Knowledge Media Institute

Facilitated Hypertext for Collective Sensemaking: 15 Years on from gIBIS

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KMI-TR-112

Sept., 2001

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ABSTRACT
Hypertext research in the mid-1980s on representing argumentation for design rationale (DR) foreshadowed what are now dominant concerns in knowledge management: representing, codifying and manipulating semiformal concepts, the use of formalisms to mediate collective sensemaking, and the construction of group memory. With the benefit of 15 years' hindsight, we can see the failure of so many hypertext DR systems to be adopted as symptomatic of the more general problem of fostering 'hypertext literacy' in real working environments. Pursuing Englebart's goal of "augmenting human intellect", we describe the Compendium approach to collective sensemaking, which demonstrates the impact that a hypertext facilitator can have on the learning and adoption problems that plagued earlier hypertext systems. We also describe how conventional documents and modelling notations can be morphed into and out of Compendium's 'native hypertext' in order to support other modes of working across diverse communities of practice.

KEYWORDS: facilitation, collaborative hypertext, formalism, sensemaking, knowledge management, argumentation, IBIS

INTRODUCTION
One of the earliest 'mission statements' for hypertext research was set out by Englebart (1963), in his seminal paper, *A Conceptual Framework for the Augmentation of Man's Intellect*. This foresaw the day when computers would enable people to overcome some of the limitations of their cognitive faculties by manipulating externalised "concept structures":

> *A concept structure (...) is something that can be designed or modified, and a basic hypothesis of our study is that better concept structures can be developed—structures that when mapped into a human's mental structure will significantly improve his capability to comprehend and to find solutions within his complex-problem solving situations.* [13], p. 54

We trace our roots to this mission statement, which can also be expressed as the search for tools and techniques for augmenting collective sensemaking. Experiments with "concept structures", or formalisms, have yielded mixed results to date, but Englebart's mission continues to inspire us.

The research reported here, the Compendium approach, is grounded in applied research that has focused on system development projects. The issues driving the research come from this perspective, and the examples and diagrams shown here are from real projects on which this approach has been used.

Some of the key issues that have driven Compendium from a knowledge management perspective are:

- improving communication between disparate communities tackling ill-structured problems
- real time capture and integration of hybrid material (both predictable/formal, and unexpected/informal) into a reusable group memory
- transforming the resulting resource into the right representational formats for different stakeholders.

In addition to extending earlier research on design rationale, our work addresses a specific hypertext research issue:

- "Where are all the 'native hypertexts'?" asked Bernstein in his 1999 keynote address to this conference. One of the problems people have in writing hypertext is the structuring required, a literacy that is hard to learn. Compendium is native hypertext, and offers an approach to tackling the capture problem.

DESIGN RATIONALE'S EARLY DAYS
A design rationale (DR) expresses elements of the reasoning which has been invested in the design of an artifact. A DR answers *Why...?* questions of different sorts, depending on the kind of DR system. Since the early days of research on DR in the 1980's, there has been an assumption that DR was valuable informal knowledge that should be captured. Eventually there was a whole book written on the subject [25]. However, it was also acknowledged that capturing and using DR was hard, particularly using the semiformal argumentation schemes that served as an experimental 'white rat' for many hypertext systems of the 1985-90 era. The research community assumed then that

the way DR capture would become common was that we would produce technologies – presumably some version of hypertext groupware – that would make it easy to capture and structure this informal knowledge. We assumed that the members of the design team would be the users of the technology, and that it would be easy enough to use that they would capture their design issues, options, criteria, and decisions on the fly during design sessions. Hypertext systems, the software technology most commonly used to represent and manage argumentation-based DR, were much acclaimed back then as the ideal representational tool, since they support 'processing' by both humans (rich, informal node content) and machines (operations across formal entity and relation types).

In those days we hypothesized that captured DR's might be reusable, or at least that the DR of a complex system would contribute greatly to the process of maintaining and evolving that system over time. And there was the possibility that if software engineers, who were presumably disciplined and motivated, could capture their informal DR knowledge, then other disciplines with design-like practices (e.g. law, policy design) could capture, organize, and reuse their informal knowledge as well. We just had to solve the "capture problem." Those were happy days of technological optimism.

However, soon after systems such as NoteCards [19] and gIBIS [8] began to be used for structuring ideas, reports began to emerge of phenomena such as "cognitive overhead," and "premature structuring" [6,9,14,18,19,24]. Practical experiences and empirical studies [2-4] kept turning up evidence that the cost-benefit tradeoff was difficult to negotiate (see also [8,19]). For many users, the representational demands of parsing ideas into discrete nodes, with distinctive names and types, seemed to impede the flow of thought [2,4,15], and the resultant structures were hard to change. Although a few success stories were reported [3,10,44], a survey in 1994 found comparatively weak evidence regarding usability and utility compared to what might have been expected given the scale of system development efforts [3]. A later survey echoed this, highlighting the pattern of failure in many kinds of interactive systems that assume the willingness of users to structure information [38]. The ray of hope that somehow we might find just the right balance of intuitive user interface, natural representation scheme, and fast computers[1] began to dim.

