

# Representations of Work: Bringing Designers and Users Together

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## ABSTRACT

Over the past several years, we have been engaged in work practice and codesign projects with users of office systems products. In order to share and make explicit our understanding of user work practices with a wide base of technology developers, much of our emphasis has been on developing ways to describe the rich and complex world of user work practices. This paper describes a variety of approaches that we are using to represent user work practices in order to inform the development of emerging technologies so that they more closely align with the needs and work practices of users of the technologies.

**KEYWORDS:** Work practices, representations, codesign, development

## INTRODUCTION

*Escaping this flatland is the essential task of envisioning information - for all the interesting worlds (physical, biological, imaginary, human) that we seek to understand are inevitably and happily multivariate in nature. Not flatlands.*

- Edward R. Tufte

For the past several years we have been involved in the development and use of participatory design methods and tools in support of technology design at Xerox. During this time, the work practices community at Xerox has developed an evolving set of methods and tools to facilitate the work, a work practices toolkit of sorts, to assist us in our attempts to move beyond the flatlands discussed by Tufte (1990). The evolution of this toolkit has as its roots some of the approaches of ethnographic field methods and anthropology, cognitive psychology, graphics design and user interface design and evaluation. Our formal training stems primarily from psychology, human factors and graphics design. Our work experience is mostly with the

design of user interfaces (UI's) and information systems for systems office products (product design). More recently, we have been using these approaches to understand engineering work practices and to codevelop tools to support the work of engineering in product development. We view the work of creating work practice representations as an issue of user interface design, where the representations are an important aspect of the interface between users and developers. Many of the principles of user interface design also apply to the design of representations (e.g., chunking information in ways that are meaningful for users, iconic representation, use of color for emphasis and contrast).

Our role as designers has expanded from a traditional role to one that incorporates a more proactive, user focused approach. Instead of providing design input to existing technology specifications, we are now establishing and facilitating an ongoing relationship with users and engineers in order to inform and shape a product concept and design. Our work has brought a new perspective to our understanding of user requirements and the implications for product design and development, with an emphasis on understanding and representing the user's work activities and point of view. Along the way, our background as designers has provided a unique set of skills to bear on the issues of representing the rich and complex descriptions of user work practices.

The focus of development teams is to complete product development cycles within quality, cost, and schedule constraints. The ways of working used by these teams do not readily accommodate the kinds of ongoing interactions with users that work practice studies encourage. (See Anderson and Crocca, 1993, regarding some of the issues and impacts they faced as engineers trying to codevelop a product prototype with users). Our work has been very challenging as we try to evolve a robust set of innovative methods and tools as well as to provide development teams with useful, compelling user data to inform their development efforts.

The focus of this paper is to discuss some of the tools and methods we have been using to represent user's work

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practices in order to support and inform technology codevelopment efforts.

### DEFINITION OF REPRESENTATIONS

In the context of our work, we view representations as accessible and understandable descriptions and images of user work based on observed or imagined scenarios of work activities, environments, people, and technologies.

One of the primary objectives of our work on representations is to engage the development team as much as possible in the user's perspective. This means involving developers in the ongoing interactions with users either through direct participation at user sites, or via the interactions that take place around the artifacts and records brought back from user sites. Another objective is to represent the user in a way that the user views as accurate. For us, that means sharing and codeveloping our representations of users' work with users. Another objective of our work is to facilitate the envisionment of change, for example, of a new technology and its possible impacts on existing work practices.

Perhaps the term *re-presentations* best characterizes our work, emphasizing the notion that we are trying to present a view of a user site that closely aligns with events as the participants originally experienced it. Representations are not intended to be inclusive of all the activities occurring at a work site. The selection of a focus for our interactions with a user site, and the subsequent representations of the site is directed by the project goals.

Representations can take shape in a variety of media, for example, as illustrations on paper, Foamcore models, computer-based prototypes, videotaped scenarios, or combinations of these media. See Norman (1993) for a discussion of some of the strengths and weaknesses of using representations.

Representations are used throughout all aspects of our work in order to support the building of a shared understanding of the users' viewpoint (about their work practices, impacts of existing technologies, imagined impacts of future technologies) and to facilitate the analysis and communication of this understanding both with developers and users. They are also used to help shape, refine, and communicate results of our analyses; and are useful for reporting on this work, beyond the context of design, to other groups within Xerox, such as marketing and training organizations.

### REPRESENTATIONS IN USE

While the work practice representation toolkit is fairly extensive, we are still evolving, expanding and exploring its uses and applications. Part of the evolution of the toolkit includes using existing tools in new ways, as well as developing new tools to complement existing ones. To organize the following discussion, we have grouped the items in the toolkit into four categories of use:

1) representations as records of a field study; 2) representations as tools for analysis; 3) representations as communications tools; 4) representations for codesign and codevelopment. This is not an exhaustive or mutually exclusive categorization. Nor is the categorization schema meant to imply that the development and use of representations is a linear process. As in the process of design, the construction and use of representations is cyclical in nature. Figure 1 provides a more visual representation of this categorization, emphasizing the non-linear relationship among the categories. Many tools listed in one category can be used in other categories, or throughout a project. Several representations may be generated, modified, or reused concurrently.

