Journal of Universal Computer Science, vol. 10, no. 6 (2004), 683-690
submitted: 21/1/04, accepted: 22/3/04, appeared: 28/6/04 © *J.UCS*

Facilitating Knowledge Communication through Joint Interactive Visualization

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Abstract: This paper presents further research findings on the use of software-based, collaborative visual communication tools for the transfer and creation of professional knowledge in organizational decision making contexts. The paper begins by describing typical knowledge communication situations and summarizes dominating problems in these contexts. It then reports on the real-life experiences in using three visual knowledge communication tools, namely the OnTrack visual protocol tool, the Parameter Ruler application, and the Synergy Map. The application experiences with these tools in four companies show that they can reduce some of the discussed problems. Their main benefits are focus, coordination, documentation, consistency, accountability and traceability. Their major improvement areas are accessibility and flexibility. Implications for further research and for further tool developments are highlighted.

Key words: visualization, knowledge communication, knowledge evasion, knowledge refusal, knowledge disavowal, joint interaction
Category: H.5.3, J.5

1 Introduction: Examples and Problems of Knowledge Communication

Communicating knowledge is a key activity for today's specialized workforce. The direct and effective transfer of experiences, insights, and know-how among different experts and decision makers is a prerequisite for efficient decision making and co-ordinated, organizational action [Straub & Karahanna, 1998]. Situations of such deliberate knowledge transfer through interpersonal communication or group conversations [Gratton & Goshal, 2002] can be found in various business constellations, as the following typical **examples** illustrate: Technology experts present their evaluation of a new technology to management in order to jointly devise a new production strategy [McDermott, 1999]. Engineers who have discovered how to master a difficult manufacturing process need to convey their methods to engineers in other business units [Szulanski, 1996, 2000]. Legal experts brief a management team on the implications of new regulations on their business model [Wilmotte & Morgan, 1984]. Experts from various domains need to share their views and insights regarding a common goal in order to agree on a common rating of risks, requirements [Browne & Ramesh, 2002], industries or clients. Project leaders need to present and share their experiences of past projects in order to assess the potential of new project candidates [Schindler & Eppler, 2003]. Scientists who work as drug developers

present new avenues for future products that product managers must assess. Market researchers present their statistical analyses of recent consumer surveys to the head of marketing [Boland et al., 2001]. Strategy consultants present the findings of their strategic company assessment to the board of directors in order to devise adequate measures [Creplet et al., 2001]. What these diverse situations all have in common is the problem of knowledge asymmetry [Sharma, 1997] that has to be resolved through interpersonal communication. Such knowledge-intensive communication situations frequently suffer from numerous problems that make reciprocal understanding (or at least partial knowledge symmetry) and knowledge creation difficult. Typical such communication **problems** include *knowledge refusal* due to defensive routines [Argyris, 1990 or Husted and Michailova 2002] and groupthink [Janis 1982], due to information overload [Iselin, 1988], or due to conflicting unarticulated basic assumptions [Isaacs, 1997, Harkins, 1999], or *knowledge disavowal* [Deshpande & Kohli, 1989] due to lacking feedback, because of a focus on minor details, because of personal attacks [Eisenhardt et al. 1997] or due to undisciplined, digressing debates [Harkins, 1999], because of sub-optimal use of meeting time, or because of the smart talk trap [Pfeffer & Sutton, 2000]. A third type of problem cluster is *knowledge evasion* where expertise-based contributions are lost due to inaccessible technical language, implicit misunderstandings, missing overview or context, undocumented contributions, mismatched abstraction levels, mutual distrust or inadequate meeting preparation [for these and other similar knowledge-intensive group communication issues see for example: McDermott, 1999, Sharma, 1997, Straub et al., 1998, Wilmotte & Morgan, 1984].

