FOCUSED SHARING OF INFORMATION FOR MULTI-DISCIPLINARY DECISION MAKING BY PROJECT TEAMS

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EDITOR: B-C Björk

Kathleen Liston, Ph.D. Candidate
Dept. of Civil and Environmental Engineering, Stanford University, Stanford, CA 94305-4020, USA
email:kathleen@listons.net

Martin Fischer, Associate Professor of Civil and Env. Eng. and (by Courtesy) Computer Science
Stanford University, Stanford, CA 94305-4020, USA
email:fischer@stanford.edu

Terry Winograd, Professor of Computer Science
Stanford University, CA 94305-9035, USA
email:winograd@cs.stanford.edu

SUMMARY: *Today's electronic and paper-based approaches to the sharing of project information do not scale to the information sharing and interaction challenges of multi-disciplinary project team meetings. The inability to share and interact with information easily and effectively is one of the biggest bottlenecks in using electronic (online) information for collaborative decision-making. Through scenarios from recent construction projects, this paper summarizes existing approaches to the sharing of information and assesses their effectiveness in supporting multi-disciplinary decision-making by project teams. It then discusses recent research into interactive information workspaces where, with minimal software overhead, participants can share information that is relevant to a particular context to establish a common focus. We believe that the construction community can make significant progress quickly in leveraging existing and future investments in information infrastructure if it not only pursues information sharing through the use of product models but also formalizes the focused sharing of information and separates information interaction and view control from software services and underlying data as outlined in this paper.*

KEYWORDS: *Interactive Workspaces, Product Modeling, Human-Computer Interaction, Decision Support, 4D Modeling*

1. INTRODUCTION

Project teams are pervasive in many industries to organize and produce work. They directly create or affect a significant portion of a country's gross domestic product (GDP). In spite of the importance and widespread use of project teams, there is no science base for the modeling and sharing of information to support decision-making by multi-disciplinary and multi-organizational teams. By their nature, project teams bring together participants from many disciplines that use discipline-specific information formats and discipline-specific modeling, analysis and visualization tools for their work. It is still a challenge today to combine the discipline-specific sets of information and representations to support multi-disciplinary access, interaction, and decision-making. However, essentially all decision-making by project teams is multi-disciplinary and needs to consider large, heterogeneous data sets. Furthermore, many parties coming together on projects have only a casual working relationship because they are from different disciplines and often also from different organizations. They need, though, at least some access to each other's information, which is typically embedded in discipline-specific legacy applications. Little support exists today to share relevant information easily and flexibly because it is difficult to predict, a priori, who needs to see and work with what information. Today's approaches to exchanging electronic and paper-based project information (e.g., standardized semantic models, software wrappers, and electronic or paper-based sharing of visualizations and documents) do not scale to the information interaction challenges of project teams. They can overwhelm meeting participants with the amount of information that is exchanged or require too much software overhead for project teams whose composition changes frequently, where participants come from many different organizations, and where participants bring many diverse sources of information to a meeting.

To address these practical needs of project teams, we can build on existing approaches to sharing information (Yu et al, 1998, Plantec and Ribaud, 1998) and on emerging research in the human-computer interaction domain (Fox et al, 2000, Johanson et al, 2001, Liston et al, 2000a). However, research is still needed to formalize scalable, testable, and sound information modelling, sharing, and interaction approaches to support decision making in project teams:

- The current information exchange mechanisms need to be complemented with an approach that responds to the needs of project teams.
- Interactive multi-user, multi-application, and multi-device user interfaces need to be designed.
- Project teams' effectiveness in making decisions needs to be measured to assess the power and generality of the information exchange mechanisms and the user interfaces.

The goal is to formalize and test easy-to-use mechanisms or approaches to enable project team members to establish a common information focus through focused data sharing. In our experience, participants do not want to share all the information they create (Staub et al, 1999). They simply want to share just what is relevant in a particular situation. We base our work on the assumptions that information sources will be heterogeneous and do not subscribe to 'one size fits all data models' to support multi-disciplinary information exchange and interaction. We envision an interactive information workspace where, with minimal software overhead, participants can share information that is relevant to a particular context to establish a common focus among the meeting participants.
Section 2 gives a specific example that illustrates the needs of project teams.

