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Collaborative Sense-Making in Design

Involving Stakeholders via Representational Morphing

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KMI-TR-74

January, 1999

Submitted to ECSCW'99

The Open University

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A central concern in CSCW research is to understand, and represent, the perspectives of the different stakeholders in the design process. This paper suggests *collaborative sense-making* as a way to view the process toward creating mutually intelligible representations. In order to do this, we describe the types of obstacles that can impede *representational literacy* across communities of practice coming together in a design effort. We then offer *representational morphing* as a strategy for addressing these obstacles, and show how it has been implemented in an approach and hypermedia groupware environment named *Project Compendium.* We conclude by reflecting on the key features of the approach and collaborative tool support which have contributed to this project's success to date.

Introduction: representations in CSCW design

A central concern in CSCW research is to understand, and represent, the perspectives of the different stakeholders in the design process. CSCW design has therefore been strongly influenced by approaches which seek representational schemes that are accessible and useful to designers, programmers, and different user communities. Designing *mutually intelligible representations* which can meet the requirements of such diverse groups is a key challenge for CSCW. Robinson and Bannon (1991) have analysed why and how the meaning of representations will invariably 'drift' as they were passed between different design communities, whilst many others have sought to develop representations which bridge between end-users' and designers' perspectives (e.g. Blomberg and Henderson, 1990; Chin and Rosson, 1998; Muller, 1991). .

This paper suggests *collaborative sense-making* as a way to view the process toward creating mutually intelligible representations. In order to do this, we describe the types of obstacles that can impede *representational literacy* across communities of practice coming together in a design effort. We then offer *representational morphing* as a strategy for addressing these obstacles, and show how it has been implemented in an approach named *Project Compendium*. We conclude by reflecting on the key features of the approach and collaborative tool support which have contributed to this project's success to date.

Representational literacy

Representations of a future system must be not only understandable (*readable*), but constructable by the stakeholders themselves (*writeable*). In this practical sense, the concept of *representational literacy* is useful, and will be used to explore some of the obstacles to the creation of intelligible representations.

'Literacy' has a vast research literature of its own which cannot be reviewed here. However, a number of concepts from literacy theory are particularly relevant to the current discussion. A good introduction to the field is provided by (Barton, 1994), who provides the definition that "a literacy is a stable, coherent, identifiable configuration of practices". In his review of the literature, he argues that 'discourse communities' share common texts and practices, that meaning is located in the interactions between writer, reader and text, and that literacy is the ability to write and read different genres of texts within the relevant discourse communities. A similar picture emerges from Wenger's analysis of 'communities of practice', who are identifiable by the ways in which they balance processes of *participation* (social interaction and interpretation) and *reification* (conceptual language and representational objects and strategies).

Contextualising this to design, Isenmann and Reuter (1997) point out that design is an inherently divergent process, where different communities have different interests. As they move toward an "anticipated state in the future," each community complicates the overall design discourse by adding their own discourse of communicative styles, concerns, assumptions, and relationships. Each group's processes of participation and reification must be combined with the others involved.

Members of different communities are always bound by the contingencies of their present situation, in ways they are only partially sensible of. These bindings affect their senses of what is possible, what is good, what is harmful, and what is unworkable. Similarly, each community has its own desires of transcending those contingencies by creating some future state, or some portion of them. Different communities are aware of different contingencies and the (possibly negative) consequences of addressing them, as well as they are aware of potential transcendences and the benefits they imagine will accrue from their realization.

To summarise, representations only take on meaning when they come to be *used*, typically within one or more communities, who evolve conventions for reading and writing—interpreting the world in terms of their representational schemes, and subsequently interpreting these in future contexts. In principle, different communities could use what is ostensibly the same notation in different ways—they have evolved different 'literacy practices'. The challenge we address in this paper is to try and facilitate integration between representations designed by different communities in the face of the inherent obstacles to such integration. We identify three obstacles next: community-specific literacies, representational politics, and decentered communication.

Obstacle: Community-specific literacies

The different communities in system design have their own professional literacy practices which naturally create communication barriers to other communities. Developers, particularly of large scale systems, use a variety of representations to formally specify behavioural properties (e.g. using mathematical/logical notations; fault tree diagnoses), track information flow and dependencies (e.g. Entity-Relationship and Data Flow Diagrams, State Transition Networks), and so forth. CSCW developers of small to medium systems are unlikely to use as many formal representations of system behaviour as those, for instance, in a large, safety critical system, but their perspective is nonetheless that of implementors, working with abstracted, information-centric models of the work practices to be supported. In contrast, a domain expert/end-user needs representations with obvious correspondences to documents, processes, tools, people, times and places in their work in order to understand the implications of the future system.

Obstacle: Representational politics

Who and what gets to be represented in any situation where there are multiple agendas and interests is tied to who has the power to represent. "History", so the adage goes, "is written by the winners". To have a voice, one must be given appropriate opportunities to speak, which in design requires that those controlling the design process make the space for different concerns to be heard and represented from the requirements analysis stage onwards.

In a CSCW context, Bowers (1991) has set out a number of respects in which all formalisms can be considered political, whilst Suchman (1993) has argued that a CSCW system that imposed the requirement to categorise communicative acts had unavoidably political dimensions. In the context of medical information systems, Bowker (1997) has critiqued the systematic forgetting and silencing effect that technology can have on the visibility of tacit, hard to codify expertise, whilst Buckingham Shum (1997) has considered political dimensions to knowledge management technologies.