#### Representations as records of a field study: Creating records of people, work, technologies, artifacts

A visit to a workplace represents a snapshot in time during the work day. Over the course of sometimes several interviews, observations and other interactions with members of a field site, we strive to build a good working relationship with the people there and an understanding of their activities so that we can reflect an accurate view of the workplace. See Holtzblatt and Jones (1993) for a detailed description of one approach for conducting and focusing interviews with users. Our goal at this point is to create records of work activity of the site: people, work, technology, artifacts, and issues they pose to us. This becomes the 'raw data' for the next steps. Some of the tools we use to capture information about a work place include the following:



*video and audio tape records*

*Video and audio tape records* are made of most of our interactions at user sites. Being present at a user site and having the opportunity to ask questions directly about work activities helps to provide a foundation for very rich descriptions of the activities of the work place. While we videotape because observation is inherently incomplete (videotaped records are also incomplete), there is an additional reason. Since it is not possible (and often not desirable) for all the members of a development team to be present at the user site at the same time, we record site visits, primarily with videotape, using audio tape as a backup or in instances when it is not possible to videotape.

There are several advantages to obtaining video records of work site activities. Key is that we leave the site with incredibly detailed records of the activities we observed or participated in. There is little doubt that hearing and seeing

*Representations in use*

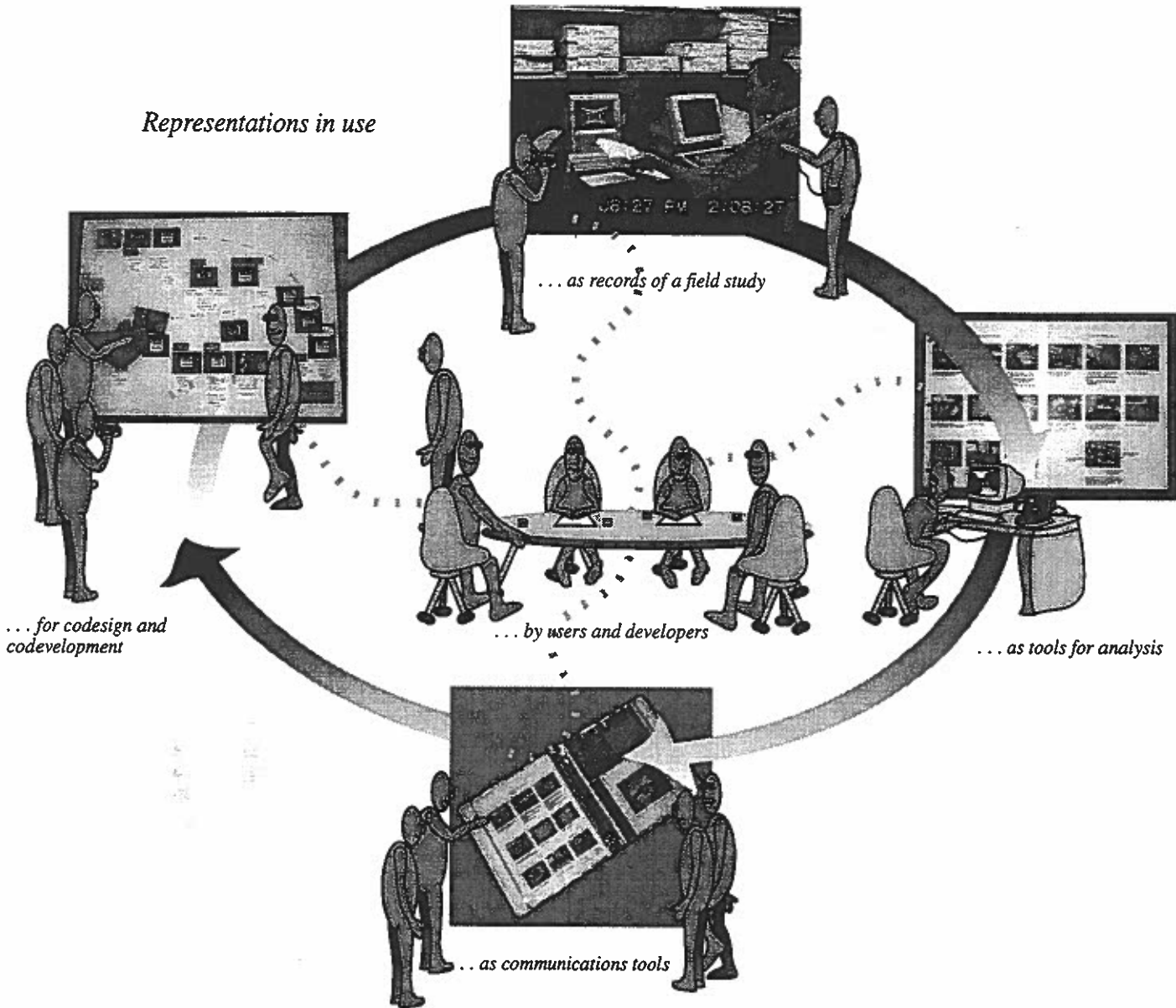
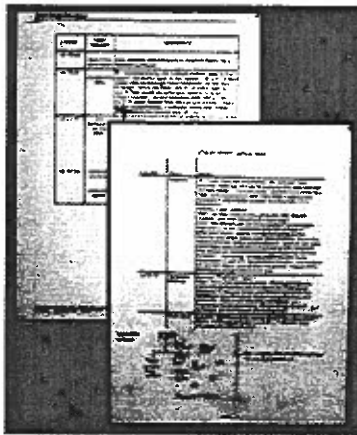