2. MOTIVATING EXAMPLE

The motivations for this work comes from our observations of meetings by construction project teams and our efforts to prototype and validate new visualization environments for these teams (Liston et al, 2000b). Our observations of project meetings reveal that communicating project information through paper-based graphical representations limits the team's ability to work together to solve problems and make decisions. The observations have also demonstrated the diversity of information in both type and source that is relevant to project work. When observing meetings we measured how the project teams spent time during the meetings. We classified the meeting tasks as descriptive, explanative, evaluative, and predictive. Fig. 1 summarizes these measurements for meetings supported by various types of information sharing approaches.

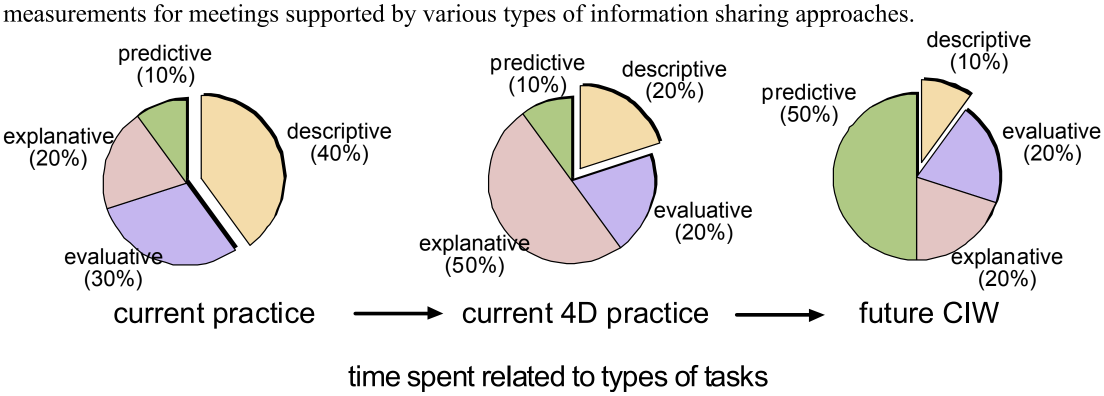

FIG. 1: The objective of our work is to shift task composition in meetings from descriptive to predictive tasks. Explanative tasks use information relationships to explain earlier decisions, and evaluative tasks use relationships to evaluate a set of information against project goals.

An objective for the development of interactive information workspaces for multi-disciplinary decision-making is to increase the number of predictive tasks performed in a meeting and to reduce the number of descriptive

tasks (Fig. 1). Predictive tasks add more value to a project because they consider 'what-if' questions through the exploration and multi-disciplinary analysis of scenarios.
First, we describe an observation of a project schedule review meeting using traditional forms of project information, followed by a brief analysis of that meeting. Then we describe a meeting where the team used a 4D visualization environment, jointly developed by Stanford and Walt Disney Imagineering (Schwegler et al, 2000) to review the project schedule. We conclude the example with a brief account of our experience in using product models to exchange project information electronically.

2.1 Traditional meetings

Scenario: On the walls of the conference room are 2D construction drawings and the project Gantt chart (Fig. 2). Each meeting participant has handouts consisting of the schedule, which contains 8,000 activities, and the meeting agenda. Participants have brought other types of documents to the meeting such as 'marked-up' schedules, some contract documents, and construction drawings. The meeting begins with the first agenda item, 'Schedule Comments.' This discussion involves the owner asking questions such as: Does the schedule meet contractual milestones? Do these activities adhere to project specifications? Why are you finishing this part of the project on this date? What if we change this milestone date? What if the steel for the main building arrives late? Throughout the meeting, project participants are distracted as they shuffle through the schedule sheets and other documents searching for activities or as they scan the walls searching for relevant information, trying to understand the schedule and the issues at hand. Meeting participants come and go. Some leave to get information such as project specifications or to get updated information. In some cases, a document is passed around for participants to review. By the end of the meeting, twenty types of documents have been referred to or used as participants try to describe, understand, review, and evaluate the schedule. Various people have marked up their schedules or other documents, but no one leaves with the full documentation of the comments, to do items, or issues addressed in the meeting. More importantly, although several problems were noted, no problems were resolved and no decisions were made during this meeting or during three successive meetings.

FIG. 2: Typical project meeting showing private and shared information and showing the different information representations and formats used by various team members from different organizations.

