Virtual Workplaces

When Metaphors Breakdown

by

Thomas W. I. Gallemore
B.Arch, Carnegie Mellon, 1991

Submitted to the Department of Architecture in partial fulfillment of the requirements for the degree of Master of Science in Architecture Studies in Design Technology at the Massachusetts Institute of Technology
June 1998

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Abstract Our model of work is shaped by the places we choose to work and the tools we choose to work with. As we introduce new technologies and build new environments our model is changing. Today's virtual workplaces are grounded in models of work that have been reformed from our experiences using current technology in physical workspace. However we are discovering opportunities and possibilities for work in collaborative, virtual environments that question physical models. Emerging patterns of distributed collaboration in persistent virtual environments are changing the way we work in time and space, recasting our notion of workplace. Virtual workplaces are interpreted and experienced through metaphors that describe a space of potential for work occurrences. Through the lens of metaphors, this research focuses on breakdowns between collaborative work and the environment in which work occurs. If what we understand and predict is based on what we already know, then by examining the breakdowns between design and use of collaborative environments we can illuminate the space of possibilities for collaborative work.

Thesis Supervisor William L. Porter
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Acknowledgments

This research is a collaboration between MITRE Corporation of Bedford, Massachusetts and MIT Space Organization Research Group (SPORG) in Design Technology. The common ground stems from MITRE's research and development of Collaborative Virtual Workspace (CVW) and MIT-SPORG's design research in physical and virtual collaborative work settings and tools.

Thesis Readers William J. Mitchell
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Tari L. Fanderclai
MITRE Corporation, CVW Development Team
For whom I am especially thankful for all her support, coordination and virtual presence throughout

Thanks RCF Team at MITRE
CVW Development Team at MITRE
For their patience, and candid good humor

Mike Joroff
Senior Lecturer in Architecture and Planning
For supporting and questioning my questions

Chuck Kukla
Senior Research Scientist, Digital and MIT-SPORG
For making opportunities happen

Turid Horgen
Research Associate, SPORG-MIT
For questioning everything and making design matter

Edith Ackermann
Associate Professor MIT-SPORG and Research Scientist, MERL
For teaching, learning, teaching, learning...

Melissa Kingman
For all her help, love and tolerance and for making life physical

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Modeling WorkPlaces

The phone rings. The doorbell buzzes. Your Email dings. Does someone want your attention or is someone just passing along a message? You screen your calls, you look through the peep hole, or filter incoming messages. Depending on who it is or what it is about, you will decide whether or not to engage an immediate response. You are in control. The door opens. A co-worker stops by your desk. A message instantly appears on your desktop. It doesn't matter who it is or what it is about, you have to respond. Not only is it easier to reach our colleagues, it is easier for them to reach us. When we work together we adapt conventions for how we interact in space and time. When someone answers the phone we expect a responding 'hello', when an office door is open we assume availability. When we work in different places and at different times we adapt our behavior to fit the context. If there are no doors we may use signage or body language. Over time the patterns of behavior become convention, through mutual acceptance and reinforcement.

The patterns in which we interact with one another and with our context, form the basis of our model[1] of work practice. If our goal is to improve the way we work, our purpose for modeling is to describe and access key features and their relationships so that they can be finessed. By constructing models we can make hypotheses and evaluate alternative theories. Models do not replicate either the real or imagined original, rather they are incomplete, and are inevitably susceptible to distortion. If our model is too detailed, the features become increasingly cumbersome to access and manipulate. If too obscure, the features and relationships become increasingly difficult to identify. The way in which we represent and describe our models are then subject to rules of interpretation for accuracy.