Just as early book literacy was actively restricted by powerful institutions, the representational literacy of more powerful design communities (typically developers) by definition excludes others. If the will is not there to present and reconcile these with other community's representations of the system, even possessing literacy within the developer community will have little impact

Obstacle: Decentered communication

Development of, and discussion about, representations usually occurs under a set of conditions that affect both individual and group communication processes. At least in industry settings, collaborative design sessions often occur in group settings, such as formal or informal meetings, under time and deadline pressure, with semi-understood external constraints (regulatory issues, management imperatives, and the like), internal tensions, and power struggles impinging on the ostensible subject at hand. In many cases, the rush to make decisions and develop solutions and designs—products—means that little attention is paid to developing a shared understanding of the problem space and constructing consensual definitions (Weick, 1993; Weick, 1995). Many participants have limited understanding (and even sheer incomprehension) of portions of the problem space, such as the subject matter, technical issues, political pressures, or factors in the external environment. There is typically more than the printed agenda riding on the outcome, and even the process, of such meetings.

Added to these pressures is the emotional dimension (under-developed in the participatory design and CSCW literature); people in organizations have feelings and emotions about each other (as individuals and as members of “other” groups) as well as about the issues they're discussing. In addition, some people are good at articulating ideas and comments about representations in such meetings; others are not, and thus unable to contribute effectively at the time representations are created, modified, or discussed. All these factors contribute to a decentering of people's communicative, which create obstacles to the development of mutually intelligible representations that will enable development and realization of the desired future state.

These obstacles can be understood as the (often unspoken) questions that people ask, or that they are troubled by, during the course of representation development. These include:

- "Why are we doing this?"
- "What am I here for?"
- "Why do they insist on (calling W what I know as X/saying that we need Y/ignoring our requests for Z)
- "How is this helping me achieve my (group's) goals?
- "Why do we have to do this in this manner?"
- "How is what we're doing contributing the project's overall progress?"
- "Why aren't my concerns getting put up on the board?"
- "What do these terms mean?"

Current approaches to tackling these obstacles

Much work has been invested in the last decade within the human-computer interaction, participatory design and CSCW communities towards developing representations of work practices and designs which can assist domain experts communicate with the software experts who are building support technologies. Three approaches are briefly reviewed below, reflecting different approaches to creating design representations that are accessible to moe than one stakeholder group.

One approach is to require requirements engineers/other designers to give up their representations, and view the world from end-user community's perspective. Radically different representational tools from those commonly used by developers would include the PICTIVE approach (Muller, 1991), which uses plastic icons of domain objects (e.g. desks, people, whiteboards), which can be moved around a floorplan in a meeting of many different stakeholders in order to understand how work is, or might be, accomplished. The time/space limitations of the physical scheme were subsequently addressed by creating a TelePICTIVE groupware system (Miller *et al.*, 1992).

Another example is exemplified in scenario-based design, for instance (Chin and Rosson, 1998). Here, the representation of the future system's behaviour is a rich, textual description by prospective end-users as they imagine tackling real tasks using the system; descriptions of system behaviour are embedded in familiar settings to the domain expert. The concrete nature of the scenario descriptions helps to bring to the surface implications for requirements as scenarios are discussed by different stakeholders. There are systematic ways in which designers can then move from scenarios to design decisions.

A second approach is to devise an intermediate representation which is accessible to both communities. This necessarily hides detail from each community's perspective that would confuse outsiders, seeking a common level of detail that all can recognise and discuss. Leigh Star (Leigh Star and Greisemer, 1989) calls such representations boundary objects (see also Kuutti, 1998). An example of this is to construct graphical design spaces showing the key questions under debate, and the tradeoffs between design ideas against key design criteria. The QOC (*Questions/Options/Criteria*) scheme was used to bridge firstly between cognitive user modellers and formal system modellers in analysing designs (Bellotti *et al.*, 1997), and secondly as a way to communicate the results of such modelling back to the designers (Bellotti *et al.*, 1995). Naturally, the abstraction and refocusing work performed by such representations has strengths and weaknesses. Whilst providing common ground in discussions, interpretive and explanatory work is still required from different communities to understand the true complexity of a perspective when summarised in a few terse words. Such boundary objects can also be used as indices into more detailed design documentation.

The approach we describe reflects the communities involved in our project to date. The primary representation is graphical maps of linked nodes, which are clearly more abstract than PICTIVE's icons/maps. In general, each node represents a single concept or object in the world, which is a finer granularity than the narrative text paragraphs in scenario-based design. The decomposition of the world into such 'knowledge elements' makes possible a number of representational strategies that we will describe shortly. Crucial to this discussion, it enables the transformation of one community's scheme and mode of working into another's, what we term *representational morphing.*

Understanding the obstacles in terms of collaborative sense-making

Developing and applying representations, whether they are mutually intelligible or not, always happens in a context of shifting and multiple *sense-making* (SM) efforts (Dervin, 1983). Everyone involved is engaged in their own SM effort. There are not only gaps in the languages, frames of reference, and belief systems that people in the different communities of practice have, but gaps between their respective SM efforts—their problematics in the representational situation are different. In many cases, different communities have mutually unintelligible SM efforts, leading to mutually unintelligible representational efforts.

