Report

Workshop

Collaboration Engineering

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Foreword

People who collaborate toward important goals often achieve far more as a group than they could as individuals. However, group work is a mixed blessing that brings its own challenges. Research shows that under many circumstances, groups who work with an experienced facilitator supported by collaboration technology are much more productive that teams who do not. However, dedicated facilitators are expensive to sustain in organizations; so many teams that could benefit from facilitation have no access to it.

Collaboration Engineering (CE) is an approach to designing collaborative work practices for high-value recurring tasks, and deploying those designs for practitioners to execute for themselves without ongoing support from professional facilitators

In the workshop, presenters reported on the latest breakthroughs in Collaboration Engineering research. Both in the morning and afternoon we first had presentations of advances and new insights in Collaboration Engineering. After the presentations we had active sessions to work on metrics to measure the effects of Collaboration Engineering interventions. This report presents an overview of the presentations and the sessions.

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Workshop Report
HICSS 40 Second Workshop on Collaboration Engineering

Introduction

At HICSS 40, the second Workshop on Collaboration Engineering convened at the Hawaii International Conference on System Sciences on January 3, 2007 to hear reports of recent breakthroughs in collaboration research and to tackle a challenging research question: the measurement of organization-patterns and evaluation-patterns.

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Background

Collaboration Engineering (CE) is a new approach to designing collaboration processes for high-value recurring tasks, and transferring those designs to practitioners to execute for themselves without the ongoing intervention of a professional facilitator. CE focuses on high-value tasks, because improvements on those tasks can yield the most benefit to an organization. CE focuses on recurring tasks for two reasons: 1) so that an organization can derive ongoing benefit from the investment in CE; and 2) so that it is worth a practitioner's time to learn the process designed by a collaboration engineer. Currently the CE research community uses the Four Ways model of engineering to organize its intellectual content.

- **Way of Thinking –** concepts and theoretical foundations.
- **Way of Working –** Structured design and deployment methodologies

- **Way of Modeling –** conventions for representing aspects of the domain and the approach.
- **Way of Controlling** – measures and methods for managing the engineering process.

For purposes of clarity, the contributions to this workshop are organized under the Four Ways model, rather than being presented in the order they were discussed in the workshop. Contributions were made to three of the four ways: Way of Thinking, Way of Working, and Way of Modeling.

Contributions to Way of Thinking

An Ethical Design Theory for ThinkLet-based Collaboration

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Motivation and Background

This paper addresses the recent call for more research on design science (Hevner et al., 2004; Iivari et al., 2005; Iivari et al., 2006; MISQ call for special issue on design science), specifically for Collaboration Engineering (CE). According to Kolfschoten et al. (2006), "CE is an approach that designs, models and deploys repeatable collaboration processes for recurring high-value collaborative tasks that are executed by practitioners using facilitation techniques and technology." CE has a fair degree of practical relevance in today's organizations with complex business processes addressing complex problems.

Based on the notion of value sensitive design (Friedman et al., forthcoming; Friedman and Kahn, 2003), this paper articulates an ethically informed design theory of CE artifacts called thinkLets. A thinkLet "*constitutes the smallest unit of intellectual capital required to create one repeatable, predictable pattern of collaboration among people working toward a goal*" (Briggs et al., 2003). They represent the fundamental conceptual building blocks for group process design (Kolfschoten et al., 2006).

Design and Design Theory

Design is both an artifact and the process of designing that artifact (Walls et al., 1992; March and Smith, 1995; Hevner et al., 2004; Siponen and Iivari, 2006). According to Walls et al. (1992) and Walls et al. (2004), a design theory for the design artifact has four components: *Kernel theory, Meta requirements, Meta design and Testable design product hypotheses*. Kernel theory refers to the theories of natural or social science that govern design requirements. Meta requirements refer to the class of goals for the design artifacts. Meta design refers to a class of artifacts that meet the above Meta requirements. Finally, testable hypotheses provide the basis to see if the Meta requirements are met by the Meta design. Design theories for the design process consist of three components (Walls et al., 1992; Walls et al., 2004): *Kernel theory, Design method, and Testable design process hypotheses*. The Kernel theories perform similar roles as above. Design method describes a set of procedures for the artifact construction (e.g. prototyping). Testable design process hypotheses provide a way for empirically verifying if the design process resulted in an artifact that met the Meta requirements.