Does this kind of project meeting add value to a project? The team covered many of the agenda items, but at a cost to the project because the team spent no time solving problems or making any decisions. Instead, the team spent most of their time trying to understand the project information rather than using the information to address 'what-if' questions. The team spent the majority of the time in the meeting describing and explaining existing information to other team members (see left part of Fig. 1). They could not evaluate and predict the performance of alternatives from several perspectives with any reliability because the:

- Information is not interactive. Paper-based information forces people to navigate through information manually, change it in their heads, and manually predict the impact of those changes. During this meeting, the team tried to consider how a change to a milestone would impact other activities and overall project cost. Several team members red-marked their schedules, commented on potential impacts, but decided, after several minutes of people flipping through the schedule, to solve this problem later.
- Focus of information is not shared. Since much of the information that the team used or referred to during the meeting, such as the project specifications, diagrams, and detailed schedules, was private, the team rarely focused on the same information. Even the shared information, the 2D drawings and schedule, provided no visual cues to guide the focus of the team because this information was created with single discipline tools. Consequently, people were easily distracted, and participants from the various organizations present could not communicate the truly relevant information to others.
- Views don't visually represent critical relationships. During the meeting, as a team member described certain activities, the member would walk to the 2D view of the project and point out 'where' the work was taking place. Similarly, when the team wanted to compare information in the schedule to contract requirements or project specifications, various team members had to search through documentation to identify the related items. Relationships between time, space, resources, project requirements, cost, etc. are not captured or communicated in today's traditional graphical representations. This forces the team to spend time comparing documents and trying to understand how the information is related, when simple visualization techniques might easily communicate these relationships.
- Views are inappropriate for group use. The Gantt chart on the wall comprised only 500 activities, represented by bars approximately 6 mm high with text at the same size. The Gantt chart provided an overall context, but was unusable for any group task. Instead, team members stood in front of the chart, searching for relevant activities and pointing to activities that then caused other members to search through their own personal schedules for the information. Current printed views of project information are designed for individual review and not group review.

By nature, most issues discussed in meetings require multi-disciplinary and multi-organizational attention. Yet in all meetings we observed, the meeting leader and the participants had a hard time establishing and maintaining focus because of the problems listed above. Teams need more effective ways to share project information and need more interactive methods of communicating project information that enhance the team's focus on the critical and relevant information and communicate critical relationships to better describe, explain, and compare project information and issues. We believe that, once teams can perform these tasks more efficiently, they will be better equipped to make decisions.

2.2 Meetings with 4D models

On the same construction project, we participated in an R&D project using a 4D-CAD environment that enabled the team to visualize the relationships between time (construction activities) and space (3D model of the project) (Adjei Kumi and Retik, 1997, McKinney and Fischer, 1998).

Scenario: The team meets in the CAVE (Computer-Assisted Virtual Environment) (Fig. 3) (Mahoney, 1999), which displays a real-time, interactive 4D visualization of the project schedule. The team first reviews the schedule by stepping through the 4D model, day by day and viewing the different kinds of construction activities taking place, as indicated by color. At various points in time, specifically at milestone dates, the team stops the 4D playback and navigates through the 3D model. Questions relating to the rationale of the schedule are asked, such as why certain activities have to finish by certain dates, or why the sequence of construction goes from north to south. Additionally, the team discusses work constraints in several areas and identifies and resolves several issues during the meeting.

During these 4D meetings, the team spent more time explaining the information than describing it, an improvement over the traditional paper-based meetings (see middle part of Fig. 1). They were able to identify several problems quickly and solve some of them. This environment demonstrated how:

- Interactive access to information helps teams to navigate through the information more efficiently.
- Shared visualizations improve focus. There was no overwhelming amount of paper documents, and everyone focused on the 4D visualization.

- Visualizations can communicate relationships between project information.
- Large-scale views are more appropriate for group tasks.

Others confirm these observations in other industrial settings, e.g., (Ye et al, 1999, Buxton et al, 2000).
The CAVE experience also demonstrated the need for functionality that enables the team to:

- visualize additional kinds of project information, such as cost, work assignments, procurement information (North (2000) reports similar needs), and
- focus on specific information in the 4D visualization through additional visual cues