A primary lesson from these early experiments is that *the effort required to think and represent hypertextually is comparable to the development of fluency in a new language — it is a whole new literacy*. As such, systems that depend on users structuring their ideas must offer rapid enough benefits (particularly in high pressured work contexts) for users to persist long enough to reap the benefits offered by hypertextual representation.

Encouraged by the limited success of gIBIS [10] that the above problems were surmountable, the early 1990s saw the launch of a commercial software tool that combined graphical hypertext, a simple DR formalism (Issue Based Information System, or IBIS), and groupware capabilities. The QuestMap tool [16] made a mark in the hypertext and groupware communities, and even resulted in a few isolated cases of extended industrial-strength use [7]. However, this effort ultimately succumbed to market pressures.

COMPENDIUM

Rising from the ashes of QuestMap, Compendium takes a more sophisticated approach to formalism and collaborative hypertext, challenging some of the assumptions implicit in early hypertext systems. It builds on the experience gained with QuestMap that showed that the value of capturing and structuring informal knowledge on the fly cannot be only for the long term, but rather must provide an immediate jump in the quality and productivity of meetings. However, Compendium extends this by providing a participatory user interface to conceptual modelling frameworks and diverse other applications required by the user community.

A key element of Compendium is the facilitative approach: the catalyst for demonstrating the power of the hypertext tool is a skilled person (i.e. analyst, practitioner, facilitator, or technographer) fluent with the formalisms and the hypertext tools. Consequently, it requires minimal learning or behavioral changes by the project team (see later for discussion of skill transfer).

Compendium is, however, more than 'just' a meeting facilitation technique. Longer term value is added through its integration with tools to support other modes of work deriving from the meeting (see later), and through the reuse of nodes (transclusions) and structures (question-based templates) which add the necessary coherence of structure to support group memory.

Compendium seeks to meet diverse stakeholders on their own ground, translating the specialized knowledge representation into whatever format the various participants require for their understanding and participation. The Compendium approach, having learned from decades of research, tackles the issues of knowledge capture and management with *ease of adoption* as the first priority.

From the standpoint of the participant in a Compendium session, the approach looks quite familiar. It takes place in a regular meeting room and has three parts:

- A graphical[2] hypertext software system designed for real-time hyperlinked semi-structured modeling;

[1] Some approaches sought to add artificial intelligence techniques that could assist in managing structures, e.g. [21,23,29].

[2] "Graphical hypertext" systems are those in which the primary access to and navigation of small, 'lightweight' nodes and links is through a graphical map browser, rather than links embedded in nodes/documents exemplified by the Web. Typical examples of early systems (all of which demonstrated argumentation as exemplars of their potential) were NoteCards [19], gIBIS [8], SEPIA [42] and SIBYL [22].

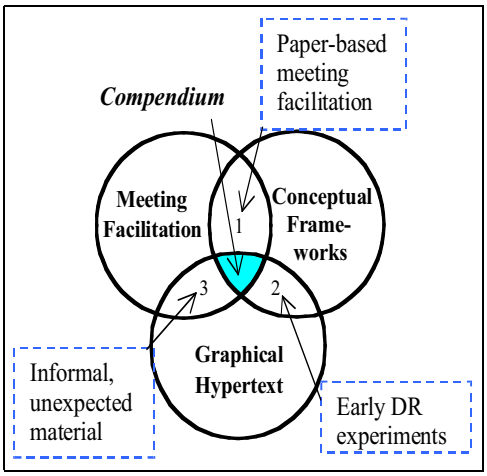

Figure 1: The three elements that constitute the Compendium approach.

- A Compendium practitioner (the facilitator) who actively works with the group throughout the session, forming a bridge between the group's conversation and the representation of it as projected on a computer display screen;
- Conceptual frameworks which structure the knowledge and shape the group's process: two of the most commonly used are IBIS [20] and "World Modeling Framework".

Compendium's uniqueness is the particular way in which it lies at the intersection of these three elements (see Figure 1). Each pairing of these elements describes a familiar, but less potent, combination:

1. The use of conceptual frameworks in meetings (top two circles) is not new[3]. Even the use of a brainstormed list on a flipchart page is a familiar example of a facilitated conceptual framework. Certainly, JAD [45] and process mapping [30] sessions impose a highly structured framework on a group meeting.
2. The early DR experiments were a blend of a hypertext system with a conceptual framework (bottom and right circles) that was oriented to the structure of design decisions. As mentioned above, even the simplest conceptual framework proved to be onerous to subjects immersed in and focused on the process of design.
3. Meeting facilitation techniques that use a hypertext system projected on a screen (bottom and left circles) were some of the earliest collaboration technology experiments (e.g. Xerox PARC's Cognoter [41]). Indeed, this combination is useful in Compendium whenever it is appropriate to dispense with formalism and simply capture informal, unexpected material.

In our experience the combination of these three elements in a single approach is very powerful, but there appears to be an art to combining them effectively. Three of the most critical elements in this alchemy are *question-based templates*, *metadata*, and *maps*. These elements taken together allow teams to move along the spectrums of *formal to informal representation*, and *prescribed to spontaneous approaches*, as their needs dictate. It also lets them incrementally formalize data [39] over the life of the project.