The need for value sensitive design and the relevance of ethics

Value sensitive design is a theoretically grounded approach to design that accounts for human values (Friedman et al. forthcoming). Based on Friedman's (1996) notion, we can say that values are inherently embedded in the design of IS artifacts and such values are widespread, systematic and pervasive. It can be argued that any design artifact that is implemented would have the possibility to impact human life and thus needs to have values embedded in them (Klein and Hirschheim, 2001). As collaboration is a social process to a large extent, such human value considerations inherently become important. Thus, related to the value based design for technology that has been argued before (e.g. Friedman 1996; Friedman et al., forthcoming; Iivari et al., 1998), the design of collaborative work practices (and thinkLets are the fundamental building blocks of such work practices) based on human values become eminently relevant.

Ethics is conceptually relevant to the notion of value sensitive design. As Friedman et al. (forthcoming) and Friedman and Kahn (2003) point out, ethics can be subsumed within a theory of values and that values have “ethical imports.” Ethics is also intended to serve an important purpose in our articulation of the design theory framework: theories of ethics would form the kernel theories to inform design. Furthermore, since design theories are normative and prescriptive (Markus et al., 2002; Walls et al., 2002; Siponen and Iivari 2006), the normative nature of the theories of ethics blends in well in order to inform design theories.

Ethical design theory for thinkLets

As mentioned before, the ethical design theory will consist of two components: one for thinkLets as artifacts and another for the process of designing those artifacts.

For the former, we propose that the rights based framework of Immanuel Kant (2002) and the distributive justice notion of John Rawls (1971) form perfect candidates for the kernel theories, since both relate to rights of individuals (in terms of liberty and equal opportunity) within a sociopolitical system (and collaboration can be argued to be a sociopolitical system). From the notions of Kraus (1980) and de Vreede and Bruijn (1999), we argue that collaboration, as a basic process, should engender the basic human rights of autonomy, equality, and freedom of expression. These form the Meta requirements for our design of thinkLets as artifacts.

Arguing on the basis of de Vreede et al., (2006) and Kolfschoten et al., (2006), we opine that thinkLets, can, and need to be, morally sound artifacts that can create value and improve the quality of human life. Thus, thinkLets can be designed such that they engender the values of autonomy, equality and freedom of expression for participants. Thus they form the Meta design component of the design theory for thinkLets as artifacts. Finally, we propose testable hypotheses in order to verify if thinkLets can indeed engender the values mentioned above and if such thinkLets lead to greater user satisfaction for the collaborative process.

For the latter (i.e. design process), we propose the same kernel theories (Kant 2002; Rawls 1971). For the design method, on how we should go about designing thinkLets, we argue for the cooperative design method (Bodker 1993; Bodker et al., 2000) within the emancipatory approach espoused by Hirschheim and Klein (1994). The key idea is that if we are to design artifacts that uphold individual human rights, then the process of designing those artifacts should also uphold such rights. Since the goal of the cooperative design is to “develop conditions for effective worker participation in order to support democracy at work and quality of work” (Iivari et al., 1998, p. 168), we find it a particularly useful candidate for the method of designing thinkLet artifacts. Finally, we present testable design process hypotheses to empirically verify if thinkLets designed with such method would indeed uphold the values of autonomy, equality and freedom of expression for participants in a collaborative process.

Contribution and implications

Arguing from a value sensitive perspective, this paper articulates an ethical design theory for thinkLet based collaboration. It brings in the notion of value and ethics to the design of collaborative processes. Thus, it adds to the literature on CE, design science and IS ethics. It also paves the way for future research to design collaborative processes based on considerations other than ethics (e.g. emotion (Brave et al., 2005)).

Furthermore, it paves the way for value and ethics based considerations in other the design of other IS artifacts. It also provides testable hypotheses which future research could empirically study. Finally, it also informs practice by providing the idea of ethical collaborative practices and providing prescriptions on how to design such practices.