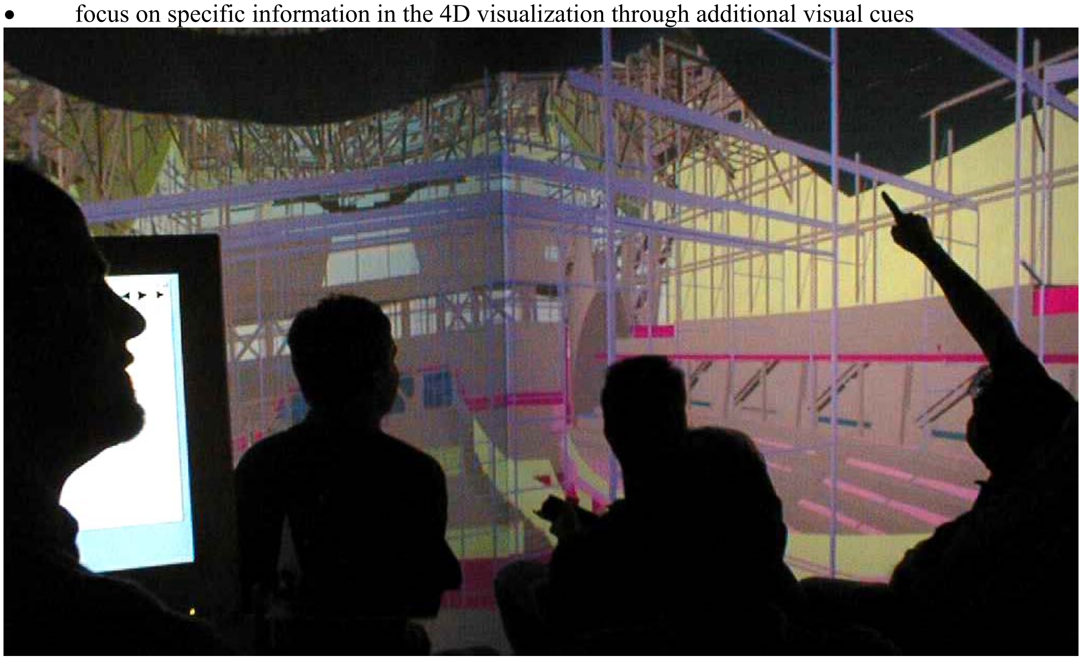

FIG. 3: Snapshot of project meeting in CAVE. Participants are much more engaged than in traditional meeting rooms.

2.3 Meetings with product model support

In the next phase of the R&D project, we were able to participate in and observe the use of semantically rich product models to exchange project information between disciplines and organizations (Fig. 4).
Product data exchange files in the IFC (Industry Foundation Classes) format (Yu et al, 1998, Faraj et al, 1999) were used to exchange information about the components and systems in a building between the various 3D CAD applications used by the architect, the mechanical designer, and the general contractor. They were also used to exchange information between the 3D applications and the mechanical design and analysis applications of the mechanical designer and the production planning applications of the general contractor (Laitinen, 1998).
The experience in using product models based on information standards showed that:

- The sharing of product models greatly enhances the consistency of the information used by the architect, mechanical designer, and general contractor and increases the speed of generating and analyzing design alternatives. Hence, they help provide a better starting point for decision making in meetings because information related to various professional perspectives is much more likely to be up to date and synchronized.
- Product models don't improve the human-computer interaction with multi-disciplinary information during meetings because they focus on software interoperability and not on the interaction of humans with information. However, product models make many of the relationships between project information explicit, which provides a starting point to improve multi-disciplinary human-computer interaction.
- Today, the overhead to add a new team member is high. Six months into the project, the architect, the mechanical designer, and the general contractor were the only organizations able to exchange building design information quite easily. On any project, many more organizations need to provide input to the project models and decisions. It typically took about two months of significant effort and attention to get

a new organization tied into the project’s information infrastructure. Many organizations would rather spend this effort and attention on their work than on getting information exchange mechanisms to work. We expect that this overhead will become smaller and smaller as product models mature, as more software vendors and practitioners gain expertise in supporting software interoperability through product models, and as more architecture, engineering, and construction students are educated about product models.

- Project participants need to share cost, schedule, contract, and other information in addition to the product model information about the building design. However, today, much of this additional information cannot be exchanged easily with the product model standards. This limitation is likely to become smaller over the next few years, as standards for data other than a project’s components and geometry solidify and as software vendors implement and test standards-based input and output mechanisms for their software.

