort toward the group's goal. To achieve this level of collaboration, significant levels of communication and coordination are required.

Collaborative work in an asynchronous, distributed environment can easily achieve the lower two levels of group work, individual and coordination. Groups can assign tasks, compile results, and move forward by compiling the individual results. However, achieving the group dynamics level is significantly harder in a distributed environment. In fact, part of the reason that distributed divergence and evaluation processes are more easily completed than convergence is that they can readily be turned into coordination level tasks. Convergence, on the other hand, requires at least some attainment of the group dynamics level. Nevertheless, additional research is needed to refine the convergence process to improve the abilities of groups to converge effectively in distributed, asynchronous settings.

3. Convergence

Convergence is the process by which groups identify logical groupings or threads from a myriad of brainstorming ideas or potential solutions. This process effectively decreases and organizes the decision space into a more coherent product.

The convergence process itself consists of numerous activities. The group must filter the brainstorming ideas in an effort to "scrub" the ideas. This filtering may be accomplished by either eliminating ideas or concepts altogether, or by consolidating different brainstorming ideas into a single conceptual representation. Additionally, conflicting or ambiguous definitions or terms are resolved to increase the consistency of the understanding [8]. The group then must synthesize the brainstorming ideas to identify relationships between the ideas, identifying common themes or threads [8].

The convergence process is critical to the success of the group and is often the bottleneck in the collaborative workflow. The synthesis of concepts or ideas reduces the cognitive load on the group to understand the issues and solution space. The key ideas are identified and described, enabling further discussion and work on the most important threads. The convergence is a sense-making activity that enables a more thorough understanding of the solution space and improves the critical analysis of the identified threads.

However, as mentioned previously, this converging is a difficult problem and groups often resort to facilitators to expedite the process [8]. The facilitator represents a considerable bottleneck in the process as the work is for practical purposes conducted serially, instead of in parallel. Participants in the collaborative work are no longer able to work in parallel and must wait for the facilitator to guide the convergence activity. The ability of the facilitator to lead the convergence activity is limited to an even greater degree when the group moves to an asynchronous, distributed venue. The synchronicity and potentially limited communication channels hinders the resources available to the facilitator to lead these activities. As stated by Briggs et al [8], "[t]here still is a void in our knowledge on effective facilitator support for distributed collaboration, especially concerning convergence" [p.55]. More work is needed to further the ability of groups to work in distributed environments [14].

The facilitator also creates a bottleneck in that oftentimes, an expert facilitator is not available to guide the collaborative work. The absence of a facilitator decreases the likelihood that a GSS tool will be utilized as the participants themselves are not as familiar with the tools themselves or the workflows [8]. The facilitator has traditionally been the constraining factor in collaborative group work.

An important line of research lies in developing effective means for collaborative convergence activities. The principle idea behind this effort is that by enabling the participants to perform convergence activities in parallel and aggregating their judgments, a GSS system can be built to mimic the efforts of a human facilitator.

4. Participant-driven convergence

Participant-driven Group Support Systems (PD-GSS) provide a framework to enable successful and highly dynamic collaboration between distributed, asynchronous groups. PD-GSS seeks to leverage the skills and abilities of each group member to reduce the burden of, or dependence on, the facilitator. The name "participant-driven" refers to notion that the participants are collectively performing more of the evaluative, subjective, and process control tasks autonomously and in parallel [15-17].

PD-GSS deconstructs the collaborative workflow into discrete modules that can be worked on iteratively by the participants. Users are able to log in asynchronously and contribute to the collaborative work, depending on the status of the group in the overall workflow and where the group needs resources allocated.

The decomposition of the convergence process into discrete modules reduces the cognitive load and complexity associated with each individual module. Each module is developed such that it is independent and the required tasks and objectives are clear to the participants. The dividing of the convergence task into the various modules should improve the effectiveness of the group work by allowing the participants to focus on specific, straightforward tasks [18].

The PD-GSS convergence activities attempt to overcome some of the difficulties associated with convergence by enabling group members to work through the concepts generated in the divergence stage to produce logical, synthesized threads. By engaging all of the participants simultaneously and anonymously, PD-GSS should speed the collaborative interaction while canceling out the biases of individual participants. Additionally, by engaging the participants, the associated satisfaction levels with the convergence process are expected to improve [19].