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Contributions to Way of Working

Collaborative Usability Evaluation in Large Distributed Teams

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Software usability flaws found in later stages of development can be extremely costly to resolve. Also, software developers are under increasing pressure to develop software rapidly and in distributed teams. Developers also need effective usability evaluation (UE) methods that are efficient and easily understood and that can be conducted by larger teams in distributed work modes. More recent economic forces, such as the increasingly prohibitive costs of professional evaluators, have driven software developers to explore the effectiveness of using novice evaluators culled from the end-user constituency associated with the application. Heuristic evaluation has been shown to be a particularly useful evaluation method that lends itself to use in groups and with novice.

Research shows that the optimal team size in traditional face-to-face (FtF) HE performed without CS is three to five people; larger teams find too many duplicates and fail to find enough additional bugs to justify size increases. Other group research has shown that CS can help larger groups be more productive than non-CS groups of the same size. For example, brainstorming research showed that CS groups could reach optimal sizes of 12 persons—a much greater optimal size than found in nominal groups. Yet, the task and processes of HE are appreciably different than brainstorming or collaborative modeling, so these findings do not generalize to HE.

Proximity choices are another important research opportunity for HE research. Several factors have made the use of virtual (distributed) teams more common in organizations, including increasing Internet use and information availability. Additionally, growing competitive pressures and globalization have led to the unprecedented use of outsourcing, offshoring, mergers, acquisitions, and strategic alliances. Hence improving distributed software development through distributed work is a useful goal. Previous research established that CS can help improve results of small distributed HE teams, but it has not established what will occur with larger distributed HE teams.

Given these opportunities, this research develops a theory to explain and predict the impact of group size and collaborative software choices on heuristic evaluation groups working in traditional face-to-face, computer-mediated face-to-face, and computer-mediated virtual groups. We conducted a rigorous experiment with 550 participants involving three-person and six-person groups working in different environments. The two major steps of the heuristic evaluation process were conducted.

This research predicted the effects of manipulating proximity, tool, and group sizes for the major steps of HE, using novice groups. It was found that proximity choices had little effect on step one; hence, step one is a creative process that can be conducted virtually anywhere, without the need to strongly consider proximity. As nominal HE groups become larger in step one, they have increasingly worse results, as compared to large groups using CS. Nominal groups, regardless of size, have to work significantly more in step two than CS groups, because CS groups achieve significantly more useful agreement in step one. This research also shows the importance of analyzing group tasks by the results at the end of major processes, as opposed to simplistic measures taken at the end of the task. By analyzing results of HE at the end of step one and step two, we found that novice groups not using CS are surprisingly generally better off not performing step two. This highlights the importance of breaking down results by processes in group research, as opposed to solely using end results.

Usability Centered Design as an approach to Collaboration Engineering

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A prototype system for collaborative strategic decision support has been developed using an agent-based modeling (ABM) and simulation approach. Based on the systems approach, the proposed prototype is intended for use by managers in strategic thinking and problem formulation. The benefits of automated support of cognitive mapping for negotiated problem solving are well established and researched [2,3,6,7]. The quantitative analytical approaches to problem solving use mathematical models to arrive at solution sets through mathematical modeling. These "hard" approaches include classical decision theory, the field of operations research and management science (**OR/MS**) and Systems Dynamics [4]. Their quantitative analytics are usually well supported by computerized decision-support systems (**DSS**).

Eden's work (e.g. [3]) exposed a gap between problem "solving", which depends on quantitative analysis and problem "framing", which depends on qualitative analysis. Problem *framing* seeks to understand a focal strategic situation and, through cognitive processes, to develop strategic visions for it. Scenario-driven planning closes the gap exposed by Eden by blending qualitative and quantitative analytics into a unified methodological approach [5]. Scenarios have long been used to support strategic thinking and are a key tool in dealing with "wicked problems" [8]. Real-world policy situations exhibit strategic complexity in that they are composed of many interrelated problems and issues. To be effective, strategies must holistically address the complexity of the situation rather than propose solutions to single problems. Formulating and understanding each situation and its complex dynamics, therefore, is key to finding holistic solutions. A systems approach to problem formulation stresses that single problems cannot be isolated from surrounding messy realities. The messiness of reality requires a shift from problem formulation to *situation formulation* [1]; the analysis of *change scenarios* [10] then allows the design of strategies to be undertaken in the messiness of real situations.