By observation and engagement in work, we are continually validating and reshaping our models of work practice (Black 1962) to test out new processes and work strategies. Our constructions and interpretations are asymmetrical and are due individual differences and contextual differences. Individual differences are due to professional orientation, personal style, background experience as well as emotional state or career position. Contextual differences are due to available resources, indexed references and presence of others. When we construct shared models of work practice for collaborative work, we need not reconcile the differences, we need only to provide a structure that can accommodate individual and contextual differences. The key to understanding, is the structural consistency in which assertions made in our model can be related to what we are modeling. If our purpose is to improve the work practice then the value of our model will be in revealing relationships and features that we may have otherwise overlooked. The challenge of interpretation then, is that of dueling inquires: what does the model reveal that is new, and what does the model hide in its incompleteness.

If we return, to the previous example, we can see that behavior is influenced by the tools and places in which we work, in this case the convenience of interaction. Eventually, as we become more familiar with our tools and our workplace, these patterns of behavior become internalized in our models of work practice. When we don't want to be disturbed we close the door. In this model of the workplace, the function of the door is to avoid unwelcome interaction, by providing privacy and maybe security. The door provides a way to control, or at least influence, interactions. When we move to an open office layout, without doors, we naturally feel the loss of privacy. If we apply our model of the door to the new context, we would look for solutions that meet our need for privacy. First, we would consider those properties of the door that provided

privacy, such as enclosure and visual and acoustic separation. Next we might consider a 'do not disturb' sign. If all else fails we might resolve to relocate. What our model hides is that the door did not function without the mutually adapted convention for its use (in this case that a closed door implies 'do not disturb').

The promise of modeling work processes and work settings is to provide insight on existing practice, to explore alternatives for new ideas, and to generate inquiry into meaningful design. The challenge is to see beneath the surface, to reveal the hidden structures that influence the construction and interpretation of models that generate solutions and preclude others. Our models of work are shaped by the contexts in which work, the tools with which we work, the people we with whom we interact and the work in which we perform. When any of those factors change, we use our models to adapt to new situations, and we adapt our models to the new experiences. Interpretation and construction of models is a continuous process of evaluation and adaptation to change. The delay between the affects of change and our understanding of change (to the point of affecting our models) results in an constant gap between our models of work and the realized work practice. When faced with rapid and radical change, the gap widens and our rules for interpretation become less and less reliable.

It is no surprise that communication technologies are again radically changing where we work, when we work and how we work. On both the academic and corporate fronts technology is transforming how organizations communicate, learn, and respond. Academically, organizational theorists have been recasting models based on change management, and market responsiveness and organizational learning. On the corporate front, most notably in the financial, medical, manufacturing research and development and software, telecommunications industries, the shift has been from service work to knowledge work. For the service organization, concern was organizing information and resources within existing technological and political infrastructures. For the knowledge organization, concern is more with innovation and networking knowledge communities between technical and political infrastructures (Worthington 1997).

Communication technologies have radically shifted the way in which we use space and time in work practice. The workplace has no boundaries, its whenever and wherever need arises. New patterns of distributed workplaces and asynchronous work occasions are reconfiguring the organization into "networks of conversations" (Winograd and Flores 1987). The workplace exists in both physical space and cyberspace. The designers of collaborative technologies are not only making tools that are changing the physical workplace they are designing places that people inhabit in the virtual workplace. Virtual workplaces are being designed with the same models that we use to design physical workspaces. Designers of physical and virtual workplaces are developing different rules to interpret the same models of work.

> "A new generation of computer network software aims at building virtual communities: permanent (or at least recurring) online meeting places where people can work, play, buy and sell, gossip and govern, flirt and fight and generally seek their fortunes. ...There is a profound need for architectural insight into the task of building virtual environments that are fit for human habitation. On the other hand, the software community has learned some quite general lessons about the design of structures flexible enough to survive repeated changes to their support systems and open enough to support repeated re-thinkings as to their functionality—topics of no small interest to anyone who designs physical places for people in today's madly changing world." Dr. R. Rockwell, Chief Scientist for Blacksun Interactive (Rockwell 1998)

What is assumed in physical workspaces about time, space and process are central questions in virtual spaces. How do our assumptions of physical workplaces operate in the design, use and evaluation of virtual workplaces? As we begin to inhabit virtual space and adapt conventions for work, how does our model of physical workplaces change? What are the structural relationships operating between physical and virtual workplace models? The question of greatest concern among organizations, workers and workplace makers, is how well does the workspace support the work processes, not whether it fits some operative model of

workplace? To leverage the workplace against work practice, will require new models that integrate physical and virtual work spaces.