Question-based templates. The World Modeling Framework describes recurring patterns of attributes as they structure the subject matter of a particular project – these patterns are reflected in question-based templates (Figure 2). Question types and Answer types may be driven by a specific methodology, but a hallmark of the approach is the ability to break from formal and prescribed representations into informal, ad hoc communication, incorporating both in the same view if that is helpful to the participants. Hypertext nodes and links can be added either in accordance with templates or in an opportunistic fashion. Note that the templates are expressed in terms of the IBIS elements Questions and Ideas, but this is not an argumentative use of IBIS as originally implemented in numerous hypertext systems. The template in Figure 2 is shown instantiated in Figure 4 (overleaf).

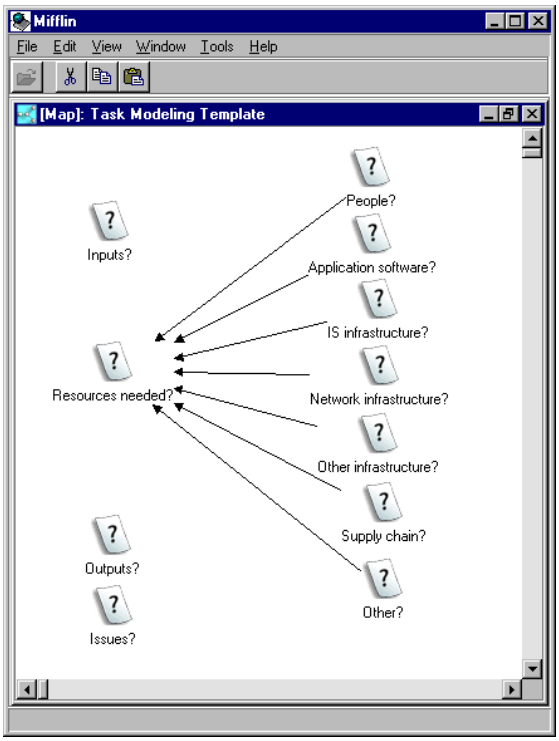

Figure 2: A Compendium question-based template representing a model of tasks.[4]

[3] Indeed, from a modeler's perspective it is an unavoidable aspect of cognition. Here we mean a learned conceptual framework used deliberately.

[4] The screenshots illustrate a Java hypertext system, currently code-named Mifflin, which extends considerably the functionality of the QuestMap system to better support Compendium.

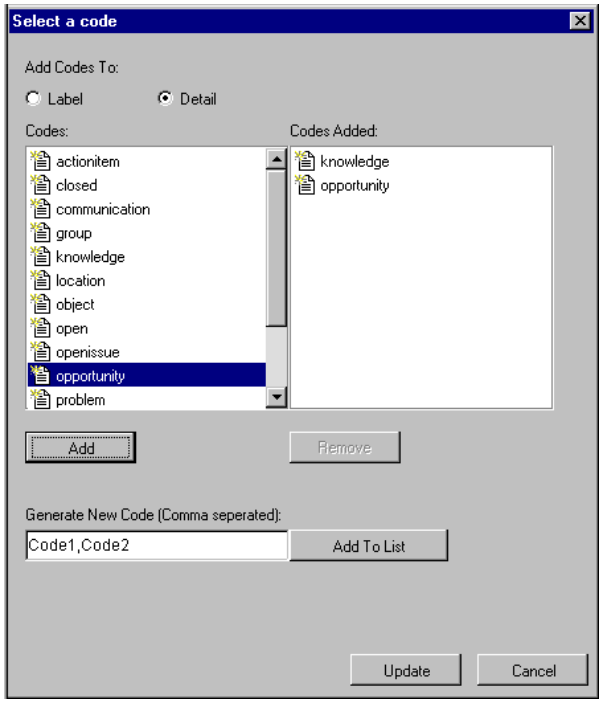

Figure 3: Optional metadata codes added to the content of a node assist subsequent harvesting and analysis of elements.

Metadata. Metadata codes are keywords that can be assigned to any concept in the database (Figure 3). For example, if an action item comes up during the group's analysis of a concept, that concept's node can be quickly labeled with an "ActionItem" code. At the end of the session all of the nodes so marked can be harvested and printed out. Ad hoc codes can be created on the fly, for example to label all the nodes that relate to a particular system component, or a company division.

Maps. Compendium's maps are designed to support the granular representation of concepts (as hypertext database objects) so that they can be spatially organized, recombined and reused in multiple contexts. By embedding maps in other maps, a group can "drill down" from a high-level representation of concepts to detailed descriptions and plans. Maps synergize with the conceptual framework to create a fractal[5] representation of the group's knowledge – the model can be deepened and formalized wherever necessary, and left superficial elsewhere.