The developed prototype addresses this problem from both an analytical and a process perspective. The analytical capability is embedded in the software and a facilitation model based on dialectical inquiry is used to structure the group dynamics. We are using usability testing as a method for engineering the prototype system in both its software and facilitation components. Usability testing is part of an emphasis on *User-Centered Design* (**UCD**) [9]. UCD is a process that designs the relationship between software or hardware products and their users with an emphasis on how the design enables user-centered tasks. This process is intimately connected to prototype development. It incorporates continuous testing and refinement by users as integral to the design process. Typically, test results reveal shortcomings of the prototype's operation, documentation and interface. This paper discusses the application of usability testing to the engineering of a specific collaboration prototype and the application of USD to develop and refine both the software components and the facilitation model of the tool.

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Contributions to Way of Modeling

ThinkLets as a research lens: the role of the modifier

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Collaboration Engineering is an approach to create sustained collaboration support by designing collaborative work practices for high-value recurring tasks, and deploying those designs for practitioners to execute for themselves without ongoing support from professionals (Briggs et al. 2006). From this approach two key research challenges are explored; the design of collaboration processes and the transition of facilitation skills. The cornerstone of the Collaboration Engineering approach is therewith the thinkLet concept. A thinkLet is the smallest unit of intellectual capital to create a pattern of collaboration (Briggs, et al. 2003a). A thinkLet provides a transferable, reusable and predictable building block for the design of a collaboration process.

The critical success factor in Collaboration Engineering practice and research is predictability of the thinkLets. For research this is because the thinkLet concept makes facilitation interventions comparable (Santanen 2005). For practice, a more predictable process design based on thinkLets increases focus and consequently goal achievement, and it is an enabler of transition of facilitation practices to practitioners.

Predictability of thinkLets can be increased in roughly 3 ways:

- Post-analysis: empirical testing, pattern analysis, best practice (Briggs and Vreede 2001; Briggs et al. 2001; Enserink 2003; Kolfschoten et al. 2004a; Vreede and Briggs 2001). ThinkLets have been documented, and they have been recognized in transcripts of GSS sessions. Furthermore, they have been used and evaluated in several case studies (Alaa et al. 2006; Appelman and Driel 2005; Bragge and Merisalo-Rantanen 2005; Briggs and Grunbacher 2001; Harder and Higley 2004; Harder et al. 2005; Vreede et al. 2005).

- Theory building: Theoretical understanding of the thinkLet intervention and the resulting patterns of collaboration (Briggs 1994; Briggs et al. 2005; Briggs et al. 2004; Briggs et al. 2003b; Santanen et al. 2004). Theory has been developed about satisfaction, productivity, consensus and creativity.

- Rigorous and precise documentation of the intervention according to the thinkLet conceptualization (Kolfschoten et al. 2006; Santanen 2005; Vreede et al. 2006). The thinkLet concept has been developed based on design pattern theory (Alexander 1979), and rule-based interventions that are documented based on insights from artificial intelligence literature on parameterized action representation described by Badler et al (Badler et al. 1998; Badler et al. 1999).

To further develop the predictability of thinkLets we need to make one last big step in thinkLet conceptualization; we need to distinguish basic techniques and variations (modifiers) and we need to understand the effect of each thinkLet rule and variation. On this level of analysis we can really make measurable testable interventions with predictable effects that we can proof theoretically and empirically (Briggs et al. 2006; Kolfschoten and Santanen 2007; Santanen 2005).

The thinkLet intervention is created by imposing a set of rules on the group to help them focus their effort towards a goal. These rules are conceptualized based on rules used in artificial intelligence to offer a parsimonious instruction for an activity of an agent, who we identify based on a role. We can find this conceptualization in the parameterized action representation described by Badler et al (Badler et al. 1998; Badler et al. 1999). The rule concept below in figure 1 is adapted from (Kolfschoten et al. 2006; Vreede et al. 2006).

The rules in the thinkLet are the essential interventions required to create the intended pattern of collaboration and result. The rules specify what participants should do (action) and with which effect. Furthermore rules describe the parameters and capabilities that need to be instantiated for its use. Some rules are conditional; they need to be executed when a specific condition is met.

Modifiers are variations that can be applied to several thinkLets. They consist of a new rule or an alternative rule. Modifiers alter the pattern of collaboration and/ or the result.