Knowledge Work

Before we consider how work is changing the workplace we need to consider the nature of knowledge work and how it relates to the virtual workplace from the perspective of the individual worker, the organization, the customer and the workplace designer

The "knowledge worker"[2] works between organizational boundaries. Working in both physical and virtual space, they build and maintain professional and social relationships across organizations and over time. Despite job, career or residence changes, the knowledge worker's virtual workplaces are populated with lifelong collaborators (Pruitt and Barrett 1994). What is important to the knowledge worker is intellectual and business opportunities, impact and lifestyle. Loyalty is to the work and personal relations rather than the organization. Unlike their physical model, their virtual workplace is an infrastructure of people and networks rather than buildings and infrastructure.

For the corporations, the challenge is knowledge management. The new knowledge worker is extremely mobile. Attracting and maintaining a talented workforce will be more a factor of the work, educational and lifestyle opportunities. Compensation, benefits and workplace amenities will be of secondary importance.

> "Managing knowledge workers is different from managing industrial age workers and requires taping into deeper human values, it demands developing an atmosphere of trust and respect and support for creativity without that, your best talent walks" Dr. Prasad Kaipa (Miley 1995)

The value of the knowledge worker is in their capacity connect and manage their knowledge network and align it with the needs and goals of their organization. The more projects that the worker is involved in, either internal or external to the organization, the more experienced and valuable they become to the corporation. As workers flow through the organization, corporations will have to become adept at capturing and incorporating knowledge contributions. Management theorists are stressing the need for 'organizational learning'[3]in order to survive and grow. Maintaining relationships and connections is becoming an increasingly important role of the virtual workplace. The facilities managers of the virtual workplace will be as concerned with intellectual property management, as the traditional facilities manager is with real estate and resource management. Workplace strategies that superimpose new technologies on existing patterns of work are blind to needs and potential of the knowledge worker and incapable of maximizing a return on infrastructure and human resource investments.

For the knowledge consumer, the shift has been to knowledge transactions. Getting what is needed, when it is needed is not enough. The knowledge consumer wants to learn the alternatives and trade-offs. For the consumer, no one knows better what their needs are than themselves. Consumers are and becoming a part of the work process. The value of their investment is how responsive the corporation is to their needs and objectives. The knowledge consumer does not buy into a product line they invest into an organization as a resource that helps them meet their needs. The role of the virtual workplace will be to provide customers access to their resources. Likewise it provides knowledge organizations access to the needs of their customers.

For the workplace design professional, the virtual workplace has only been a means to an end for designing physical spaces. Virtual reality has enabled design teams and clients to simulate and predict design alternatives intended for the physical environment presupposing that virtual reality is intended to become physical reality (Chaplin 1995). Communications technologies are becoming increasingly prevalent in the workplaces of design professions, but only to the extent that any another tool can be added to their toolkit. Undoubtedly the tools that architects and engineers use and create have influenced their perception of

possibilities for what things that they can build in physical space. However as designers of places where people live, work, and play, the design virtual places remains an unrecognized, callow practice.

Physical Workplace

Physical workplaces are not designed, they happen wherever and whenever needed as long as the environment can support work. We adapt our work processes to fit the social and physical contexts. Likewise the practice of workplace making is the artful reversal of this process, adapting the social and physical context to fit the work practice. Information technologies are radically expanding the space for potential work occurrences. To many, the question is not how space can support work practice but how the technology can support it. Innovations in information and communication technology are the most active agents of change work practice and work settings.