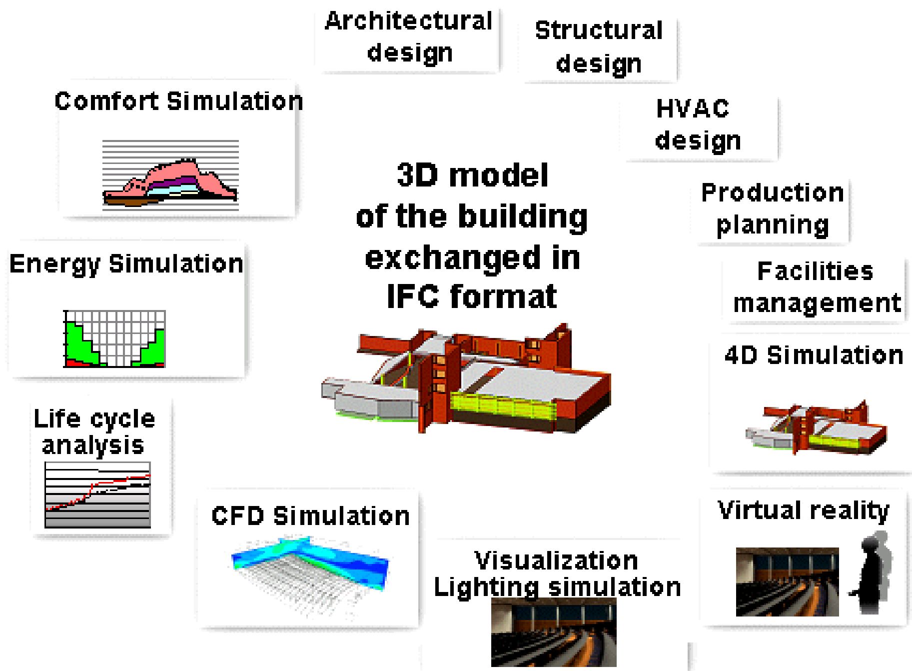

FIG. 4: IFC-based product models are used to exchange information about building components throughout life cycle phases (shown in the upper right hand corner Fig. 4). Specific kinds of analyses supported by the IFC-based product model are shown on the left and bottom part of Fig. 4. While helpful and powerful for these analyses, product-model-based information exchange does not yet support quick and flexible interactions with project information in multi-disciplinary settings.

The current limitations of IFC-based product models to support multi-disciplinary human-computer interaction point to research, development and testing needs to extend the usefulness of product models.
In summary, the three experiences show that essentially all decision-making by project teams is multi-disciplinary and needs to consider large, heterogeneous data sets. Furthermore, many parties coming together on projects have only a casual working relationship because they are from different disciplines and often also from different organizations. Nevertheless, they need at least some access to each others’ information, which is typically embedded in discipline-specific legacy applications. However, little support exists today that allows participants to share some of their information easily and flexibly because it is difficult to predict, a priori, who needs to see and work with what information. The overhead to use semantically rich information approaches can be high. It is time-consuming and costly to build visualizations for each meeting. The traditional paper-based approach does not effectively share relevant project information and establish focus between participants from multiple disciplines and organizations. The inability to share information easily and interact with the information

in multi-disciplinary settings is currently one of the biggest bottlenecks in leveraging existing electronic (online) information for collaborative decision-making.

Section 3 extends this brief critique of the suitability of existing approaches to support project teams with multi-disciplinary access to project information.

3. INFORMATION EXCHANGE AND INTERACTION APPROACHES

Most software applications used by project team members are typically point solutions designed to support the discipline-specific work of individuals rather than support multi-disciplinary interaction. They are designed to support single users in modeling, analyzing and documenting their work. They do not support multi-disciplinary interaction with their data models because it cannot be expected that all team members will learn all the discipline-specific interfaces to the many software tools used on projects. It is also not realistic to expect that all the project participants who created project information are present or available during meetings to interact with the software tools they use. Bechtel, for example, reports that it regularly uses 240 different software tools to model, analyze, and document its projects (Killen, 2000). However, coordination of project information for project teams is essential for every project's economic success. As shown in the example above, several approaches to share project information exist or are emerging.

The paper-based approach does not provide the interaction needed to focus a project team's attention on the most relevant information.

Visualization-based approaches can be more powerful than paper-based approaches because they support professionals in coordinating work and related information on projects by making face-to-face discussions more effective. However, creating visualizations at several levels of detail for the many issues a team has to discuss over the life of a project is a cumbersome task. Furthermore, 3D and 4D visualizations do not today typically support the display of all essential project information.