As stated previously, both the divergence and evaluation activities can be accomplished at the coordination level of collaboration. The convergence activity, when lead by a facilitator, is significantly more complex than either the divergence or evaluation activities. Convergence can, nevertheless, be decomposed into more simple operations. The decomposition of the convergence process into discrete modules yields specific operations that the participants can follow that are unambiguous and require little instruction. Moreover, these discrete modules do not require difficult group dynamic level collaboration. The decomposition of convergence enables the specific convergence modules to be cognitively accessible at a degree similar to the divergence and evaluation modules. The specific convergence modules are illustrated in Figure 2.

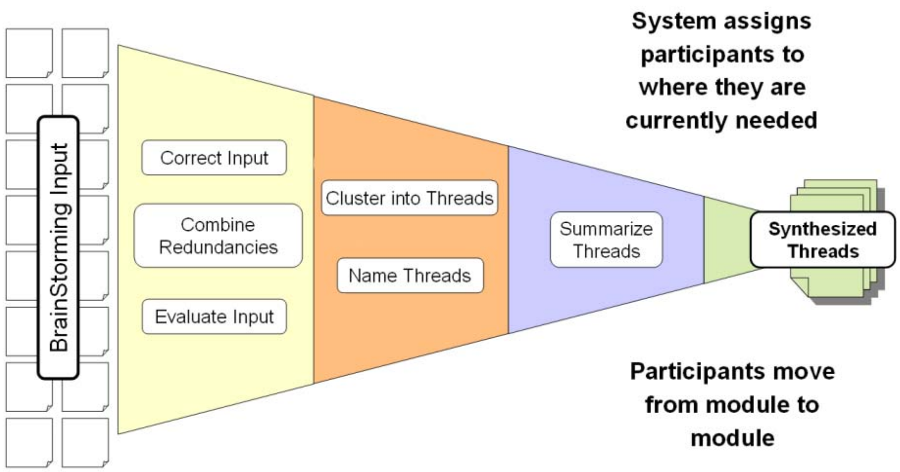

Figure 2 – Collaborative convergence process

On the left side of the image, the documents represent the output from the divergence process. This output could be a set of brainstorming ideas or alternative courses of action. These brainstorming ideas serve as the input to the various convergence modules:

1. Evaluate input
2. Correct input
3. Combine redundancies
4. Cluster ideas into threads
5. Name and rename threads
6. Summarize threads

It is important to note that though we have listed these modules sequentially, they are not strictly performed serially. Since each individual participant is able to contribute independently, they can be tasked at different modules in the convergence process. The group members will also be providing the process judgments that will determine when a given part of the greater process is complete and effort should be moved forward.

4.1. Evaluate input

The first step in participant-driven convergence is the Evaluate Input module. This module provides the individuals within the group an opportunity to review the incoming brainstorming ideas and provide ratings for each idea.

This evaluation stage provides two critical benefits. First, the group is able to come to some consensus on which ideas are the most important, salient, or worthy of further attention. This rating can be used as a sorting mechanism or priority queue in later modules to prioritize which items should be processed first. Second, the act of engaging the participants in reading each concept increases the level of comprehension of the solution space and enables the participants to begin to mentally develop logical groupings. The evaluation provides an opportunity for the participants to improve situation awareness and the context necessary to improve the understanding of the solution space [20].

4.2. Correct input

The second module or step within the dynamic convergence process is to correct the input that was generated during the divergence activities. It is not uncommon for GSS participants to enter fragments, non sequiturs, and other errors that limit utility. This stage, which could potentially be fused with Evaluate Input, will give participants an opportunity to disambiguate and correct errors in entries, making them more useful to the group. At the very least, the ratings developed in the Evaluate Input module can be used to weight the items that participants will be asked to correct since lower rated items will likely be those that are unclear or flawed by errors that can be corrected.