To resolve some of these problems and improve the communication of insights, experiences and know-how, various visual formats can be applied in co-located or mediated team communication situations. Visual formats have been shown to provide various advantages in knowledge communication, such as making implicit knowledge explicit [Sparrow, 1998] providing overview and detail [Larkin & Simon, 1987] or assisting inference processes [Tversky, 2001; Bauer & Johnson-Laird, 1993]. In order to test and evaluate new ways of visually supporting knowledge-intensive conversations and representing knowledge for improved knowledge transfer [Boland et al., 2001], we have devised three new ways of visualizing the content and the process of group communication. The three tools address central team activities (e.g., goal setting, planning, and rating). They are discussed below.

2 Visual Knowledge Communication Tools

[Card et al., 1999] define information visualization as the use of computer-supported, interactive, visual representations of data to amplify cognition. In analogy, we define knowledge visualization as the use of computer-supported, interactive visual representations of insights, assessments or expert opinions to amplify communication. Knowledge visualization tools can facilitate various group communication and reasoning processes, such as those outlined by [Briggs et al. 2001]:

- **Diverge** – moving from having fewer concepts to having more concepts
- **Converge** – moving from having many concepts to focusing on a few concepts deemed worthy of further attention
- **Organize** – moving from less understanding to more understanding of the relationships among concepts
- **Elaborate** – moving from having concepts expressed in less detail to having concepts expressed in more detail.
- **Abstract** – moving from having concepts expressed in more detail to having concepts expressed in less detail.
- **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.
- **Build Consensus** – moving from having less agreement among stakeholders to having more agreement among stakeholders.

The three tools discussed in this paper enable these collaborative communication and cognition tasks through systematic interactive visualization. Their function and benefits are described and depicted below.

The **Synergy Map** helps to identify and discuss the objectives of a team and their interdependencies in terms of synergies and possible goal conflicts. By aligning all the team's objectives according to their time horizon and importance (the number in front of every goal) the discussion of each goal's parameters can be represented graphically. In this way, goals can be evaluated (in terms of their compatibility) and an emerging consensus can be documented by drawing or labeling lines (see figure 1).

The **On Track Visual Protocol** tool helps to structure the exchange of knowledge into divergent and convergent phases. It represents an abstract view of the sequence of interactions and helps to steer a complex conversation towards consensus. In doing so, it organizes the participants' contributions on a vertical meeting time line. The OnTrack tool thus provides an overview of the process of knowledge communication. In doing so, it shows the main goal of the discussion as well as its most important milestones. It also serves as a instant visual protocol that everybody can see via a beamer or desktop representation (while it is completed by a protocolist), see figure 2.

The **Parameter Ruler** is an application that visualizes the collective evaluation criteria and ratings of a group of experts and decision makers. It facilitates collective evaluations and assessment meetings and allows to explore alternatives together. It makes judgments explicit and combines them visually (see figure 3). The participants of a discussion can instantly change the rating criteria, the attributes, or their rated positions. The consensus is beamed onto a whiteboard, as are changes. The metaphor of a ruler facilitates this process and shows the rating in overview to avoid overload.

These three tools have been used in corporate, knowledge-intensive communication situations, where experts had to exchange and combine their analyses, experiences and assessments to make decisions or take actions. Specifically, the Parameter Ruler has been used in a financial services company, the On Track application has been applied in three companies (financial services, logistics, and

pharmaceutical), and the Synergy Map has been applied in two financial services companies.