In response, innovations in building and information infrastructures are driven by the demands of communication technology as well as benefiting from it. Cabling systems and wireless technologies are rapidly filling the market with new options. 'Intelligent building' systems are integrating architecture and building services with information technology and improving building performance [4]. Many building technologies leverage information technology in the design and evaluation of building systems.[5] Innovations are improving building controls, reducing energy consumption, and extending life cycles of building systems. Technologies are responding by humanizing the built environment, providing personal environmental controls, and healthier lifestyle options.

For the workplace designer, the demand is to improve efficiency and add value to the workplace by integrating information technology, and providing greater flexibility for changing work practices (Worthington 1997). To meet demand for flexibility, both building technologies and information technologies aim to accommodate the needs of the individual worker. Technologies to support collaboration and group work have taken a back seat to innovations centered around the preferences and needs of the individual. The approach of information technology has been to connect individual PC's through networks and communications software. Consider the typical tools in the workplace of the knowledge worker: a PC, phone, calendar and desk , all designed for the accumulation, processing, transmission and distribution of information. The office is a node in a network of communications and information technology. A closer look reveals an underlying design ethic aimed to the support the individual, there is very little if any tools explicitly designed to support collaboration (Schrage 1991). Given an approach that focuses on the individual, the potential of the organization is limited to nothing more than the sum of the individuals. When we consider the impact of information technologies on the design of workplaces we cannot ignore the generative causality of the PC paradigm. The model of the individual worker in a personal workspace is so deeply internalized in design of workplaces and information technologies that the causal relationships are resisted and difficult to surface.

Mobile information technologies that support anytime anyplace are making workplaces more distributed, blurring the traditional boundaries between work and play, home and office, individual and community. The places that we identify as workplaces will become more conducive for interaction, more adept to change and more responsive to the needs of the occupants. Patterns of work will likely continue to become increasingly mobile and nomadic, erratic and spontaneous. Workspaces will become increasingly diverse with dense pockets of shared resources and specialized task based spaces. Knowledge workers will make use of multiple shared workspaces for individual and group activities that claim temporary and shared ownership as work demands. (Laing in Worthingon 1997) As mobile personal computing becomes an indispensable part of our lives the home office and office home will obscure the distinction between work and play.

Facilities managers are adapting new strategies to cope with the demands for flexibility (Vischer 1996). Telecommuting from the satellite office and the home office are providing attractive alternatives for work practice. Research has shown that corporate telecommuting strategies are yielding comparable levels of

productivity, and reducing some of the commuter stress. However, in most cases telecommuting does not relax the need the social interaction, and face to face meeting with co-workers (Becker & Steele 1995). In response to the demand for flexibility, facilities managers have been adapting non-territorial strategies. Hotelling and motelling[6] provides standardized enclosed offices on a per reservation basis for temporary occupancy. Hot-desking and Just-In-Time strategies provide well equipped interchangeable workspaces that several workers can share intermittently. Universal Planning and Free Addressing provide flexible open plans in standardized environments that can be easily reconfigured to fit the need of teams to interact frequently on a per project basis. In response to the demands of knowledge work, facilities managers are increasingly taking proactive approaches that are more responsive to the changing needs of the occupant. These approaches require constant cooperation, negotiation and improvisation between facilities managers and building occupants.