Weick (Weick, 1993) calls for "sensemaking support systems" that can aid the process of constructing "moderately consensual definitions that cohere long enough for people to be able to infer some idea of what they have, what they want, why they can't get it, and why it may not be worth getting in the first place." SM itself is largely tacit, even to the individual. In many situations there is so much going on that participants aren't aware that they are trying to make sense of the situation, let alone that the ways in which they are trying to make sense are not the same as those of other participants.

Dervin's (1983) model of individual sensemaking posits that a person is always attempting to reach a goal, or set of goals. The goals themselves shift in time and place. Some are tacit, some are explicit; some are conscious, some are unquestioningly assumed or inherited. Individuals will continue trying to reach the goal until they are impeded by some obstacle. This obstacle stops their progress and stymies their efforts to continue. In order to resume their progress, they need to design a movement around, through, over, or away from the obstacle. The actions they take at the moment of confronting the obstacle are *sense-making actions*, which can be understood as attempting to answer a set of questions: What's stopping me? What can I do about it? Where can I look for assistance in choosing/taking an action

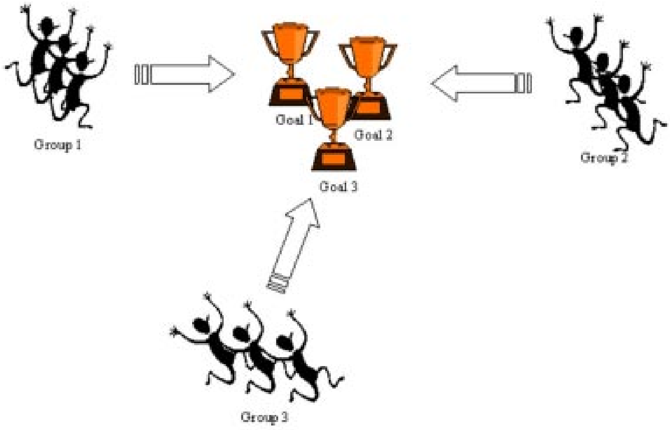
The following depicts the individual sense-making process:

1. An individual is always attempting to reach a goal;
2. Obstacles interfere with the individual's progress;
3. The individual figures out how to deal with the obstacle, often through communication with others;
4. Having surmounted, avoided, or otherwise dealt with the obstacle, the individual continues on their way, making progress towards their goals(s).

In systems development contexts with multiple groups involved, multiple stakeholders, as well as multiple individuals within the various groups, the problem is compounded, because all the groups and individuals involved are engaged in their own (overlapping/conflicting) sense-making efforts.

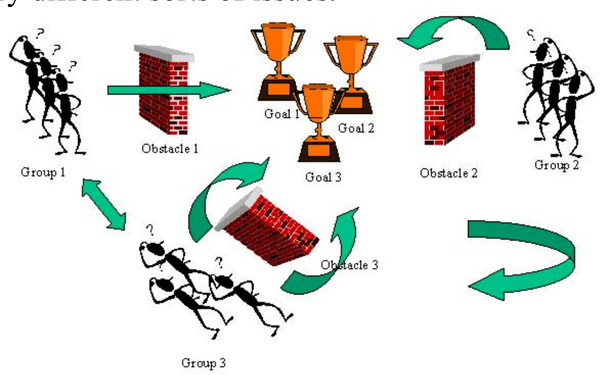
The following four pictures depict this collaborative sense-making process.

1. Each group is always attempting to reach its goal; the goals themselves are sometimes shared, sometimes divergent. There is no unitary goal. The groups may even think that their separate goals are the same. Group 1 believes that Group 2 is happily trying to achieve Goal 1, which is even called the same thing ("The XXX Project"). In reality Group 2 is trying to achieve Goal 2, which means something different to it even though it has the same name.



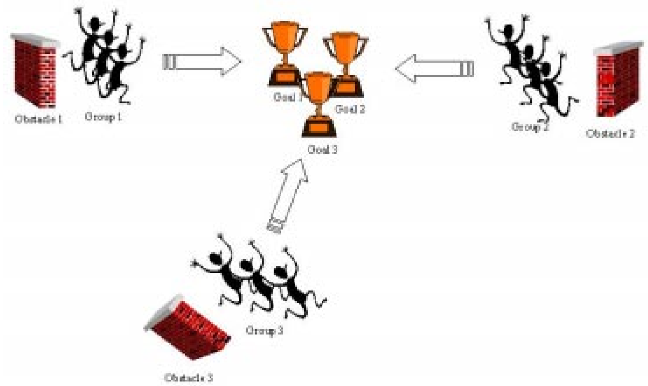
2. Obstacles interfere with each group's progress. The obstacles appear for the different groups at different times, in different forms, at different levels of comprehension and articulation.

3. Each group attempts to find ways through, around, over, or away from their own obstacles. They communicate with each other and with members of other groups; this either helps them along or hurts their efforts. Like the appearance of obstacles, the attempts to overcome obstacles are happening at different times for the different groups, at different levels of granularity, and often concerning very different sorts of issues.



4. The groups, assuming they have been able to gather good information, communicate effectively, and make decisions, continue on their way, making progress towards their goal(s). However, the goals are still not well understood by the different groups, and it is unlikely they have developed any degree of

shared understanding.