It is worth noting that Moore's Law has been an enabler of the Compendium approach, not by the increase in size or speed of memory or processors, but in the rapid evolution of brighter computer display projectors. The ability to have a large, high-resolution computer screen in a well-lit meeting room has made the facilitative approach a practical option. An essential aspect of this facilitative approach is that the hypertext map is projected in a

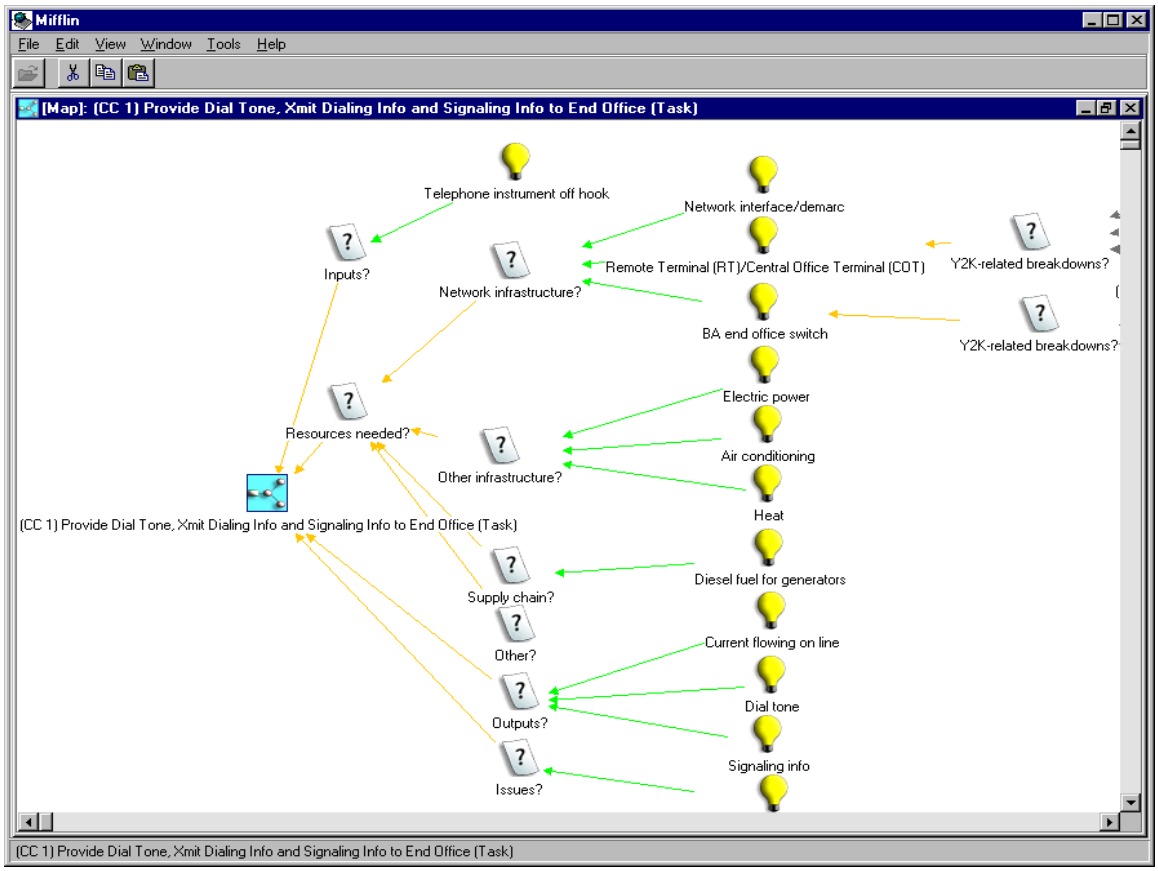

Figure 4: Instantiating the Compendium template from Figure 2 (case study detailed in [26])

shared display which all participants in the session can see clearly [12]. One of the key skills of the Compendium practitioner is getting the group to orient their discussion process to this shared display. This is done by continuously interacting with the group about the displayed map – asking for information for a template, capturing comments and discussions, and validating the concept nodes with the group. This use of the shared display appears to enhance the quality of the sense-making process [31].

Transclusive Links

One of the more advanced hypertext features of QuestMap was that it allowed the same object to appear in multiple views (maps or lists), such that one could easily navigate between different analyses in which the object played a role. However, this kind of "transclusive" link [26] was counterintuitive enough that most users did not understand it and never used it (exemplifying another new element to hypertext literacy that must be acquired). An exception to this trend were two users, Al Selvin and Maarten Sierhuis, who found that it provided precisely the representational capability that they needed to build semi-structured models of the object(s) of discourse in their business.

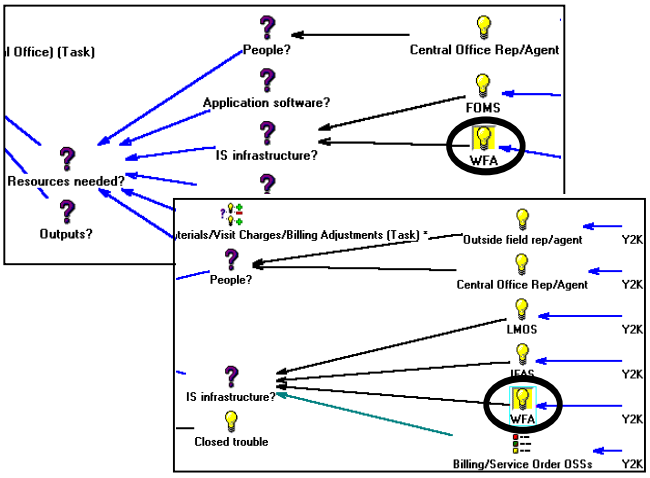

Figure 5: Use of the WFA node in two different teams' maps. One can display a menu of all contexts in which a node has been used; selecting a context highlights the relevant node in its context of use.