The product-model-based approach does not yet support the frequently changing composition of project teams. Approaches building on information modeling may work for large organizations like Boeing and Ford who can dictate certain information modeling systems and approaches (Gottschalk, 1994), but they are too rigid and too expensive for the project-based production of goods and services in construction. Emerging semantic information standards facilitate the sharing of computer-interpretable information between software tools, but they do not yet scale to the multi-disciplinary, multi-phase, multi-objective, and multiple level of detail nature of projects. Pre-defined semantic models are unlikely to support all the information needs by multi-disciplinary project teams because each project needs to address a unique set of requirements, which require the generation of project-specific information views to address project-specific decisions. Further research and application will show to what extent standards-based product models combined with computational mechanisms that infer information that is not explicitly available from a product will be able to support the project-specific information needs (Haymaker et al, 2000). Furthermore, product models typically contain large amounts of information, and sharing of product models can sometimes overwhelm the receiving parties. Easy-to-use mechanisms to share partial product models on an as-needed basis will undoubtedly be developed to make product-model-based information sharing more widespread.

Software wrappers are another approach (not illustrated in the examples above) that is often used today to exchange information between software applications (Hammer, 1999). However, the wrapper-based approach does not support the needs of project teams because new wrappers have to be written for every new set of applications, and they have to be revised as new versions of applications appear.

In summary, little computational support exists today to enable professionals to share relevant information easily, quickly and flexibly. An approach that allows project teams to share and interact with heterogeneous information in multi-disciplinary settings requires research on information exchange approaches *and* on interaction design. Given the limitations of existing information sharing approaches, we have started to investigate a 'minimalist' approach to information sharing that does not depend on the a priori alignment of

large semantic data models, but that makes it easy to focus a team's attention on relevant information (Froese et al, 2000).
A 'focused sharing' approach to electronic information exchange will enable project team members to share information as needed in a 'just-in-time' fashion and avoid the limitations of the current 'just-in-case' information sharing approaches. Our on-going research will show whether this is indeed a more appropriate approach for the multi-disciplinary, multi-device interaction with large, frequently changing, heterogeneous, multi-format project information. Recent research projects at Stanford University' Center for Integrated Facility Engineering (CIFE) have shown that very little of each discipline's information is actually shared with other disciplines and that multi-disciplinary collaboration can be supported when just a few information items are shared (Han et al, 1998, Arnold et al, 1999).

The following challenges need to be considered for such a focused information sharing and interaction approach:

- An effective information sharing approach needs to make use of legacy sources of information that were not initially designed for multi-disciplinary settings.
- Information sharing approaches also need to provide a uniform representation that has enough semantics to provide useful structure while being flexible enough to be usable by multiple parties who bring different perspectives and representations to a project team.
- Furthermore, an effective information sharing approach needs to integrate structured information (of the kind in model databases) with unstructured information (text, HMTL, etc.) that is provided as supplementary material, annotation, etc.

The user interaction metaphors and methods need to augment the existing representations (rather than covering them over) while providing the power for information seeking and presentation activities based on the structure of common links.

4. INTERACTIVE WORKSPACES

4.1 Overview of iRoom Technology

FIG. 5: Interactive Workspace consisting of several interactive touchscreens, a table display, and other information devices such as laptops, PDAs, cameras, scanners, etc. Specialized input and output devices such as LCD-tablets, laser pointer trackers, microphone arrays and pan-and-tilt cameras are also present in the

environment. The information workspace supports direct interactions with the information that is shown on the various information devices.

The Interactive Workspaces (iRoom) Project at Stanford has constructed a prototype (the iRoom) of an integrated, technology-rich work environment with computing and interaction devices on many different scales (Fox et al, 2000). Environments such as the iRoom are being developed in a number of projects (Abowd, 1999, Buxton, 1997, Rekimoto, 1998, Rekimoto and Saitoh, 1999, Streitz et al, 1999) and will become economically and operationally practical for widespread use within a few years. The iRoom serves as an experimental hardware and software testbed that includes large, high-resolution wall-mounted and tabletop displays as well as small, personal mobile computing devices such as laptops and PDAs connected through a wireless LAN (Fig. 5). The interactive workspace provides far more screen real estate (pixels) than typically found in meeting rooms or offices. Hence, large amounts of information can be shown in close proximity. The information workspace also supports direct interactions with the information that is shown on the various information devices. The purpose of the iRoom is to support the 'moving around of information' between information devices to make it easy for participants in a meeting to share relevant information. Software applications connected to the iRoom send messages to an Event Heap and listen to messages in the Event Heap from other applications. See (Johanson et al, 2001) for a detailed description of the technology infrastructure for the iRoom. These technological opportunities require the development of mechanisms to focus team members' attention on specific information and corresponding relationships.