4.3. Combine redundancies

The next module will allow the users to begin to narrow the range of ideas. Often group participants will enter similar and even duplicate ideas. By identifying and combining these redundant entries, the participants can decrease the complicatedness of the decision space without sacrificing any of its richness. This can be accomplished by asking individuals to identify these redundancies. Subsequent users will verify these judgments before the items are deleted or combined. This process will also tend to improve the quality of the idea pool as the group keeps the stronger and clearer of the redundant entries.

4.4. Cluster ideas

The primary convergence task is the clustering of ideas into more encompassing and coherent threads. By aggregating the work of the individual participants, we believe that the process can be made quite intuitive, efficient and effective. Specifically, individuals will cluster random subsets of the input pool. Through statistical inference, the system will derive the clusters for the entire pool.

Typically, GSS utilize the analogy of named buckets for collaborative clustering operations. Automated clustering techniques, on the other hand, are much more likely to use spatial analogies in which like items are more proximal. We intend to leverage the advantages of both of these approaches. Humans are very comfortable with sorting using the bucket analogy, so we would present individuals with random subsets of the idea pool. They would then be asked to sort the items into as many categories as they would like. The system will then infer the spatial proximity of ideas from the aggregation of the participants many sorted categories.

We believe such an approach has several advantages over more traditional clustering methods. First, there is a process gain from not having anchoring bias associated with clustering on names developed early in the process. The individuals are able to cluster the ideas based strictly on the ideas themselves without anchoring on existing buckets. Second, by allowing each individual to independently develop their own subset clusters, the outcome of the aggregated effort represents a group consensus and is less likely to be subject to the influence of any single member. Third, this approach also lends itself to more a more accurate representation of membership of an idea in any given cluster. Current methods rely on a dichotomous membership in clusters and cannot easily show indeterminate membership or ambiguities. Finally, we expect this clustering technique to be quite fast as parallel user effort is maintained throughout.

4.5. Naming and renaming clusters

As with the previous modules, the participants in the group each work independently and anonymously to provide names or labels for each of the clusters. The process involves the first participant receiving a cluster and being asked to provide a name. Subsequent users are able to either approve the name or submit a new name. Work proceeds in this manner until all of the developed threads or buckets receive some level of consensus regarding the label.

4.6. Summarize clusters

A final, optional operation for the group prior to moving into evaluation is to develop concise textual summarizations of each cluster. This subprocess provides three main benefits. First, it helps the group to actually arrive at a common, consensus understanding of the clusters they have created. Second, it provides practical value in that it better packages clusters for further work, and provides a means for understanding by people outside of the group. Third, it provides a more persistent view of the group consensus.

4.7. Process judgments

A large part of the facilitator's value comes in making process judgments. The facilitator often gauges the progress of the group and where effort should be applied. Without these process judgments, the group can get bogged down and waste time and effort. As such, a major component of PD-GSS is that the participants will regularly be queried about the state of the process and products. By doing so, we hope to constantly apply appropriate effort to the many subtasks.

5. Conclusion

The participant-driven convergence approach advocated in this paper has the potential to significantly improve distributed and asynchronous GSS sessions. In spite of the success and demonstrated efficacy of facilitated collaboration, there are considerable barriers to the use of a facilitator, even in collocated and synchronous groups. The participant-driven approach seeks to further empower the participants to conduct the critical convergence activities through parallel, anonymous work in order to arrive at a group consensus.

Preparations are underway to develop and experimentally examine the PD-GSS convergence framework. The results from this preliminary examination will serve to further refine the convergence approach. The first experimental design will compare the time and results required by a traditional GSS groups to PD-GSS groups. The groups will be required to generate a set number of brainstorming ideas and categorize the ideas into buckets. Elapsed time and clustering metrics will be employed to examine the differences in effectiveness and efficiency between the two groups.

6. References

[1] J. Fjermestad and S. R. Hiltz, "An assessment of group support systems experiment research: Methodology and results," *Journal of Management Information Systems,* vol. 15, p. 7, 1998.

[2] G. J. de Vreede, D. Vogel, G. Kolfschoten, and J. Wien, "Fifteen years of GSS in the field: A comparison across time and national boundaries," 2003.