Confusion often arises in teams when the same idea or object is represented in more than one way. In Compendium, as far as possible, one node is reused every time the same (or a sufficiently similar[6]) concept arises (e.g. an idea, plan, person, system, location). For example, "the WFA system" (as illustrated in Figure 5) is a "transcluded" hypertext object [26] appearing in multiple contexts (right-clicking on a node shows the views it appears in). Thus, one group can leverage the work that others have done by re-using the same node in multiple contexts. Corrections or updates to a node are immediately updated in every context in which it appears. Transclusive links are created simply by copying and pasting a hypertext node from one map into another, so it is fast and easy to do on the fly in a meeting.

Negotiating Formalisms

There is little doubt that formalism can be a powerful tool in cognition. Orality and literacy studies demonstrate the enormous impact that writing had on the reasoning ability of early cultures [27], and more recently, there is good evidence of the importance of visual symbol systems in scientific discovery [5].

The research debate around formalisms for collective sensemaking begins with the tradeoff between complexity and expressive power, and how and when a given formalism is deployed. The use of formalisms in collaborative technology also raises issues concerning the implicit theory of communication embodied in the scheme, and its political dimensions (cf. the debate on the Coordinator system [1]).

Formalisms *always* constrain and enable at the same time. The only philosophy is to be pragmatic: to adopt a formalism with one's 'eyes wide open', acutely aware of the cost-benefit tradeoff, and ready to break out of it when needed. This is one of the skills of a Compendium practitioner, assisted by the Compendium concept mapping tool which supports this kind of flexibility with its *notation* (e.g. we can capture any kind of idea we want), and its *environment* (e.g. we are not constrained to particular layouts, or textual expressions).

One of the formalisms used by Compendium, IBIS, is a simple notation consisting of three elements: Questions, Ideas (possible answers), and Arguments (pros or cons to the Ideas). IBIS is used in two ways. It provides the Question and Idea elements for templates and model building (see Figure 4). IBIS is also used as a DR notation for capturing free-form design discussions, precisely as IBIS was originally intended to be used [20]. The key difference between Compendium and earlier uses of IBIS (and other DR notations) is Compendium's use of the facilitative approach – only the Compendium practitioner need actively engage with the formalisms during a session.

Another formalism used by Compendium is the World Modeling Framework (WMF). This framework provides a semi-structured notation for describing objects and relationships in the world. For example, in analyzing the requirements for a telecommunication system, the team may construct qualitative models of the tasks, system components, organizations, and resources involved in the project [17,40]. The participants in a Compendium session need know nothing about the IBIS and WMF formalisms, because the Compendium practitioner is responsible for weaving the formal notations into the group's interaction. The participant, the "user" of the Compendium approach, is thus released from the learning responsibility imposed by earlier approaches. The Compendium practitioner, through training and practice, applies the formalisms fluently and interactively with the group. Fluency is an apt

[6] What counts as "sufficiently similar" is either decided 'on the fly' by the practitioner and validated by the group, but if important enough, this may become an explicit focus for discussion.

metaphor here, because these formalisms provide a kind of language, and, as with any language, the key to fluency is practice.

MORPHING INTO AND OUT OF NATIVE HYPERTEXT

Meetings do not take place in a vacuum, but rather, in a rich conceptual and historical web of previous meetings, concepts, tools and documents. We focus now on how, once 'captured' in Compendium, the products of a meeting can be integrated with consequent work processes and their associated tools. A common assumption among early DR efforts using hypertext was that the DR formalism should serve as a *common language* for all of the different participants and perspectives, in order to converge on shared understanding. This was a natural assumption, because hypertextual DR so nicely serves as a semi-structured glue to hold all of the formal design documents together in context. However, to the extent that this strategy required diverse stakeholders to learn and use the DR formalisms and tools, it foundered on the rocky shore of hypertext representational literacy.

Compendium's solution is to recast the 'native hypertext' representation into the familiar document types and formats that project participants are comfortable and familiar with[7]. Again, this innovation is practical because there is a designated "owner" of the project's knowledge – the Compendium practitioner – and, assisted by tools (see below), she can publish specific views and subsets of the knowledge base in specific formats, such as process diagrams, data flow diagrams, and requirements documents. By speaking the languages of the various stakeholders, Compendium thus engages project participants between meetings, increases the likelihood that they will reflect on, understand, and respond to the work done during the meeting, and bring their insights and concerns to subsequent meetings. Compendium integrates the sensemaking and knowledge creation activities of meetings and between-meeting work. In the following sections, we present some examples of what we mean by this.

From Maps to Other Organizational Documents

One of the most common purposes of meetings is to advance a project deliverable of some sort, typically an organizational document of an established genre, using established notations and stylistic conventions. To invoke the knowledge management mantra, in order to 'deliver the right information in the right form to the right people at the right time', we need automatic morphing from visual maps to myriad file formats and notations for direct importing into other applications. If hand-coding of maps is required, Compendium's visual mapping will either fall by the wayside or fail to be adopted except by a few enthusiasts. In Figure 6, we illustrate how a map can be used as a collective user interface to elicit the information required to generate a completed data flow diagram and requirements specification document for other communities.