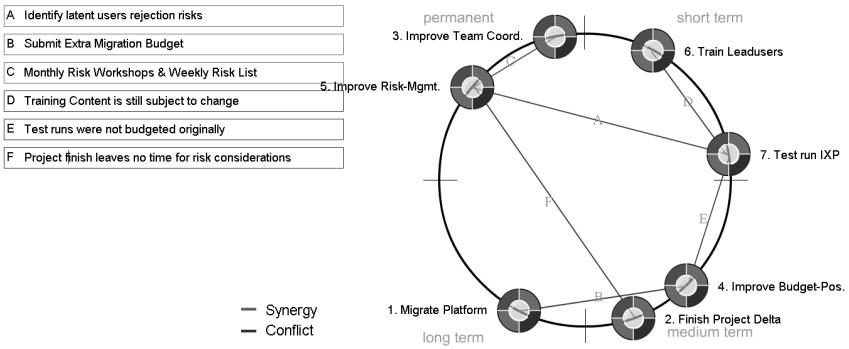

Figure 1: A screenshot of a synergy map

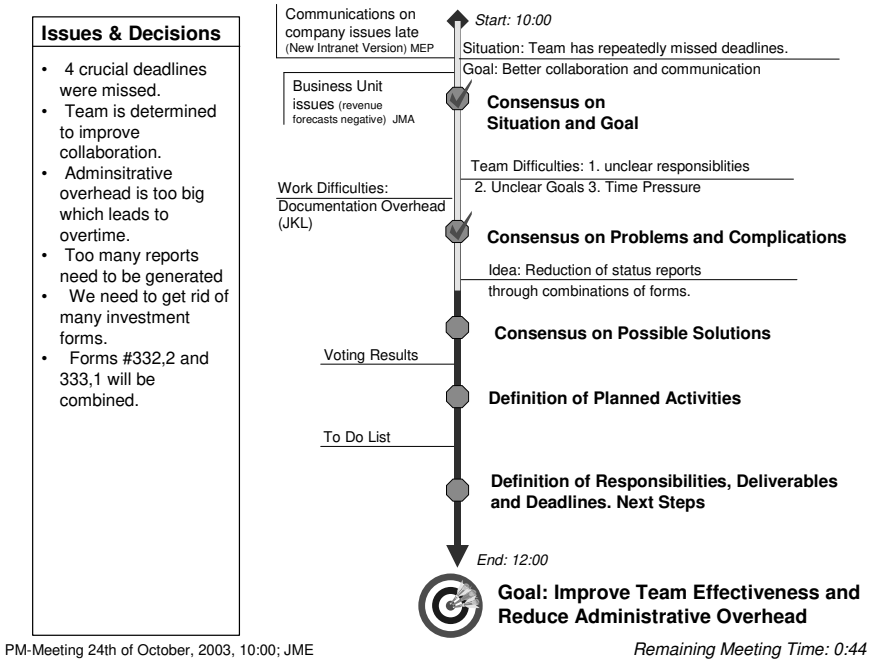

Figure 2: A screenshot of an On Track Protocol

Comparing the three instruments to already existing visualization tools that can be used in group contexts, our instruments tend to be simpler in terms of the scope of functionalities, as each was developed for one specific team situation. They are also more focused in terms of their visual arena (i.e., there is no need for scrolling) and they are more visually appealing or salient than similar applications, such as system dynamics software (which often becomes too complex for group debates), argumentation mapping tools (who also quickly crowd the screen), or mind and concept mapping software whose results tend to be difficult to read by people who have not attended a mapping session.