4.2 iRoom Application: Construction Information Workspace

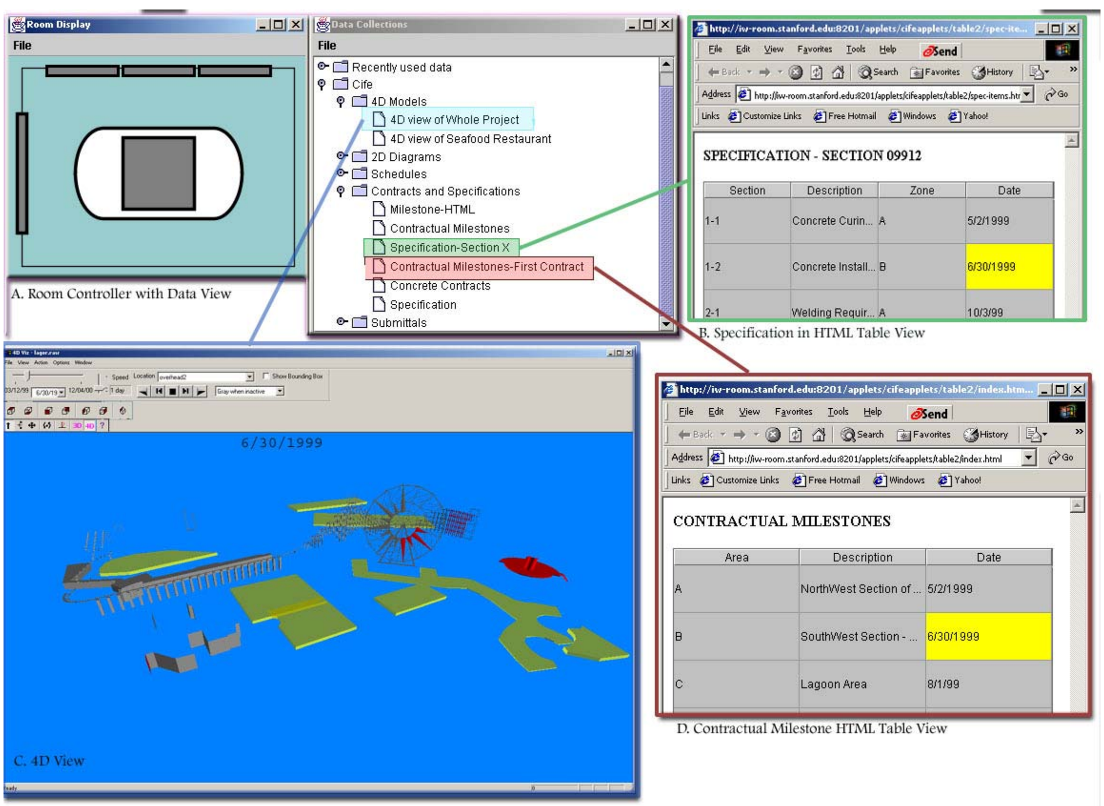

FIG. 6: Important relationships and corresponding information sharing between documents on a construction project. The figure shows the various views in close proximity. In the interactive workspace each view can be on a separate information device that is connected to the workspace. The selection of a milestone date in the contract document in the lower right window of Fig. 6 triggers the highlighting of related (same date) items in a specification document (upper right). It also adjusts the view in the 4D CAD window (lower left) to the same

date, i.e., the 4D application shows the planned state of the project (what has been built, what is being worked on) at the selected milestone date. The upper left part of Fig. 6 shows the room controller and a list of available documents. The room controller allows users to drag a view and service to a particular device.