The demand to the workplace professional is to increase efficiency and effectiveness in the workplace. Efficiency translates into getting higher output with less input, effectiveness translates into adding value by improving quality of output. Current strategies to increase efficiency focus on leaner organizations and turn to information and building technologies for answers. By implementing intelligent building systems and policies organizations can gain more from less resources, reducing the overhead costs of space and energy consumption. The use of mobile and wireless communications along with standardized and interchangeable infrastructures provide greater levels of flexibility and reduce the cost of reconfiguration. Other strategies aim to improve efficiency organizationally by increasing the density of people and physical resources thereby intensifying the use of space and time-sharing resources. Strategies to improve effectiveness depend on the ability for an organization to realize the potential of its human and physical resources. Current strategies emphasize improving the alignment between spaces, technology, work processes and organizational goals. The demand for flexibility is to accommodate a wider range of work activities by providing options of varying support spaces. To stimulate interaction within and between organizational boundaries designers are emphasizing planning and clustering of social spaces familiar to urban theory. To create an image of trust and vision in the organization, design is leveraging the expressive power of architecture (Duffy, 1997).

DEGW, a leader in workplace design, has developed an approach and a language to describe the patterns of occupancy and interaction in *The New Office*. Hives, Dens, Cells, and Clubs are shorthand notations for patterns of interaction and occupancy of workspaces (See Figure 1.a). Although all patterns are likely to appear in most workplaces, the demands that each type places on the workplaces varies considerably. The most common spaces in today's office stock are Hives to support individual process work that assumes lower levels of interaction. As information technologies automate individual processes, work practice shifts to higher interaction. Work that is completely automated by information technology is siphoned out, thus the downward arrow in the lower left. As information technologies 'informate'[7] the work practice, the demand for highly collaborative interactions as well as highly autonomous concentration will increase. To survive and grow, the knowledge organizations must invent new ways to work and learn together. Through knowledge transactions, knowledge is shared and creative synergy and effective learning are maximized. The metaphor that DEGW proposes to support this pattern is the 'Club' concept, in which a variety of social and individual activities are supported and shared over time. Despite the nostalgic image of 'the Club', the indirect and lasting value to an organization will be the creation and perpetuation of relationships between workers sharing experiences that can transcend internal and external organizational boundaries. The increasing demand of knowledge work is likely to increase the demand for highly interactive workspaces that can support various and unpredictable levels of occupancy. In Figure 1.a the gray areas indicate the current proportions of office stock, the dotted circles represent the demand for reapportionment over the coming years as knowledge work matures. The arrows indicate the direction of reallocation of workspaces to meet the new patterns of work.

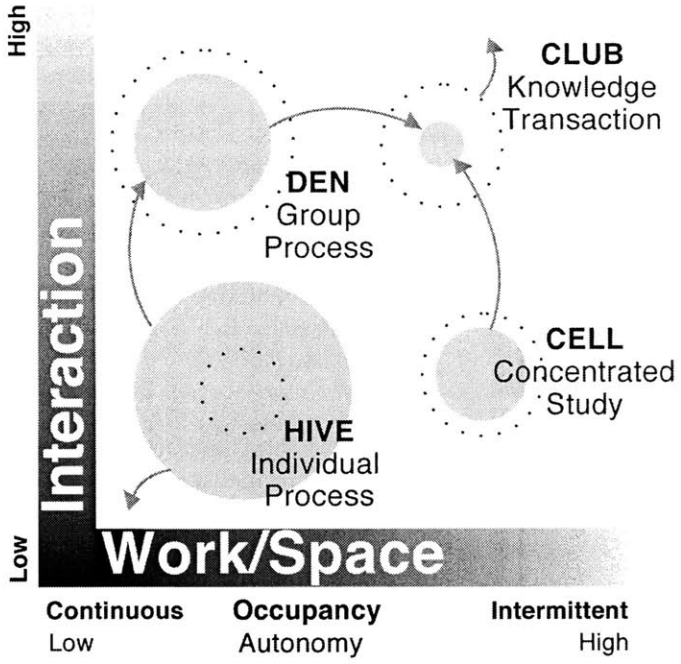

Figure 1.a From Duffy 1997
Changing patterns of work and space

To meet the increasing demand for change and to understand the complexity of change, many organizations are implementing workplace pilots. These pilots provide a chance to try out new information technologies, spatial configurations and demonstrate returns on investments. The Xerox Corporation[8] has adapted 'rapid prototyping' strategies to quickly test alternative configurations and technologies and get rapid feedback. Future@Work is a non-profit consortium that creates an experimental exhibits to investigate how the workplace supports changes in technology and social and organizational structures (Hunt et.al. 1998). Ongoing research between MIT-SPORG and Xerox considers the way in which organizations conduct workplace pilots and internalize the process of workplace making. The role of information technology in the practice of workplace making has been largely concentrated on organizational memory (to capture design rationale[9]) or on the evaluation of design alternatives and models for predicting organizational patterns of change (Miley 1995).