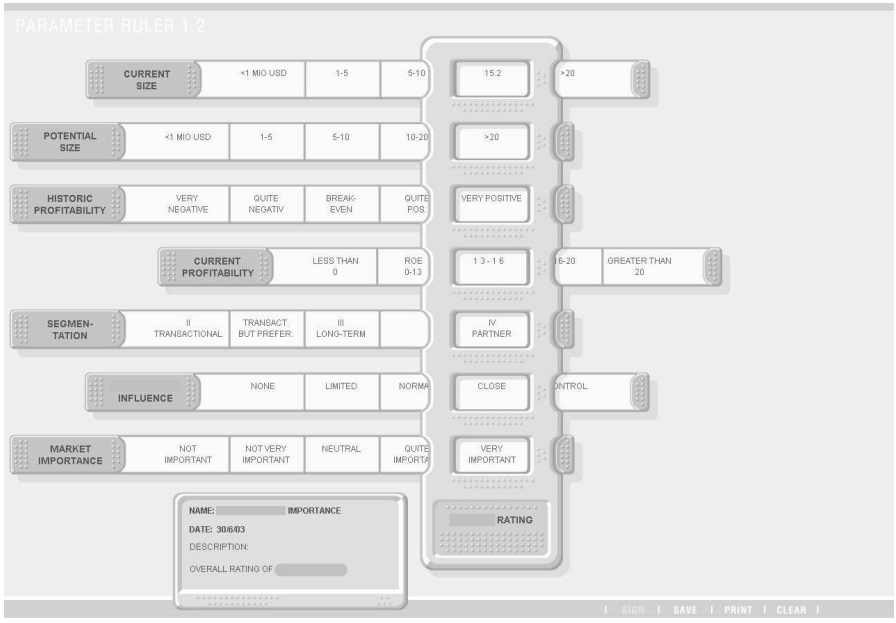

Figure 3: An (anonymized) screenshot of a Parameter Ruler session

The experiences in using these tools to facilitate knowledge communication are discussed in the next section.

3 Application Experiences and Improvement Needs

The use of these three tools in authentic 'high-end' communication contexts shows the potential, but also the limitations of facilitating knowledge transfer through 'instant' interactive visualization. These business contexts were five meetings in which 5 to 20 experts (from various teams) discussed complex issues, such as their activities for the next year, the business terms with key customers, or the development of a new strategy. When interviewed about their satisfaction with the

tools, the (thirty-four) users consistently indicated the following **benefits** of the three tools:

- **Focus**: through their visual, updated presence, the tools focus all participants on the issue at hand. Everybody knows what is discussed and can see the progress of mutual understanding and consensus through the beamed computer image.
- **Coordination**: The tools provide a step-by-step structure to organize the interaction among meeting participants. This prevents circular, unfruitful debates.
- **Documentation**: The achieved results of the knowledge transfer are instantly documented in electronic and printed format. In high-speed environments this saves critical follow-up time (that was needed before to validate meeting minutes).
- **Consistency**: By constantly seeing what has already been shared, commented, agreed or rejected, the participants can make more consistent contributions and comparisons.
- **Accountability**: Because the participants know that their contributions are captured visually and documented electronically, they behave more responsibly and mutual accountability is fostered.
- **Traceability**: After the interaction, the tools allow to re-construct the interaction and the flow of ideas. The development of an argument can be better understood, even if one hasn't participated (by 're-playing' the conversations in the meeting).

The mentioned benefits thus mainly address problems associated earlier with the term *knowledge evasion*, while having only minor effects on knowledge refusal or disavowal. In these first tool tests, we have chosen the interview format for evaluation (rather than surveys) in order to gather more qualitative (background) information on the perceived benefits and drawbacks of the tools. These in-depth comments (together with participatory observation) allow for a more rapid improvement of the tools than the more closed format of a follow-up survey which will be necessary in the next phase of tool evaluation.

With regard to **improvement needs** the users indicated that the tools' visualizations were sometimes not optimally *accessible*. This was due to sun light that interfered with the beamer projection in the meeting room or it was due to the difficult readability of the font in large meeting settings. A further improvement need that was repeatedly voiced by the practitioners who used the tools was their *flexibility*. As the tools were designed for specific knowledge communication situations (such as collaborative goal analysis, rating clients, or documenting meetings), they sometimes could not handle ad-hoc discussions that served other purposes. An example for such flexibility would be to add other elements besides goals to the synergy map or to be able to switch the vertical order of the sliders in the Parameter Ruler.

4 Conclusion

In conclusion, and based on a very limited sample, we confirm that interactive visualization tools offer great potential for the improvement of (synchronous) knowledge communication. However, the three tools mainly address knowledge evasion problems. Future research should focus not only on tools that address

knowledge evasion or support tasks such as converging, evaluating, organizing or consensus building, but also facilitate criticizing, elaboration and abstraction tasks. Another future development task concerns one of the key success factors of the tools, their simplicity. While their simplicity is crucial for the acceptance and use in management groups, it limits the flexible use of the tool and the accommodation of ad-hoc changes in team communication. To overcome this trade-off between simplicity and flexibility, a larger set of simple tools must be developed in order to cover a greater range of team knowledge transfer situations. In terms of methodology, future tool testing should not only rely on follow-up interviews with participants, but also employ survey instruments to allow for statistical analysis of the achieved results.

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