We analyzed a set of thinkLets to distinguish modifiers from basic thinkLets and based on this analysis we derived the following classes of effects that can be created or amplified with the use of modifiers:

- Increase of quality; depth, elaboration, specificity or clarity
- Increase of sharing ideas, participation and breath of the exploration
- Increase of efficiency in the process of generating, reducing, building consensus, etc.
- Increase of commitment / agreement among the group members

Each of these effects can be considered an important phenomenon of interest in collaboration science and Collaboration Engineering. Further research is required to measure and compare the effects of modifiers as a research lens, and to increase the predictability of their effects.

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The Research Challenge: Measuring Patterns of Evaluation and Organization.

It is the practice of this workshop to attempt to advance knowledge by posing an intractable, yet important research problem to participants to see whether they can devise an approach that might allow research to move forward. This year, participants were asked to devise ways to measure patterns of evaluation and patterns of organization.

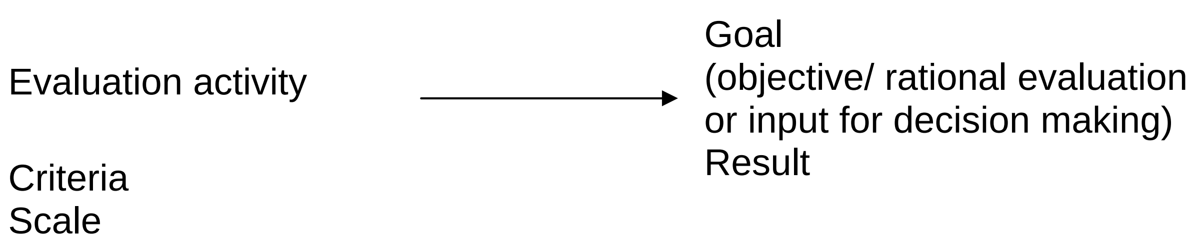
Collaboration Engineering researchers have identified six general patterns of collaboration: generate, reduce, clarify, evaluate, organize, and build-consensus. A great deal of work has been done on ways to measure idea generation a modest amount of work exists on measuring ways to reduce a brainstorming list to the set of concepts deemed worthy of more attention, and on establishing shared meaning. However, little has been done to study patterns of evaluation and organization. This may be, in part, because it has been difficult to conceive ways to measure the effectiveness of an evaluation activity or an organizing activity. *Evaluation* is defined as moving from less to more understanding of the instrumentality of ideas toward goal attainment. *Organization* is defined as moving from less to more understanding of relationships among concepts.

To pursue these research challenges, the workshop divided into two groups, one to work on measurement of evaluation patterns, another to work on measurement of organization patterns. Both groups surfaced issues surrounding the measurement of their respective patterns, and at the end of the workshop, both proposed metrics that could be used for empirical research on these phenomena. Below we report the findings of both.

Evaluation Metrics

This sub-group focused on devising metrics for the quality of a collaborative evaluation activity. We focused on how a researcher might measure the merits of a process or the merits of the deliverable from a group that evaluates a set of ideas based on one or more criteria. For this effort we asked ourselves ‘How can we measure whether a group performed a high quality evaluation?”

We created the following conceptual model



An evaluation activity is targeted to some goal. This goal can be classified as an objective relational assessment of quality or the ideas can be evaluated as input for decision making in which case stakes involved in the outcome of decision making are likely to affect the evaluation activity. The evaluation activity creates a result, which consists of a group-quality indication and possibly a ranking of ideas. The activity uses one or more criteria and a scale for evaluation.

We proposed two sets of metrics to indicate the merits of the process and the merits deliverable of an evaluation activity. These can be classified as *acceptance of the process* and *quality of the ranking*. These approaches have limitations that are common to newly-formed measurement approaches, but they provide a starting point for more rigorous development.