The case is often made that by understanding patterns of change we can speculate on the directions and expectations for the workplace of the future. However our understanding of change must be tempered by the blindness inherent in our approaches.

> "In the act of design we bring forth the objects and regularities in the world of our concern. We are engaged in an activity of interpretation that creates both possibilities and blindness. As we work within the domain we have defined, we are blind to the context from which it was carved and open to the new possibilities it generates. These new possibilities create a new openness for design, and the process repeats in an endless circle." (Winograd & Flores 1987)

New approaches to workplace making stress critical inquiry in the process of design. 'Process Architecture' (Horgen et. al. 1998) is an approach to workplace making that emphasizes participation of all the stakeholders in the design process: design professional, workplace occupant, facilities management, builder, and organizational management. Co-design approaches requires mutual participation between design professionals and the stakeholders. By initiating change through the process of design the process of workplaces making becomes internalized in the work practices Over time, the role of the design professional changes as the organization learns through its experiences how to understand and effect change in the workplace. Increasingly the success of the organization will be in its ability to identify, respond and affect changes in work practice using all of its available resources fully.

The effectiveness of co-design approaches rely on engaging participants in problem framing and resolution. In doing so, the design process creates shared experiences and an atmosphere responsive to change. In research conducted in the use of video for remote collaboration, the process of design has been described as a "fundamentally a social activity characterized by ambiguous communication, continual negotiations and the enrollment of participants into a group process".[10]

Many of the challenges and barriers in the co-design approaches are familiar to experienced teams of knowledge workers. Designing a process as you go, sharing knowledge across disciplines and backgrounds, confronting uncertainties of change, risking exposure of competence, creating a shared vision are the some of the many difficulties in co-design approaches. The skills acquired from a successful co-design approach correspond to those skills acquired by knowledge workers experienced in collaborative work. *Situational awareness* requires the surfacing of the values and perceptions of participants and stakeholders to develop a shared understanding of the issues, consequences and rewards. *Process design* results in an agreement of procedures to be followed and a plan for the remaining design process. *Artifact design* is the generation and exploration alternatives and proposals. *Making Decisions* is the process of arriving at decisions and plan of action towards implementation. *Evaluation* is continuous throughout the process as criteria evolve, ideas are tested and new ones introduced.

The vision of Process Architecture is to create "dynamic coherence" in the workplace. In contrast to an acquired fitness between work practice and workplace, dynamic coherence is a continually evolving, responsive and proactive process that balances work process and work place[11]. Some of the key characteristics of a dynamically coherent workplace that bear on the effectiveness of work practice are incompleteness, transparency, visibility and flexibility, blurred boundaries, and artifactual presence[12] *Incompleteness* encourages change and adaptability by engaging participants toward completion. *Transparency* affords awareness of activity and progress of co-workers. *Reciprocal visibility* increases the potential for interaction in various locations. *Flexibility* is the ability of the workplace to support diverse work activities easily and efficiently. *Blurred territorial boundaries* stimulate interaction across traditional organizational boundaries. *Artifactual presence* is necessary for visual (and tangible) access to abstract ideas. Tools for thought, for coordination, and establishing and expressing goals and objectives create a visible identity and collective ownership.[13]