Representational morphing

We have introduced several perspectives that together provide a vocabulary for describing the process of collaborative sense-making in which we have been engaged in software design, and which our approach is designed to support. *Literacy, politics, boundary objects* and *communities of practice* are the concepts by which we are coming to understand *representation* as a *collaborative sense-making* process. The act of representation *always* occurs in a contested, shifting, terrain of multiple sense-making efforts. Consequently, tools are needed to help each community see and appreciate each other's goals, obstacles, and strategies; to learn from each other, as opposed to a simplistic model that all that is required is to retrieve, represent and integrate domain knowledge. Tools can help each community to understand elements of other communities' literacy strategies, and incorporate them into their own.

We propose *representational morphing* as an approach to the design of such tools. Representational morphing is the ability to transform a representation, or elements of a representation, at any moment, with little or no delay, in order to respond to the sense-making requirements of one or more of the communities involved in a design effort. By doing so, the different group can read and/or write the representation according to their own literacies. Representational morphing further supports the ability to incorporate these new writings and transform them into other forms or contexts to aid in the sense-making efforts of the other involved communities.

Two broad requirements have guided Project Compendium 's development:

- **Representational consistency:** representations sometimes need to be consistent, template-based, cross-referenced with earlier efforts and/or those by other teams. We contend that this supports group dynamics within and across communities of practice, information reuse, and critically, automation of representational morphing.
- **Representational malleability:** representations sometimes need to be ad hoc, breaking from a predefined scheme, in order to respond to an

emergent communications need—a situational need to create a representation that helps bridge a boundary between two communities.

The Project Compendium environment

Project Compendium (Selvin, 1998; Selvin, 1999) is a system that knits together off-the-shelf tools and documents to create a customized environment for collaborative project work The system provides the capability to convert the elements of various types of common documents (email, word processing, spreadsheets, etc.) into nodes and links in a hypertext concept-mapping tool, create associations between those elements while preserving the original set of associations in the source document, and export the associated elements in new documents. In addition, Project Compendium prescribes a set of techniques that can be used within the off-the-shelf tools themselves to add keyword coding and labeling schemas that allow the cross-referencing of ideas and elements from the different sources within the hypertext tool, as well as a set of representational forms that allow groups to do collaborative modeling using hypertext representations.

The system supports a wide range of project activities, including issue-tracking, modeling, planning, analysis, design, and other project management tasks. The system also supports facilitated group planning and modeling sessions, conducted either face-to-face or over a network. To use the system, groups must define the types or categories of information they are interested in and then create a number of "templates" embodying these categories that can be used by the various tools involved. Documents loaded into or created within the system are then represented as collections of nodes and links corresponding to the relationships between individual ideas (for example, each paragraph in an email is a separate node, linked to a node representing the subject of the email). Once available to the hypertext database in this manner, the individual nodes can be linked to any other nodes in the database through associative or transclusive[1] links. For example, individual points in a meeting minutes document can become "action item" nodes that then reappear in lists of assigned action items to project members, elements of design models, items in a test plan, and so forth.

Project Compendium facilitates both formal model-building and unstructured, exploratory, and informal conversation. The approach is unique in the degree to which it integrates both dimensions in a single software environment.

The approach has been used in more than twenty software development, business process redesign, and other projects at Bell Atlantic, as well as with

1 Transclusive links were first proposed by Ted Nelson as a hypertext mechanism to ensure the integrity and ownership rights to nodes that are embedded in other nodes. A modification within PC is that a node's title/content can be edited from *any* of the views pointing to it (there is no privileged view), and is immediately updated in all other views.

community organizations, software companies, and research groups to support a variety of collaborative analysis efforts. Project involvements have ranged from small software development teams of two to five people to large process redesign efforts involving dozens of participants in both large group meetings and small sub-group work sessions. Project durations have ranged from several weeks to more than two years (one current software development project team has employed Project Compendium continuously since its onset in 1996). Database size range from hundreds to more than ten thousand nodes, many of which reappear in many contexts in the database.[2]

Representational morphing in Project Compendium

Project Compendium employs a variety of representational morphing strategies to facilitate collaborative sense-making amongst participating communities and their members. Two will be discussed here: transformation of template-based concept maps into developer-oriented representations such as data flow diagrams (DFDs) and review documents; and rapid recombination of knowledge elements for ad hoc, opportunistic collaborative representational activities.

Morphing of template-based concept maps into DFDs and review documents

One of the central aspects of Project Compendium is the ability for users to define the types or categories of information they are interested in and then create a number of "templates" embodying these categories. Templates follow a question-and-answer format. Questions are drawn from the categories, or attributes of categories, of interest, while the expected answers conform to the rules established for that category or attribute. Figure 1 shows the general form of templates in this technique. Some Project Compendium questions and templates are derived from structured modeling approaches, while others grow out of immediate and/or informal concerns participating groups. For example, in one project which used Project Compendium, questions about objects and their attributes were inspired by formal object-oriented analysis (Coad and Yourdon, 1991; Jacobson, 1992) and questions about organizations and roles were originally based on elements of the CommonKADS Organization Model (de Hoog; Kruizinga and van der Spek, 1993) Questions about problems and opportunities in the domain, however, were generated spontaneously by members of the participating groups themselves, in response to domain-specific issues.

2 Detailed quantitative analysis of Compendium's use remains to be conducted. However, to give an indication of scale, from December, 1996 – January, 1999, the FMT project database has 11,833 nodes in 582 views. 13 users are registered within the system, but this does not reflect the number of participants in meetings facilitated and recorded by the tool, who would numberapproaximately 40-50.