Figure 1: illustrates the four categories of representations and their relationship to one another. The development of representations for a work practice study is a cyclical process. Central to their inception and further development are the initial interviews, observations and interactions that take place with users. From these and subsequent interactions with users and members of the development team, representations of user work practices, design concepts and their potential impacts on work practices can be defined, iterated and used to facilitate further analyses, codesign and communication activities.

users in the context of their day to day work activities impresses upon observers what the work and issues surrounding the work are for the workers. The sights and sounds captured on videotape serve as a basis for some of the future work to be done on building representations of the work. Videotape records make it possible for people who were not at the site to have access to conversations and images from the original interactions. Videotape also makes it possible to go back, many times if necessary, to review events, to obtain more detail or to clarify a sequence of actions. For a discussion of videotape as a medium for understanding work practices see Suchman and Trigg (1993). Blomberg et al, (1993) discuss some of the options and issues with conducting site interviews and creating videotape records of interactions with users.



transcripts and logs

*Transcripts, content logs, and field notes*<sup>1</sup> or some combination of these are compiled after each site visit. In addition to videotape records, we make transcripts, some quite detailed, of audio and videotapes. In cases where a full transcript is not necessary, or possible given time constraints, there are content logs, which denote the highlights or major events, dis-

ussions, or observations contained on a video or audio tape. Also, there are notes and sketches taken in the field. Generally, these are stored electronically.



sample artifacts

*Artifact collections* are compiled. These consist of available artifacts such as sample documents, process and organizational descriptions and maps used by the site, and samples of what the site delivers to its customers. These artifacts shed considerable light on

the user's customer, which is critical to the success of the workplace and hence provides us with another key to the worker's perspective of what is important.

*Library collections* consisting of the tapes, transcripts, and artifacts are stored in a work practices library, for reference and reuse at a later time. The library serves as a collection point for a project. One initially unanticipated benefit of maintaining this collection, is that we have been able to refer to tapes from previous projects and sites in the context of new issues on new projects. At the onset of any project, we generally pose some very open-ended questions about work, technology and document use at the worksite. Often we hear about issues, technology uses, and work practices, which although not central to current development efforts, become so in subsequent studies. The work practice library has enabled us to reuse relevant user input on issues based on earlier work.

**Representations as tools for analysis:  
Describing and analyzing site records**

Once data are collected from a site, one of the most critical, and difficult steps is to make sense of what is in the data. The work of analysis can result in a series of representations and take a variety of forms. As soon as data are manipulated, analyzed, and interpreted in some way, a new form of a representation will exist. The representations we build attempt to convey the rich interactions of the people, places, things and activities in a workplace. Some of the representation formats we have found most useful during the course of analysis include the following (See Figure 2):

*Illustrations* are typically used to characterize some aspect of a site, a work activity or a proposed design. Illustrations typically highlight the flow of information, artifacts and activities and include descriptions of technology, documents, and of course, people and practices. Illustrations can be made up of sketches (computer-based or hand drawn), videotape stills, photographs, copies of notes or documents, or combinations of these.

*Collections of videotape excerpts*, either in videotape format or as a series of videotape still images, can be used to illustrate key highlights or observations about site activities to review and share with members of the development team who were not present at the site, so they gain a sense of the user's work, the challenges they face and potential solutions to these challenges. Videotape excerpts can also be used in discussions with participants at the user site, to clarify and confirm our understanding of activities captured on videotape.

*Storyboards* consist of a series of images (illustrations, video stills, photographs) with captions to describe, for example, some portion of a work activity, a proposed use of a technology, or a process change. Storyboards are particularly effective when comparing an existing process or activity with a proposed version, because you can examine

<sup>1</sup>We recognize logs and transcripts as analysis, but include it here because they are the detailed records that provide the basis for more detailed analyses.