For comparison we can plot workplaces along a social technical dimension, see Figure 1.b. Towards the technical extreme, workplace strategies are solution oriented, focusing more on spatial and technical characteristics of the physical workplace such as information technology, spatial configurations, and time sharing. Towards the other extreme, co-design approaches are problem oriented, focusing on social and

	Technical		Social
Workplace Approach	Hoteling Hot-Desking Free Addressing	Hive Den Cell Club	Co-Design
Evaluation	Strategic		Pragmatic
Inquiry	Solution Oriented		Problem Oriented
Responding to	Time-Space Technology	Interaction Patterns	Barriers Catalysts
Change by	Reactive Intervention		Proactive Intervention

Figure 1.b *Social Technical approaches to Workplace Making*

human factors in the process of working and affecting change collectively. In between, the approaches focus on social patterns of interaction leveraging space and technology to accommodate work practice. At the technical extreme approaches are strategic and evaluated against explicit goals and objectives, at the social extreme approaches are pragmatic, evaluated against criteria that emerge in the process of design.

Virtual Workplace

Information technology is, without a doubt the most active agent of change in the work practice and workplace design. Innovations in information technologies are changing how, where and when we interact with each other[14]. To improve the effectiveness and efficiency of work practice, communication technologies focus on interaction between people and between people and information. The assumption underlying most R&D in communication technologies is that improving communication increases collaboration which in turn improves work practice. For the designers of collaborative technologies, their models of collaboration are the most fundamental principles underlying the design, implementation, and evaluation of new technology.

Communication is the exchange of information between individuals or groups. Communication can be distinguished from collaboration by its directional nature, uni, bi or multi. Collaboration, on the other hand is activity (usually communication) on the part of multiple participants working toward a some goal (not necessarily a shared goal or well defined). In his book *No More Teams,* Michael Schrage defines collaboration as "joint engagement in creating and producing something....an outcome, that is perceived as important by all involved and too big for each individual to achieve alone. ...The realization that joining forces with others may actually add value to one's individual enterprise is a key to collaboration" (Schrage 1991). Schrage distinguishes different types of collaboration along two dimensions based on the results: problem setting versus problem solving. (See Figure 1.c)

- *Conceptual Collaboration* is similar to group brainstorming: creative activity to generate concepts, ideas, themes, metaphors, and analogies that may yield insights into problem framing. The result of conceptual collaboration is often a better defined problem or discovery of new ideas or relationships to be explored and developed in technical collaboration.

- *Technical Collaboration* seeks to solve well defined problems by bringing together people with complimentary skills

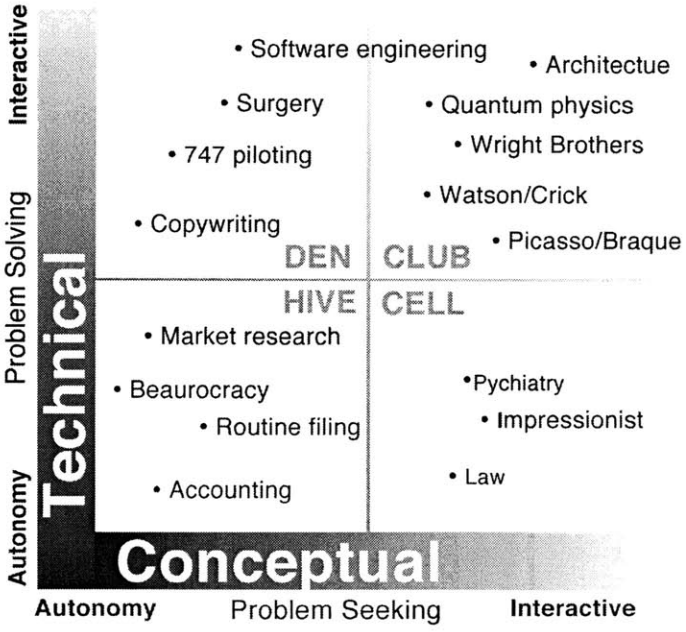

Figure 1.c Technical Conceptual Collaboration
From (Schrage 1991)

The examples of work occasions plotted in Figure 1.c approximate the distinctions in work and space patterns observed by DEGW (Figure 1.a). Work that is highly interactive, involving both problem solving an problem seeking are favorable for shared settings that support individual concentration coupled with frequent 'knowledge transactions'. Work that is highly autonomous and does not require high levels or interaction is more likely to be siphoned out of the lower left as routine tasks are automated.