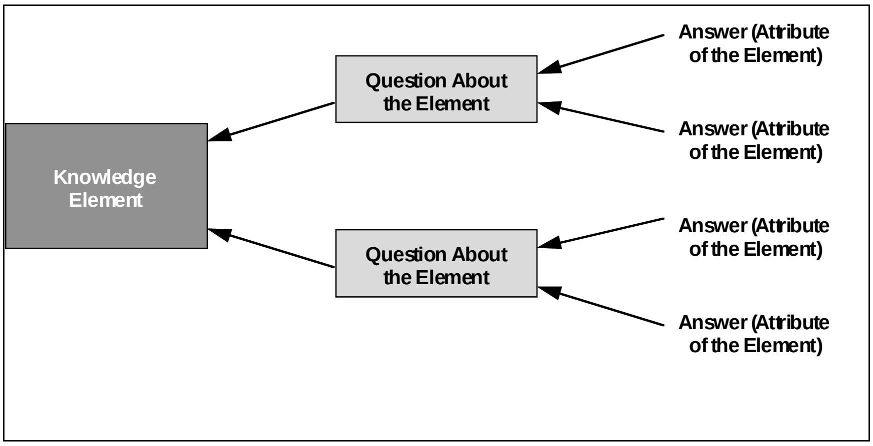


Figure 1. General form of Project Compendium templates

It should be noted that the predefined templates are *suggestions* for which combinations of questions and attributes “belong” to model elements for the various model types. How closely a particular team must hew to the templates is a function of the time available, goals, preferences and skills of the participants. Adding ideas, attributes, or questions that don’t “fit” with a predefined template but which are important to the team during a session is part of the value of the approach.

In the following example, a process redesign team composed of representatives from various engineering departments has created a map of one activity of a new design for the Central Office Capacity Creation process, a complex business process composed of more than seventy distinct activities (Figure 2). Elements depicted on the map fall into two categories: questions corresponding to a template developed by the project’s Core Team, and answers gathered in collaborative sessions. The nodes representing answers were themselves drawn from “browser lists” of answers that other sub-teams gave to similar template-based models in other sessions. When the team constructing the map below decided that, for example, the engineering data item called “Installation Details/Specs/NDO” was to be an input to the “Build Assignable Inventory” activity, they chose the icon representing that data item from a browser and pasted it into the current activity. By doing so, subsequent users can right-click on that icon to see all the different activities (maps) in which the data item appears.

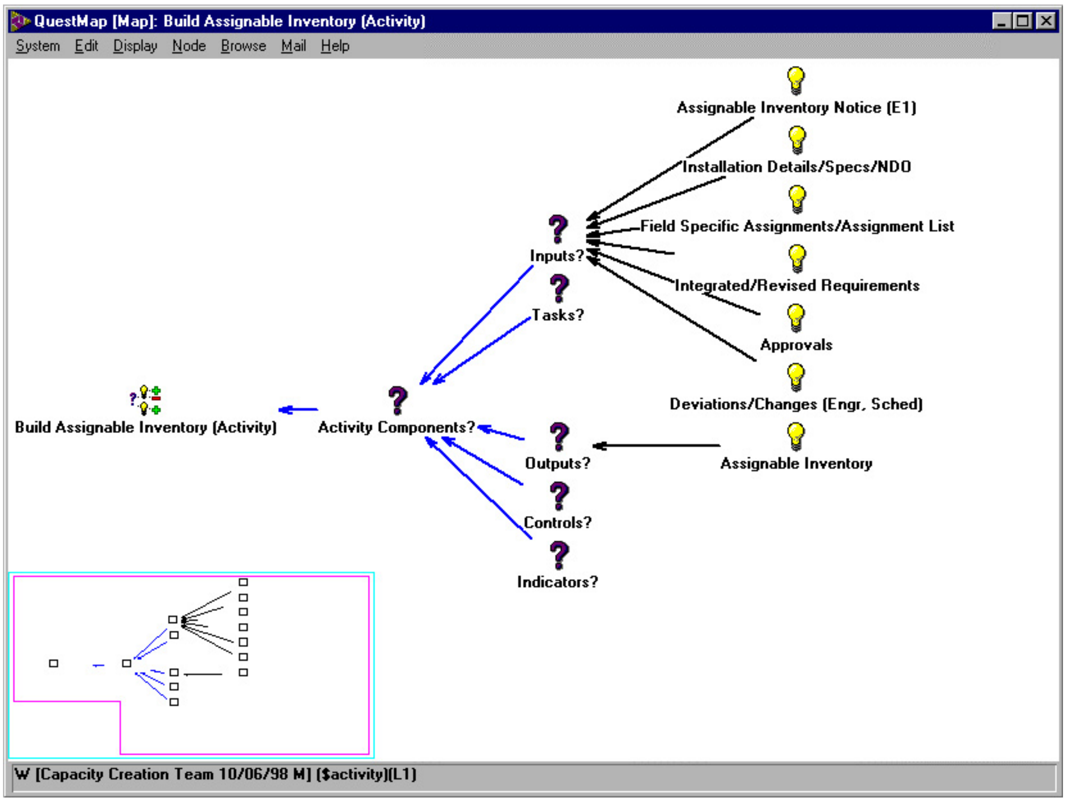


Figure 2. Concept-map style representation for group analysis for activity "Build Assignable Inventory"

This concept-map type representation, while useful to the analysis teams working in group sessions, was not the best representation for two other communities involved in the effort: software development teams accustomed to working with representations like data flow diagrams, and teams of managers approving the redesign, who were more comfortable reviewing "books" in a familiar format.