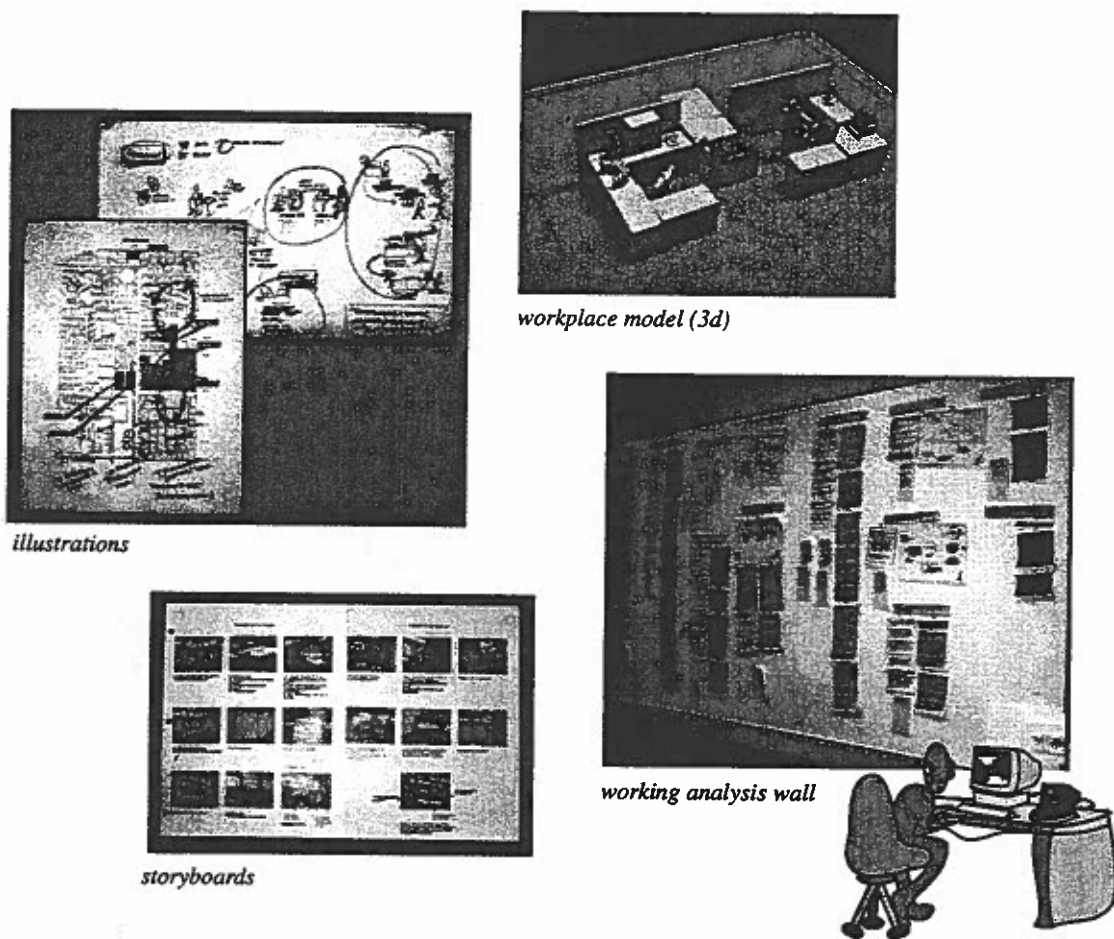


Figure 2: Representations as tools for analysis

the two versions side by side. Storyboards lend themselves to describing activities in a linear fashion.

*Workplace models and maps* of the workplace enable layout of existing workspaces (people and technology) for review and revision in 2 or 3-dimensional form. Overlays (clear plastic sheets) placed on a clear Plexiglas shelf above the models can be used to make notes, annotations, or sketches in reference to the model. (See Holtzblatt & Beyer, 1994, for a description of physical models of work. They present physical descriptions of user sites in diagrammatic form).

*Working analysis walls* are large, pinable boards or wall space where analyses-in-progress can be posted and worked on collaboratively with other team members. As we examine data collected from the site, initial impressions, sketches, questions, etc., are noted and posted. Results of subsequent interpretations can be added as they are developed. By placing clear sheets of plastic over the top of the walls, we can create and organize the results of our analyses in layers. This can be useful in simultaneously presenting various perspectives of the results and making them available to a team of people. See Blomberg et al, 1993, for a brief discussion of an example of a 'video analysis wall' that represents the results of analyzing site

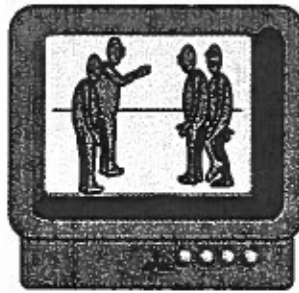
videotapes. Working from transcripts of a site visit, Holtzblatt and Jones (1993), discuss the recording of successive interpretations of data using Post-its. The Post-its are then categorized using Affinity diagramming.

**Representations as communications tools:  
Building a shared understanding with others**

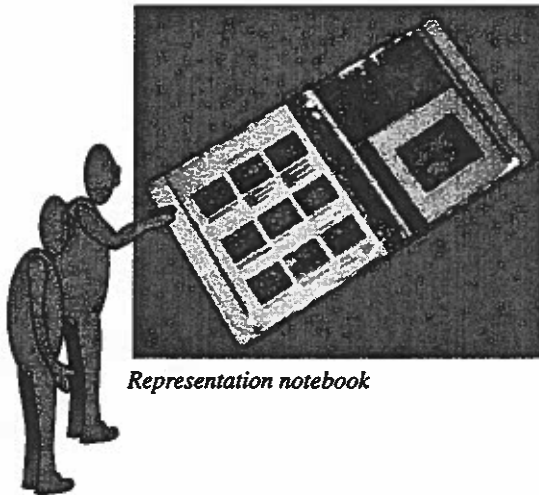
As analysis and work with users proceeds, it is important to verify and modify our emerging understanding of the people and work practices of a site with the participants from the site. We also need to share our findings with members of the development team, many who may not be as involved with the user site. The above mentioned representations start to provide the foundations for this sharing. Often, we will take the static representations (maps, storyboards, models) to the user site so the participants can review and help us revise the representations. Depending on the structure of our team, technology developers may participate in some or all of the interactions with users at the users' work site. In addition to providing us with information, this process helps build our relationship with the users. It offers them an opportunity to see and modify the representations evolving from the information they are



*Coviewing session*



*Animations*



*Representation notebook*



*Developer workshop*



Figure 3: Representations as tools for communication

providing and facilitates understanding between members of the development and user communities. A key goal is to facilitate communication and the iteration of ideas and information.