From Synchronous to Asynchronous Interaction

Compendium mapping has primarily been used to mediate face-to-face interaction, although asynchronous mapping via LANs has been used on occasion. However, in keeping with the notion that the wider organization may prefer more conventional documents and user interfaces, we can generate a structured Web document discussion site from a map, as shown in Figure 7. By exporting a hierarchical map to a textual outline in HTML, subsequent processing by the D3E system [11,43] generates a Web user interface in which the document is tightly linked to a threaded discussion space. This makes it possible to circulate the results of a meeting captured in Compendium to a wider audience to solicit feedback via a more familiar style of interface.

In contrast to the preceding examples, we have also developed ways to *generate* Compendium maps from other applications, to support the collective, conceptual analysis (e.g. chunking, clustering, linking, systematic reuse) that granular, hypertextual objects facilitate. For example, a requirements document can be automatically parsed into a Compendium map, providing the seed for a group's first use of the tool. In this way, participants in an existing project to the Compendium format with familiar content, smoothing the transition into working with a hypertext representation. Thus Compendium's maps allow technical and non-technical people to collaborate on the development of a conceptual model, including material from technical documents.

Indeed, the benefit of a conceptual model in Compendium is the lack of syntactical and semantical complexity that comes with other conceptual modeling languages (such as semantic networks). In other words, answering *Questions* in a natural language is easier than having to understand what the arrows and boxes mean in most other languages. The visual notation hides the complexity of the modelling language from the user, releasing them to focus on answering the questions posed by the template. Maps are then converted into entries for subsequent analysis in other tools.

CHOREOGRAPHING HYPERTEXTUAL SENSEMAKING

Critics may say that the use of a skilled facilitator is a weakness of the Compendium approach. It is true that we have backed away from some of the optimistic ambitions of early DR research which hoped that DR notations and hypertext tools would be so intuitive that people would just use them. However, in Compendium the facilitator is not a 'patch' to get the approach to work in real settings, but a central feature that allows us to enter the world of project teams and communities of practice directly and powerfully. In this section, we introduce some of the craft skill involved in choreographing meetings and representational activities around the graphical hypertext maps introduce above.

The facilitator functions as "technographer"[8]—actively crafting structures on a shared display screen that both capture the

[7] In one gIBIS case study we documented the resistance (in other parts of the organization not using gIBIS) to concept maps as a medium for communicating [10].