Project Compendium allows generation of both formats without additional user work or time delay. In the example below, a data flow diagram was generated from the above concept map (Figure 3). Note that questions and other material unnecessary for this type of representation are abstracted away in the diagram (the software recognizes components of the template and creates diagram elements according to predefined schema for data flow diagrams).

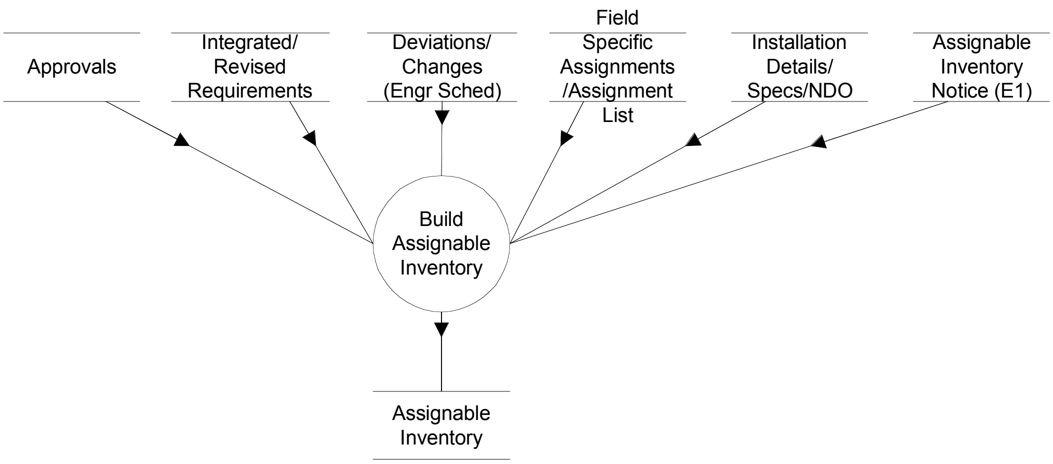


Figure 3. Data Flow Diagram generated automatically from Figure 2

Rapid recombination of knowledge elements for ad hoc representational activities

This second example of representational morphing shows knowledge elements originally developed in late 1996-early 1997 as part of a requirements analysis effort for a systems development project. The map below shows a high-level overview or collection of maps containing the requirements specifications for the various modules of the system (Figure 4).

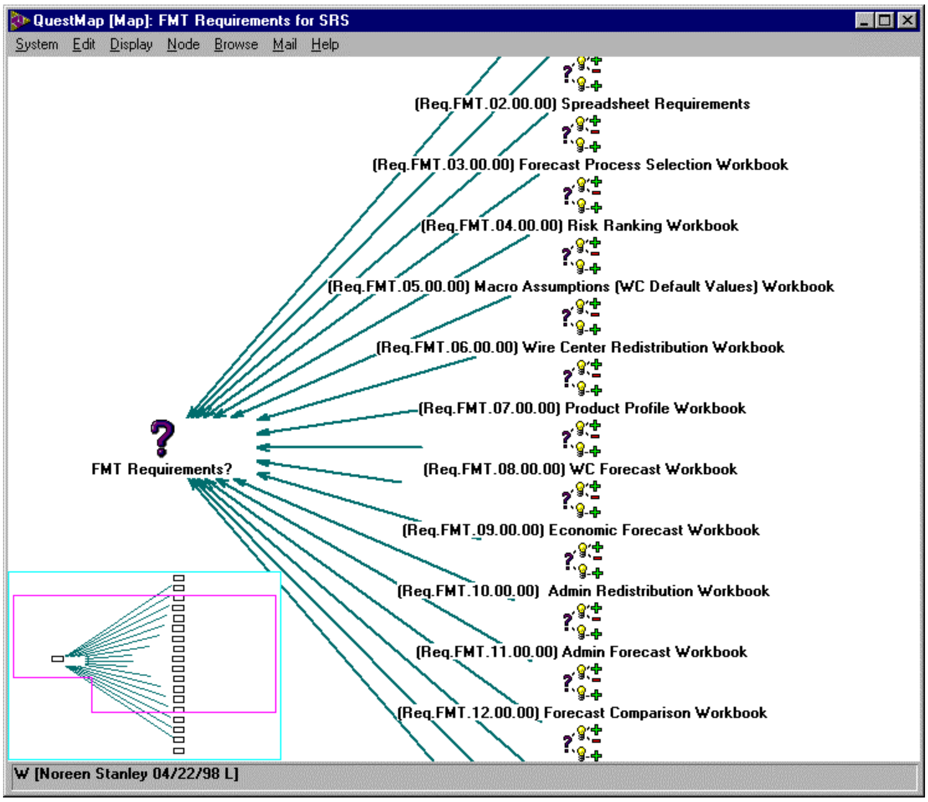


Figure 4. Overview of requirements specifications (represented as map nodes)

Each of the map nodes could be opened (Figure 5) to reveal the nodes representing the detailed requirements for that module (each node could itself be opened to display further information about the particular requirement).

Eighteen months after the original requirements had been developed, the project leader gathered the map nodes representing the discrete groups of requirements on a new map. This was used in an interactive session with the project's Core Team of users and customers to prioritize development for the various modules of the system.