Over the course of several projects, we have observed users at the work sites make use of codeveloped representations in interesting ways. For example, users and their management have used representations to display their work to others in their workplace. In one case, we characterized some unique skills and working styles within a group that was about to merge with another department. The characterizations were used in the merger discussions so that the teamwork and work practices exhibited by the group would be preserved in the merger. In some situations, representations, and the process of codeveloping them with users, provide a voice to workers who, though they may be experts at the work they do, may not be very articulate about it. Representations provide a way to characterize work practices, responsibilities and issues in a sharable format. In addition, representations make explicit some aspects of work that may have become transparent to the workers.

The following are a combination of representation formats and processes that may come into play as vehicles to communicate and put representations in a context for use by and with others. (See Figure 3).

*Reports* are typically paper and electronic documents that could include text, illustrations and video stills to describe a project and findings to date. In relation to all the other forms of representations, reports are not particularly useful to or used by the development teams. They are used primarily as a form of introductory reading for potential collaborators on new projects.

*Animations*, usually combinations of computer-generated graphic illustrations and videotape excerpts, are useful in reporting key findings and conclusions in a dynamic and succinct way. Animations can also be used to help define and construct scenarios of technology use that do not yet exist. Animations help bring these concepts to life.

*Representation notebooks*, are collections of representations developed over the course of a project. Notebooks provide a useful visual description of our



progress and insights in a portable format. The notebooks can be arranged by project or site, or can contain representations from a variety of projects and used somewhat like a portfolio of representations that can be used to discuss work practice methods with new collaborators.

*Project walls* are somewhat a continuation of the working analysis walls discussed earlier. Like working walls, project walls consist of a large pinable space. In addition to the results of analyses, the project walls may contain more refined summaries of findings, issues, questions for the site, and artifacts, as well as design documentation, concepts and product schedules from the engineering community. Project walls serve as a dynamic, sharable, centralized description of a project in progress.

The following set of tools, although not representations in and of themselves, are key to the development and use of representations. They are included in this section because of the central role they play in facilitating communication among the collaborators in a work practice/codesign project. Kyng (1994) describes the value of representations in facilitating communication about the system being designed and in identifying issues and misunderstandings about the participants work activities. We find that the following sets of tools are very effective in encouraging the kinds of communication Kyng describes.

*Coviewing sessions*, previously described by Brun-Cottan (1993), are usually informal meetings where selected segments of videotape are reviewed and discussed with members of the development team. Coviewing sessions can also take place with participants, or with a combination of users and developers. We typically videotape the coviewing sessions. This provides a record of meetings where issues are raised, potential design solutions are proposed, and insights are gained by those in the development community. See Suchman and Trigg, (1993) regarding videotape analysis and its relation to design.

*Site workshops* can happen for several reasons. See Kensing and Madsen (1991), for a report on the use of Future Workshops and metaphor discussions to generate design solutions. Greenbaum and Madsen, (1993) used Storytelling Workshops to allow people within an MIS department to share experiences about computers use in their day to day work. This was followed by Future Workshops to help characterize current issues, identify potential solutions and plans to implement the solutions. Most of our experience is conducting workshops with users to: 1) codesign concepts; 2) summarize our findings to date, solicit user input on them, define next steps; and 3) to conduct "what if" sessions where several potential scenarios or technical possibilities are discussed in the context of current work practices. During site workshops we use many of the representations resulting from our analyses. These often need to be repackaged or resized, so they can be used in a group context. These workshops are videotaped.

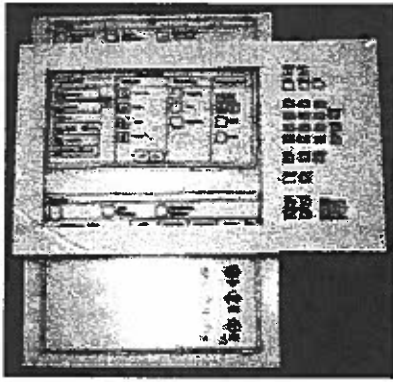
*Developer workshops* can take place throughout the course of a project. We encourage developer participation in the field work and use workshops to conduct hands-on training of ethnographic field methods and tools. The development teams we have worked with range in size from 10 to 50 people who are directly concerned with utilizing work practice information. This often means that only a few of the developers will be actively involved at the user site at any one time. To reach a broad base of the development community, we also have workshops to communicate findings and insights, generate sets of issues to be addressed by design, generate design solutions with the development team and organize future working sessions with the user site. These workshops are usually videotaped.