[8] The CoWorking Institute: www.technography.com

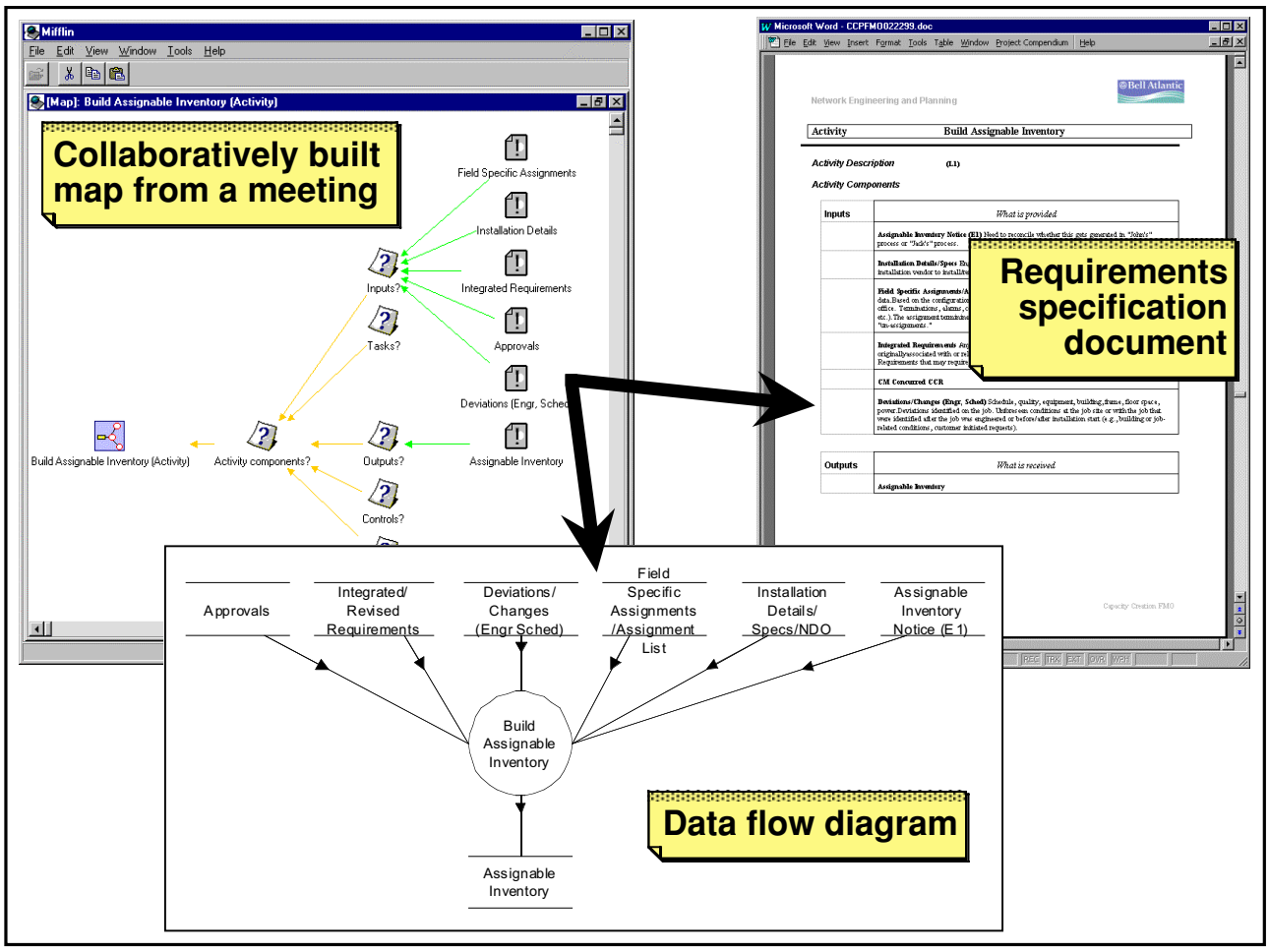

Figure 6 Generating organizational documents from a Compendium hypertext map [25]

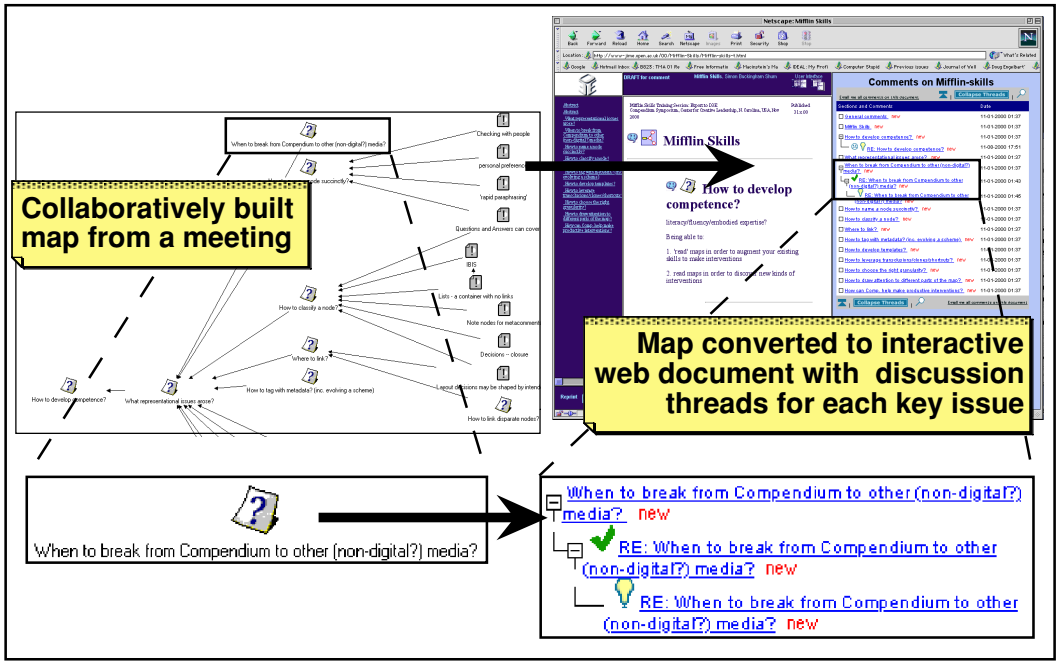

Figure 7: Publishing a Compendium map as a document for structured, threaded discussion on the Web, using D3E [11]

meanings and ideas of the group and reflect back to it the larger implications of their thinking [12]. The growing community of Compendium practitioners[9] reports time and again the common experience of finding a qualitative improvement in the process of meetings. To borrow a musical metaphor, there are several shifts in the 'rhythm' or 'timbre' of a meeting when Compendium is used well:

- **Beneficial slowing down.** A common complaint with early DR was that issue/rationale capture disrupted the dynamic flow of a meeting. When done appropriately, however, we find that it can be extremely beneficial to 'disrupt' dysfunctional dynamics by focusing attention on a feature of the hypertext map. More generally, people learn to listen more attentively.
- **Depersonalization of conflict.** When ideas and concerns are mediated via a shared display, challenges to positions assume a more neutral, less personal tone. We are by no means claiming that this kind of technique ushers in peace and harmony, but in ill-structured situations where there are competing agendas, it helps participants clarify the nature of their disagreement. We have seen Compendium defuse meetings which otherwise looked to be polarized.
- **Flexible rhythmic review.** To a surprising degree, collaborative knowledge work can be characterized as "group list processing." Whether the list is a set of requirements, budget items, or action items, a common activity is group review of a list of potentially complex elements. While some items draw little comment, others can lead into deep discussions and even debate. With Compendium, the facilitator and the group establish a "call and response" rhythm during these exercises, creating a sense of shared purpose and momentum. When occasional elements lead to intense discussions about meaning, or spark disagreement among group members, the Compendium practitioner can seamlessly open a new map and keep facilitating, mapping or modeling the new conversation. With the new issues captured in the shared display, the group can "pop" back to the previous review task without losing momentum.
- **Incremental mediation of conversation.** We are discovering a variety of strategies for introducing Compendium to a new group, strongly determined by the context. Some of us simply start to capture the normal discussion in a meeting, and at appropriate points use it to reflect back to the meeting personal insights gleaned. Curiosity about what one is doing often leads to natural opportunities to introduce it. If the shared display is used from the start, again, there is a spectrum of how strongly discourse is mediated via this display (cf. the DR continuum in [3]). It may be used to punctuate discussion to reflect on progress, but at its most powerful, the discussion and the map 'dance'—each shaping the other. It is hard to convey this in writing, but we contend that it exemplifies the kind of synergy between tools and sensemaking that was hoped for by the developers of early 'idea processing'/DR hypertext systems.

[9] www.CompendiumInstitute.org

COMPENDIUM'S DEPLOYMENT IN THE FIELD

The Compendium approach has been used on over 60 projects during the last 10 years, contributing immensely to a practical understanding of the issues [28,33-35,37]. A small sample of these projects includes a school district wrestling with student reapportionment, work practice analysis on the Apollo moon missions, the design and launch of a tele-marketing campaign, enterprise-wide Y2K contingency planning, and requirements analysis on a wide variety of system development projects.

As of this writing a small group of trained Compendium practitioners, including a group at a consulting company[10], works full time facilitating projects for external clients using the Compendium tools and techniques.

One of the toughest practical issues has been the learning process for new Compendium practitioners. A facilitative approach is of no use if intelligent people cannot learn to do it in a reasonable period of time. Although no formal training process exists yet, experience to date suggests that the learning cycle takes three to six months to reach expert level, depending on the student's existing familiarity with the hypertext tools and the intensity of study. As many companies are recognizing, useful knowledge resources do not come for free —there has to be investment in people and infrastructure just as there is to manage other valued assets.

Expert Compendium practitioners may be needed in contentious, unstructured contexts, but we have found that 'normal' people can learn this approach for more stable contexts. Our experience demonstrates that a two-day training course[11] equips people to use this approach at work. In other cases, an individual may start using it simply after experiencing its use in meetings.

CONCLUSIONS

There has been well-grounded concern in the hypertext and CSCW research communities about the disruptive effects of formalism in design and other sensemaking processes—indeed, our earlier system building and evaluation studies contributed to this understanding. Taking this agenda as our point of departure, the work presented in this paper describes a strategy, now tested in real business cases, that provides evidence that the problems with formalisms for capturing issues, modelling problems, and helping diverse stakeholders come to shared understanding *can* be effectively addressed.

[10] GDSS, Inc. in Washington, DC.

[11] VIMS, Visual Issue Mapping System, teaches an IBIS-based facilitation technique that is a cornerstone of the Compendium skill set. See: www.gdss.com/omq/VIMS.html and groups.yahoo.com/group/vims .

A central part of the solution is in meetings, through the use of a trained facilitator. In addition, we have described how Compendium's native hypertext format can then be integrated into the wider stream of work activities in which meetings are embedded, by importing from and exporting to other applications. It is not necessary for everyone to read and write native hypertext. This literacy can be initiated and nurtured in a core group which may grow as the effectiveness of their tools is recognized.

Nevertheless, there are still very significant challenges in the evolution of DR-like systems. The more complex the formalism, the more challenging to apply it live in the heat of discussion, and the longer the learning process to reach fluency. The tools do not need richer sets of features so much as a few critical features and fast response to user inputs. We have found that latency in the process of node/link creation and editing, especially in a live setting, can be a significant distraction.

More importantly, Compendium shows some maturity in the DR field not so much in technology as in developing a richer understanding of how human activity can be choreographed around and mediated through shared displays to structure collaborative interaction. It takes us beyond a technology-centric focus, simplistic user scenarios, and naïve expectations regarding sustained user adoption.

It is important also to recognise that much of the hypertext system research in the 1980s may have been before its time. The more recent emergence of organizational memory and knowledge management as important themes in the business world has helped to create a more favorable climate for the Compendium approach. For example, the appearance of meeting facilitation is increasingly common in the corporate landscape.

One major thrust of on-going research is to explore deeper integration of this approach into the cycle of work in projects. So much happens between formal group meetings that might benefit from the coherence-creating effects of the Compendium representation of knowledge, if the challenges of asynchronous collaboration could be overcome.

Another goal is to share and consolidate the 'craft skills' of the Compendium practitioner such as those introduced above. Recently we have been experimenting with a mentor/apprentice approach to training, rather than our previous traditional classroom theory/practice lecture approach, with encouraging results. To return to one of the themes introduced at the start, fluency in a new language comes from practicing 'in the field', not in the classroom. Compendium's case studies drive home this lesson for the fostering of hypertext literacy to "augment human intellect."

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