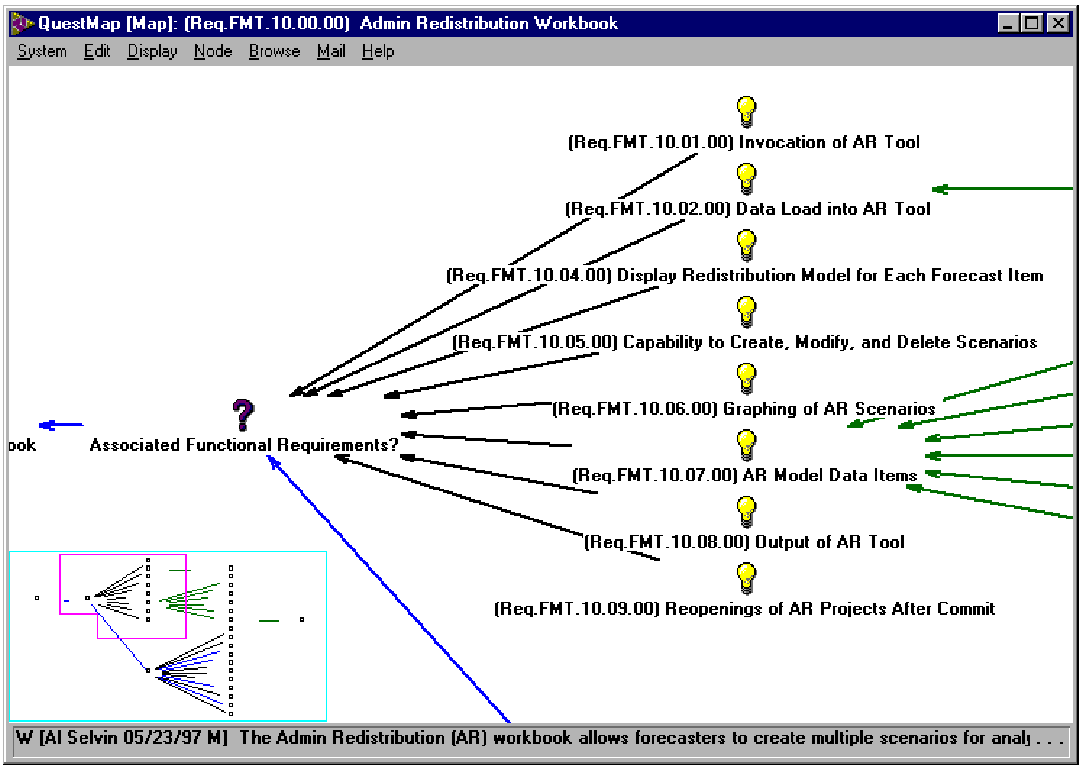


Figure 5. Contents of a requirements specification map (from Figure 4)

The maps below show the result of the work done in that session. With the map displayed in front of the group with an LCD projector, the project leader first facilitated a general discussion of issues pertaining to the various requirements up for consideration for inclusion in an upcoming software release. Following this discussion, the group manipulated the horizontal order of the icons representing the various modules to indicate the priority order for development. As part of the prioritization exercise, individual map icons were opened to display both the original requirements and any additions and modifications that had been made between the original creation of the requirements node and the mid-1998 meeting (Figure 6).

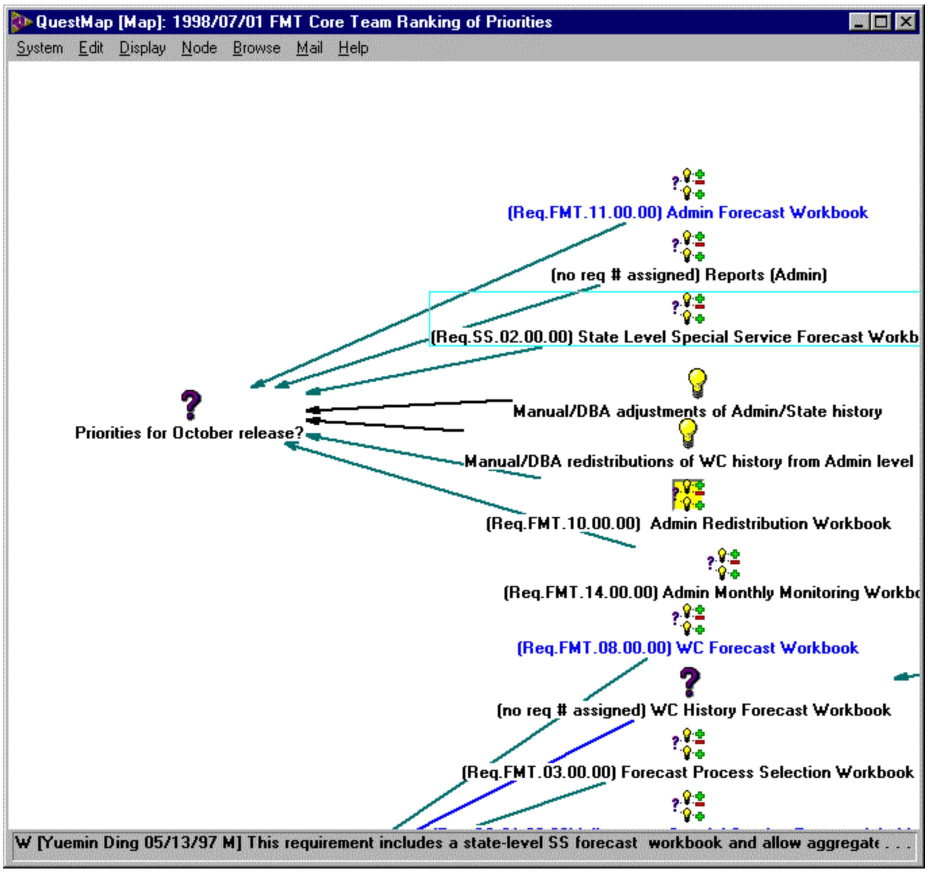


Figure 6. Map showing ranking of priorities

This allowed the members of the Core Team, many of whom had not been involved with the original requirements analysis effort, to get immediate access to background and reference information (contained in the contents of the requirements nodes), hold discussions about the individual requirements as they related to their present concerns, as well as perform their prioritization task, all with a few mouse clicks, with no time delay to create the various representations involved.