#### **Representations as codesign and codelvelopment tools: Putting the design in the hands of users**

One of the key elements in codesigning with users, is building representations and concepts that put the design in the hands of the users. During the course of a project, participants at the site will have seen and helped construct many of the representations discussed so far. When it comes to concept or prototype design, it is important that the concept representations be portable so that they can be taken to the user site. It is also important that the concepts be easily manipulated and modifiable by potential users of the concept. We want to encourage the kinds of discussions and input that arise as users begin to envision how a concept for a technology will fit in with their current work practices and expectations. We also want to encourage the users to try the concepts and experiment with changing them. Most of the representations we use during codesign are intended to be modified by the users, by marking them up, adding annotations, adding new pieces, moving pieces, etc. Our strategy is to keep the concepts looking unfinished, so the users will feel at ease making changes to them. Some of the representation formats we have found most useful in facilitating codesign include:

*Storyboards, illustrations and maps*, as described above, can be used extensively in codesign to describe current and proposed work activities and processes. They are easily marked up, rearranged, and edited by potential users. Madsen and Aiken (1993), developed an approach called Cooperative Interactive Storyboarding Prototyping as a way to involve users in the design of user interfaces for VCR's early on in the development process. This approach brings traditionally static storyboarding into a more dynamic realm.

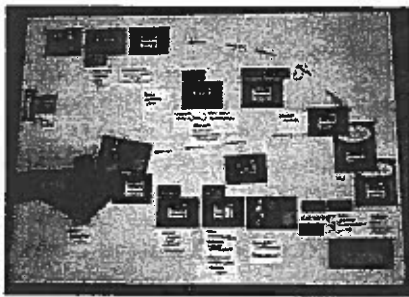
*Concept models* can be either be 2 or 3-dimensional mock-ups of a technology under development. Three dimensional models are usually constructed of Foam-core and are used to represent the size and shape of a proposed technology and its components. We typically use 3-dimensional models to simulate the design of computer-based user interfaces. These models may have a display bezel with some controls and



*concept model*

ups for cooperative design include, Ehn & Kyng, 1991; Bødker, Grønboek, & Kyng, 1993; Sanders, 1992.

*Concept sketches* are usually rough illustrations depicting what a proposed technology might look like and how it might function. These can easily be marked-up by users, but are typically less modifiable than concept models. They are used early on in a study to confirm design direction, prior to building a concept model.



*visualization game*

**Visualization and construction games**

have been used primarily to represent work activities as well as user interface design concepts. They are similar to a children's toy called Colorforms. They are intended

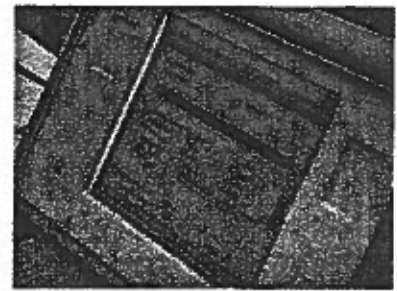
to be easily modifiable, fun to use, and encourage interaction and discussion between the developers and users. The games consist of a static cling vinyl game board and vinyl game pieces. The pieces may represent components of a technology design, or the people, technology, documents, and activities involved in a work activity. The goal is to codevelop an arrangement of the game pieces that represents, for example, an accurate description of a work activity or an agreed upon proposal for a technology concept. See Muller (1993) and Ehn & Sjögren (1991) for their application of 'game-like' tools to support design.

*Prototypes* are intended to be a somewhat functional version of a proposed concept. Our experience here has focused primarily on user interface prototypes for computer-based equipment and tools. For user interface applications, it is often possible to display interactive concepts on a laptop computer. Prototypes may also consist of an early release of software that can be installed on the user's computer. Prototypes are typically more dynamic and interactive than concept models and storyboards. Several authors have described the use of prototypes in

displays, and an area to represent the screen itself. Here we may use sets of illustrations depicting various configurations of the contents of the screen that can be overlaid or inserted in the bezel. Others who have used concept models or mock-

participatory design efforts (Bødker, 1991; Thoresen, 1993; Bødker & Grønboek, 1991).

The use of these representations to support codesign results in the generation of more data based on the videotaped



*prototype*

interactions of users and the representations. These data can be used to inform the design. The representations can also serve to introduce a new technology into the field site, placing the technology in the context of existing work practices. The outcome is an understanding of the impacts of such a technology, the implications for its continued design, and gaining insight into the direction a project should proceed in with a particular set of users.

Figure 4 illustrates how representations within each of the categories in the toolkit have been used throughout the course of a project. Representations from each of the categories are developed, used and interwoven with the needs and directions of the project in a cyclical manner.

**TECHNICAL ASPECTS OF CREATING REPRESENTATIONS**

We have found a variety of tools and techniques to be useful in the creation of our representations. The level of representation being created determines the type(s) of tools to be used. It is important to note that this list is evolving as we are always exploring new and different ways to represent information.

**Data Collection.** For the collection of raw data we use a HI-8 video camera, a professional quality audio tape recorder, a sketchbook and/or notebook and a Macintosh computer. During data collection, it is preferable to have two people on site at one time: one to manage the technical equipment and one to interact with the participants. In some cases, a camera can be left on a tripod and let run. This could be the case when only one researcher is available to be on site. This technique could also be used to observe without the presence of the researcher. We have recently begun experimenting with real-time video logging tools so we can create preliminary logs of videotaped interactions while videotaping at the site.