A first version of a construction information workspace makes it easy for users (project team members) to start and use software services on multiple devices (e.g., on the wall-mounted touchscreens and on a laptop). Currently the following services are included: a 4D service, an HTML table service, an HTML tree hierarchy service, and an image viewer service. We call this suite of services CIFE services. When a user selects an item in one of the service views, the service sends a 'CIFE' group message to the Event Heap. A program called the CIFE 'listener' picks up the message and broadcasts or directs the message to specific services or devices. The receiving services subscribe to the types of events in which they are interested. Fig. 6 shows how the 4D service and the HTML table service listen for messages and, after they have received an event, translate the event into an appropriate action, usually the display of a particular visualization or the creation of a specific relationship. Specifically in this example, the user selected a milestone date in the table summarizing the milestones. The table view relating to the project specifications then highlighted the same date, and the 4D view of the project schedule and 3D model jumped to the selected date. Fig. 6 also shows how information interaction and view control can be separated from software services and their underlying data.

This simple example shows how a combination of interactive information access (e.g., participants in a meeting can get up and tap with their fingers on a date displayed on a touchscreen), some data sharing (the date is shared between different services) and simple visualization techniques (e.g., highlighting) help focus the attention of the participants on the information that is relevant for a particular issue.

When we started this work in late 1999, we planned to build the initial version of a construction information workspace on top of the semantic information exchange standards for the exchange of product data that have been proposed over the last decade, like STEP (Plantec and Ribaud, 1998), IFC, etc. They seemed to offer the best starting point for information sharing (Fischer and Froese, 1996). These information exchange standards can be powerful once a group of organizations has gotten them to work because a range of analyses based on the same information can be done very quickly. However, experience in applying them (see example above and, e.g., (Froese et al, 1999)) has shown that this is, so far, not a scalable solution because very tight coordination and working relationships are needed to make sure that all the semantics are aligned between software vendors and users in various organizations. Hence, today semantic information standards do not address the information sharing and interaction needs of project teams outlined in the introduction and in the example. A solution that lies between the semantic-rich information standards and the semantic-poor graphical information sharing approach is needed.

Currently the types of messages that provide the cross-linking of information are:

1) view
2) component name
3) date

These simple mechanisms to cross-link information quickly have, so far, proven to be easy to use and powerful in focusing users' attention on relevant information. They make it easy to share relevant information. By establishing important relationships between information in various documents and views generated by different applications they create visualizations that are effective in focusing team members' attention.

4.3 Planned next steps

In our next step, we will implement a context memory for interactive workspaces so that users can generate interactive views on the fly. We will test whether a team supported by the initial version of the construction information workspace is able to make better decisions than a team that is working in traditional settings. The value of information technology is often measured in terms of worker productivity (Brynjolfsson and Yang, 1996). Brynjolfsson and Hitt (1998) identify problems with typical methods to measure productivity that are based on ‘counting things’ but do not measure improvements in quality. We will measure the value of the information workspace for multi-disciplinary decision making with the following metrics:

- the number of tasks completed
- the amount of information considered in a task (completeness of analysis or discussion)
- the relative proportion of types of tasks performed in the meeting
- accuracy
- reliability (or consistency) of task performance

In the long run we will investigate what information needs to be shared, how it is best shared, and how users can best interact with heterogeneous information. We will study the power and the generality of the information sharing and interaction approaches we will formalize. An objective of our continued work is to refine these metrics and methods for applying them. If we are successful in our research, we will have developed an initial set of visualization functionality requirements for construction information workspaces and formalized metrics for future information workspace designers and developers to prioritize implementation of that functionality.

5. CONCLUSIONS

Significant research and development on interoperability of semantically rich data has been carried out over the last decade or so. With the commercial availability of IFC-based 3D product models from a number of CAD vendors and with the use of IFC data to drive applications such as cost estimating and energy analysis, a significant milestone has been reached in the last year. Our research in the context of the Center for Integrated Facility Engineering at Stanford University has shown that easy exchange of product models is certainly a desirable goal. The research in the interactive workspaces (iRoom) project has shown that the exchange of product models needs to be complemented with easy-to-use, easy-to-set-up information sharing and interaction approaches. We believe that the construction community can make significant progress quickly in leveraging existing and future investments in information infrastructure if it not only pursues software interoperability through the use of product models but also formalizes a focused sharing of information as outlined above. In the absence of well-tested interoperability of software, focused sharing of information can be set up more quickly than the exchange of product models. It will enable project participants to bring their expertise to bear on a set of related project documents and support multi-disciplinary decision-making. Finally, the separation of information interaction and view control from software services and data will lead to more intuitive and standard ways of interacting with and consuming project information. It will also create demand for the integration of product and other models and for the further development and use of visualizations for the multi-format information found on all construction projects.

6. ACKNOWLEDGMENTS

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