Discussion

Why has Project Compendium been successful to date? In the light of the conceptual perspectives intrduced in the first half of the paper, we are able to understand several key features that distinguish the Project Compendium approach.

Templates and communities of practice

Wenger (1998) has argued that a characteristic by which a community of practice can be recognised is its repertoire of representational tools and genres; drawing on literacy research, we might reinterpret this as its ‘literacy practices’, which can exclude as well as include. Representationally, this can manifest in the form of media templates which reify the particular concerns that the community typically brings to a particular kind of problem. Templates which are themselves the products of group practice and reflection are therefore a powerful concept to support in a sense-making tool. Templates provide starting points for discussion, helping groups to avoid the paralysis of the “blank page” effect—they can see how and where they are supposed to contribute to the project. Furthermore, they make a portion of at least one of the groups’ SM strategies, as reified in the templates, visible and explicit to the other groups.

Reading and writing: instantaneous shared display

It was earlier noted that representational literacy and politics are intertwined. It is critical to provide space for stakeholders, who must also be literate themselves, not dependent on someone else to express their views. A sense-making system that supports the integration of different knowledge communities perspectives faces the challenge of representational integrity—how to record diverse perspectives to the mutual satisfaction of all stakeholders? An ideal requirement from this analysis is that there should be no delay between writing and reading, that is, between the articulation of an idea and feedback as to how it has been recorded (Conklin, 1996 discusses the principle of the ‘shared display’ in more detail.) If this requirement is met, the power of the writer is now distributed amongst all present, who take responsibility for owning what is entered. This is very different to the frustrating situation where someone might record an idea in one form on an easel sheet, only for it come back in a different form possibly days later, with different abstractions and meaning, in a diagram printed from a specialised modeling/diagramming tool that is conceptually and temporally divorced from the role it played as a ‘living’ element in the meeting.

Neutral representational medium for sense-making questions

Project Compendium provides a relatively “neutral medium” for the articulation of ideas. By this we mean that there is a ‘good faith’ effort to represent all that is said by members of the different communities; even if its relevance to the immediate issue is not obvious, it should be captured and made part of the shared display, and group memory that is constructed as a by-product. Conklin (Conklin, 1998) characterises the spectrum between *transcribing* what is said and *interpreting* it, which usually involves distilling. Distilling/shortening is acceptable as long as representational integrity (as judged by the idea’s owner) is preserved. A representational sense-making tool should have the ability to represent issues and ideas even when they do not immediately fit the predefined format. This legitimises the posing—and representation—of sense-making questions (Dervin, 1983) such as “why are we doing this?” or “are we at the right level?”

Affordances for provoking active remembering/reconstruction

Project Compendium can clearly be understood as a group memory system, designed to be tailored by different communities of practice. (The community of practice seems to us to be a better unit of analysis for analysing how to support organizational memory than the corporate-wide level, which requires simplistic abstractions over very different communities.) It should be clear from the principles underpinning Project Compendium that we concur with Bannon and Kuutti (1996) in viewing a group memory system not simply as a ‘bin’ into which ‘knowledge’ is deposited, but that ‘group remembering’ is an active process of interpretation, in which meaning is reconstructed from representations in a particular context, for particular ends.

Many hypermedia/IBIS-based systems have been proposed as support for the reuse of past ideas, but there is relatively little evidence of this reported in the research literature to date (although see (Conklin and Burgess Yakemovic, 1991) for one example). Project Compendium assists this process by making it easy for participants to reuse knowledge elements (nodes) from previous maps in the present context. Intelligibility is aided by on-the-fly cross-validation of what is being entered, by asking for instance: “It sounds like what you are calling ‘budget reconciliation’ is what Tuesday’s group called ‘book closing’—do you want to use that icon here?”

Grounding use in templates provokes useful questions such as “what template elements should we use?”, provoking appropriate reflection on how the current context relates to past problems.

Future work

Future work will include a deep contextual analysis of how representational morphing has aided collaborative sense-making in situated project team use of Project Compendium. This will aid in the further development of the Project Compendium toolset. As the examples in this paper indicate, work to date has been done with using GDSS, Inc.’s QuestMap™ product as the collaborative hypermedia environment and data repository, along with a number of small helper applications written at Bell Atlantic. However, driven in part by the desire to integrate representational morphing capabilities in ways that QuestMap can not easily be made to support, Bell Atlantic is currently developing a Java-based toolset to serve as the collaborative hypermedia environment. We will report on that work in a future paper.

Acknowledgements

The authors wish to thank Michael Bieber (New Jersey Institute of Technology) and Janne Kaipala (University of Jyavaskla) for the conversations that led to the concept of representational morphing.

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