**Data Analysis.** In order to manipulate raw data for analysis and communication purposes, we use a Hi-8 video player, a Macintosh computer with a video board and software for capturing still images and QuickTime movies, graphics, animation and word processing software applications, a color printer, a sketchbook, Foamcore and CVideo, which is a software application for transcribing time stamped videotapes. The video board is used for digitizing collections of videotape excerpts. The graphics



*The evolution and interweaving of work practice representations*

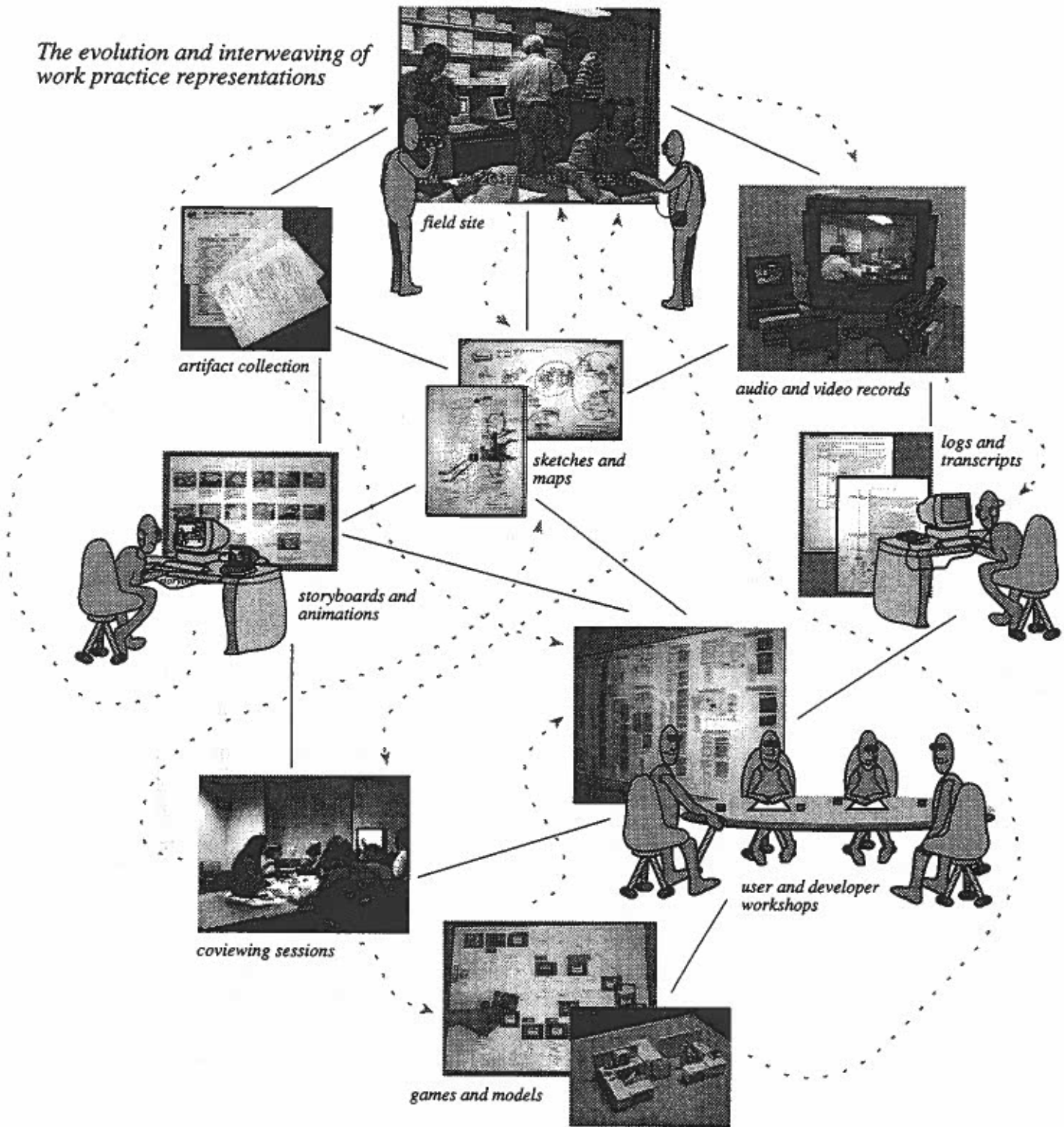


Figure 4: illustrates how many of the representations discussed in this paper are used during the course of a work practice/codevelopment project. On the basis of the ongoing interactions with users and developers, the representations evolve, interweave and affect further representation generation as a project progresses.

and animation packages are used for creating maps, animations and storyboards by incorporating original drawings of people, places and technologies in combination with real video. Word processing software is used for writing reports and creating transcripts. Foamcore is used for the creation of project walls, 3D models of user environments, and technology concepts. A considerable amount of storage is required for these representations. Digital image files can consume megabytes of disk space while project walls and 3D models require dedicated lab space. Storage space of raw data is also a consideration as the volume of videotape, audio tape and collections of artifacts continue to grow with each project.