Acceptance of the process can be decomposed in the following aspects;

- Satisfying goal, criteria and scale; if people do not accept the objective of the evaluation or the criteria and scale used in the evaluation activity, the evaluation process and its result will have a low quality

- Validity; if the people that perform the evaluation activity are not knowledgeable or biased, the evaluation process and its result will have a low quality

- Individual instrumentality of method; if the evaluation method that is used does not support the individual to communicate his preference to the group, and to convince the group of the qualities of the ideas of his preference, the evaluation process is less likely to be accepted

- Efficiency/effectiveness/productivity; an inefficient or ineffective or unproductive evaluation process will less likely be accepted

- Commitment to the evaluation results; If people commit to the results, they therewith accept the evaluation process.

Quality of the evaluation results (ranking of idea quality) can be decomposed in the following aspects;

- Domain dependent; for different domains there might be different quality indicators for the result; for instance, an evaluation effort for innovative ideas in an engineering context should result in a ranking that reflects innovativeness and the use of emerging technologies.

- Goal dependent; for a negotiation setting the result can be evaluated on different quality indicators than in an assessment setting (e.g. inclusion of stakes or truthfulness).

- Replicable/ Reliability; if the same group does the same evaluation activity on the same but randomized data set, without viewing or discussing the results, the same ranking should result.

- Expertise held by the panel; if the panel has no expertise with respect to the ideas or the evaluation criteria, the results are not reliable

- Objectivity of judgement; if the panel has a bias towards specific ideas under evaluation the results will not be objective

Organization metrics

The sub-group on the measurement of organizing-activities surfaced a number of issues surrounding the measurement of this pattern of collaboration, and then proposed approaches to measuring its merits.

Issues for Measuring the Merits of an Organizing-activity

The issues raised by the group before they began to devise metrics are as follows:

The Process of Organizing. The process of moving toward a better understanding of relationships among concepts has at least three parts:

- Creating an organizing scheme
- Sorting ideas into the organizing structure
- Validating the sort

It may well be that there will be different metrics for each of these three parts

Validation of the Organizing Scheme. It is not possible to validate or verify that any organizing scheme is "right" or "true." The same set of concepts can be organized in many different ways, limited only by the creativity of the organizers. The value of an organizing scheme must therefore be judged in terms of its utility toward goal attainment, not in terms of its "truth" or "validity".

Purpose of Organizing. Organizing is never an end in itself. The only reason to organize a set of concepts is to make some follow-on activity easier. From a cognitive perspective, it might be that we organize to mitigate the limitations of short-term memory, possibly to create larger chunks or more-elaborated frames of knowledge. Therefore, on approach to comparing organizing-activities is to measure the degree to which people find the follow-on activity easy or hard.

Simultaneity of Patterns. Sometimes groups generate, evaluate, clarify, or reduce at the same time as they organize. Metrics for organizing-activities must allow for measurement of organizing-process and organizing-outcome even when other patterns also manifest during the activity

Structure of Results. The deliverable of an organizing-activity may have one of several structures:

- List
- Ordered list
- Tree
- Network

Metrics of the deliverable must be able to accommodate these differences of structure. Or, alternatively, it may be that different metrics will be required to measure the merits of deliverables with different structures.

Some organization schemes are mandatory, others are not. Sometimes the organizing scheme and the structure of the deliverable are imposed on a task. Other times the group must devise the organizing scheme as a part of their work. Metrics of process and deliverable may be different depending on whether the scheme was mandatory or group-generated.

Different Ways to Devise Organizing Schemes. There are different methods for devising organizing schemes. E.g.:

- Abstraction
- Cluster-and-name
- Decomposition

It may be that metrics for the merits of the organizing scheme will differ by the approach.

Taxonomic vs. Non-taxonomic Schemes. Some organizing-schemes are meant to be taxonomic, such that each concept will fit in one and only one category. Others are not. It may be that metrics of the merits for an organizing scheme must vary by whether or not the scheme is meant to be taxonomic.

Proposed Approaches to Measuring

The group proposed the following approaches to measuring organizing-activities.

- Internal consistency of the organized-deliverable
- Degree to which concepts fit the categories in which they are placed
- Time on task
  - To build the organized deliverable
  - To understand the organized deliverable after the fact.
- Degree of understanding of the organized deliverable by people who use it for the follow-on step
- Risk that the organizing-activity will not produce an organized deliverable.
- Consensus on goodness-of-deliverable
  - Perceived value/utility
- Degree to which organized-deliverable makes the next step better, faster, easier
- Thoroughness of deliverable (breadth, depth)