[3] J. F. Nunamaker, Jr., R. O. Briggs, D. D. Mittleman, D. R. Vogel, and P. A. Balthazard, "Lessons from a dozen years of group support systems research: A discussion of lab and field," *Journal of Management Information Systems,* vol. 13, p. 163, 1996.

[4] L. D. Phillips and M. C. Phillips, "Facilitated work groups: Theory and practice," *Journal of the Operations Research Society,* vol. 44, pp. 533-549, 1993.

[5] M. Adkins, M. Burgoon, and J. F. Nunamaker, Jr., "Using group support systems for strategic planning with the United States Air Force," *Decision Support Systems,* vol. 34, pp. 315-337, 2003.

[6] M. Aakhus, M. Adkins, and M. Glynn, "Layers of learning: Facilitation in the distributed classroom," in *Proceedings of the Thirtieth Hawaii International Conference on System Sciences*, 1997, pp. 598-609.

[7] R. O. Briggs, G. L. Kolfschoten, and G. J. d. Vreede, "Defining key concepts for Collaboration Engineering," in *Proceedings of the 12th America's Conference on Information Systems*, Acapulco, Mexico, 2006.

[8] R. O. Briggs, G. J. Vreede, de, and J. F. Nunamaker, Jr., "Collaboration engineering with thinkLets to pursue sustained success with group support systems," *Journal of Management Information Systems,* vol. 19, pp. 31-64, 2003.

[9] H. Barki and A. Pinsonneault, "Small group brainstorming and idea quality: Is electronic brainstorming the most effective approach?," *Small Group Research,* vol. 32, pp. 158-205, April 1, 2001 2001.

[10] T. Connolly, L. M. Jessup, and J. S. Valacich, "Effects of anonymity and evaluative tone on idea generation in computer-mediated groups," *Management Science,* vol. 36, pp. 689-703, 1990.

[11] A. R. Dennis, J. S. Valacich, T. A. Carte, M. J. Garfield, B. J. Haley, and J. E. Aronson, "Research report: The effectiveness of multiple dialogues in electronic brainstorming," *Information Systems Research,* vol. 8, pp. 203-211, 1997.

[12] E. L. Santanen, "Directed brainstorming and the cognitive network model of creativity: An empirical investigation of cognitive factors related to the formation of creative solutions using an electronic brainstorming environment," Tucson, AZ: University of Arizona, 2002.

[13] E. L. Santanen and G. J. de Vreede, "Creative approaches to measuring creativity: Comparing the effectiveness of four divergence thinkLets," in *Proceedings of the Proceedings of the 37th Annual Hawaii International Conference on System Sciences*: IEEE Computer Society, 2004.

[14] J. F. Nunamaker, Jr., "Future research in group support systems: Needs, some questions and possible directions," *International Journal of Human-Computer Studies,* vol. 47, pp. 357-385, 1997.

[15] J. H. Helquist, Santanen, E.L., and Kruse, J., "Participant-driven GSS: Quality of brainstorming input and allocation of participant resources," in *40th Annual Hawaii International Conference on System Science*, Waikoloa, HI, (Under review), 2007.

[16] J. H. Helquist, J. Kruse, and M. Adkins, "Developing large scale participant-driven group support systems: An approach to facilitating large groups.," in *Proceedings of the First HICSS Symposium on Field and Case Studies of Collaboration*, Los Alamitos, CA, 2006.

[17] J. H. Helquist, J. Kruse, and M. Adkins, "Group support systems for very large groups: A peer review process to filter brainstorming input," in *Proceedings of the Americas Conference on Information Systems* Acapulco, Mexico, 2006.

[18] J. H. Helquist, "Participant-driven Group Support Systems: An approach to distributed, asynchronous collaborative systems," Tucson, AZ: University of Arizona, 2007.

[19] H. Chen, P. Hsu, R. Orwig, L. Hoopes, and J. F. Nunamaker, Jr. , "Automatic concept classification of text from electronic meetings," *Communications of the ACM,* vol. 37, pp. 56-73, 1994.

[20] A. R. Dennis, "Information exchange and use in group decision making: You can lead a group to information, but you can't make it think," *MIS Quarterly,* vol. 20, pp. 433-457, Dec. 1996.