**Codevelopment.** For the manipulation of representations for codesign and codevelopment, we incorporate all of the above mentioned tools as well as static cling vinyl, Post-it notes and colored markers. These tools are used to create visualization and construction games, concept models and sketches and interactive prototypes.

#### **FUTURE DIRECTIONS FOR REPRESENTATIONS**

As our user base increases, as technology improves, and as the work practices community evolves, our representation toolkit will continue to grow in new and interesting ways. We are currently examining several avenues of tool development, such as exploring new methods of capturing information as users continue to adopt new methods of doing work. For example, some of the engineering organizations we work with are using Media Space technology in order to help bridge the geographical distances which separate members of a community. (Refer to Bly, Harrison & Irwin, 1993 for a comprehensive description of Media Space technology). The Media Space, although facilitating remote collaboration with the aid of video technology, presents a challenge in collecting data at one site that is (virtually) connected to another site. Not only is the collection of these data a challenge, but the representation of this type of rich information will add new dimensions to our work.

Applications that are faster and easier to use for the creation of representational images are continually being introduced. People will continue to communicate in new and different ways, across various platforms and using a variety of media. Our representations will need to reflect these new forms of communication. Paper will probably never disappear as a vehicle for representations, but as these images become more complex, so must the media which displays them. We are exploring ways to create more interactive, dynamic representations of work activities.

Storage and retrieval of our representations has always been an issue and will continue to be in the immediate future. Repositories are currently being investigated to house a variety of media that is easily accessible to a wide audience across a range of platforms. Such wide access may have its advantages but privacy and security of information poses

some difficult challenges. How do we determine which information to make public and which to keep private? How do we protect images that are so easily accessible? We want to share the information, but we must protect the interests and privacy of users and collaborators. These are questions that must be continually explored as the future unfolds.

#### **CONCLUSIONS ABOUT OUR WORK WITH REPRESENTATIONS**

Representations have been instrumental in facilitating our understanding and interactions with user groups and development teams. Reflecting on our experiences with a variety of user sites and projects, some key themes and lessons learned about representations emerge.

**Representation reuse.** The ability to reuse data, analyses, tools, representations and even user sites across projects has been an unanticipated and welcome benefit of our work. Part of our ability to reuse data stems from the fact that our projects have been focused for several years on office document technologies. However, because we focus on the general topics of people, their work practices, documents and technology, we obtain a wide variety of descriptions of the work activities and the technologies and practices that support them. It is this variety, and its richness of detail that has provided the foundation for reuse.

Many of our tools have been intentionally structured to support reuse. For example, we have a library of basic images that illustrate many of the elements of the workplace such as animations of people, graphics of computers, and descriptions of document use. This library can be used to quickly construct new maps and work flow descriptions.

In addition, the work practices community has made an investment in developing standard procedures for documenting and storing, records (e.g., tapes, transcripts, etc.) from site and codesign activities so that they are available when an opportunity for reuse arises.

**Facilitating communication and innovation.** Our studies of user work practices and codesign efforts are about building understanding and communication on the way to developing innovative solutions. In our case, the purpose of the communication is to facilitate the process of developing technologies that better fit the work of the user. One role of representations is to be an interface between the developers' interpretations of user activities and the users' perspective. Thus, representations can provide a way to bring issues and misunderstandings to the surface. Representations can also increase the bandwidth of understanding between a group of developers and a group of potential users of a technology. Developers may gain an appreciation for the user's efforts to overcome the shortfalls of a technology that gets in the way of completing a task, or an appreciation of the rather insignificant role a technology may play in the grand scheme of the user's day

to day work activities. Sometimes, to the dismay of developers, they may find that the technology into which they are putting so much effort, can be viewed as an inconvenience to be overcome, or avoided, from the user's perspective. Representations may also be used by a site to support their current work practices, help realize desired changes to work practices, and communicate to others within their organization.

**Putting design in the users' hands.** The representations discussed in this paper are constructed in a variety of media, covering a range from high to low technology implementations. To encourage user input, representations are often presented in an informal state. The way they are modified can also be very informal, e.g., using markers, Post-its, rearranging pieces of a map or controls on a user interface. Our emphasis is on the development of accessible representations early in the project, so they can be shared, modified, expanded as the project progresses.

**Keeping users in the picture.** Using computer-based video capture tools, we have been able to include images of users and their workplaces in the representations. This adds a dimension that influences both user input and developer acceptance of data. Users can identify themselves in the representations, and are eager to ensure the representations are accurate expressions of their activities. Developers have a set of real users to associate with the results of the project. Our experience has been that developers more readily accept input as more credible when it comes directly from the users, rather than through an interpreter or a report.

The story of work practice and codesign representations is one of trying to understand and describe the users' point of view, with the intention of providing technology solutions that fit with and support users' existing work practices. In developing representations we strive to understand the essential elements in the interactions we observe in user sites and to characterize them in ways that are meaningful to the user and development communities. It is in this sense that we see our work on representations as helping to build the bridges between the work of users, their understanding by developers, and the technology solutions that reflect this understanding.

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