Many collaborative technologies are built on one or more models of collaboration. Some models distinguish purpose or intent of communication. These may be knowledge building, coordination, information dissemination, cohesion or decision making (Pena-Mora & Hussein1996). A further distinction can be made

against the properties of communication along the dimensions of time, commitment, intention and structure. At one end of the time dimension is asynchronous such as email and the other synchronous such as face to face or video teleconferencing. At one extreme of commitment dimension are media that commit the receiver to a response such as a phone call or face to face, at the other extreme are media that conventional uses do not require a response, such as advertisements and bulletin boards. At one end of the intention dimension are unintended chance encounters common in lounges and around coffee stands. At the other are purposeful meetings with a preset time, place and agenda. At one extreme of the structure dimension are unstructured informal interactions typical in social settings or brainstorming sessions at the other are formal meetings with clear patterns for interaction and floor passing.

Other models distinguish between communication (pushing and pulling information through an organization), collaboration (sharing information and building shared understanding) and coordination (delegation of responsibility, approvals, and scheduling)[15]

In their book *Understanding Computers and Cognition* (1987), Terry Winograd and Fernando Flores proposed a direction for a collaborative tool, that is based on a model of communication as committals and responses. Their model of communication, rooted in the Speech Act Theory[16] suggested that by specifying illocutionary force, breakdowns in communication could be reduced. The context for which they conceived their model of communication was that of business organizations as "networks of recurrent conversations". Coordinator, the implementation of this approach which sought improve communication by reducing breakdowns has received recognition and criticism. Schrage suggested that the power of Communicator is that it requires people to reduce what they are saying into "communicable, manageable, and measurable chunks of commitments" that flush out ambiguity. Criticism of Coordinator suggest that reducing interaction to commitments and promises can have an anit-collaborative effect and is a less than desirable means for establishing professional relationships. Other criticisms suggest that communication occurs in learning situations in which people negotiate and learn from one another about problems, perspectives, and concepts. (Suchman, Ackerman) Coordinator reduces situational information to what can be gained through intentions and commitments. More important than the successes and criticism of Coordinator was that it began a critical inquiry into the nature and purpose of collaboration as opposed to communication technologies.

Early attempts to categorize collaborative tools distinguished the spatial and temporal properties of communication. Taxonomies included synchronous versus asynchronous and remote versus co-located. Later distinctions expanded these categories to distinguish the dynamics and predictability of interaction, see Figure 1.d. This distinction could be mapped to work occurrences such as formal meetings versus ad-hoc interaction and brainstorming sessions versus presentation format[17]. A broader time-space taxonomy distinguishes session-centric and document-centric tools from place-based tools. The difference is Place based tools support both persistence and real time collaboration. (Spellman et al 1995, Appendix A) Other taxonomies distinguish collaborative tools by the generic set of services offered. These could be identified by the functions provided such as video conferencing, messaging systems, multi-user data bases, and application sharing (Wells 1995). Another elaboration on this approach distinguishes personal applications from groupware in which collaboration occurs in shared interactive environments.[18]

PLACE \ TIME	Same	Different Predictable	Different Unpredictable
Same	meetings presentations	work shifts	Team rooms
Different Predictable	desktop VTC	E-Mail	Collaborative Writing
Different Unpredictable	multi-cast interactive seminars	BBS	Daily workflow

Figure 1.d Time-Space
From J. Grudin IEEE June 1994

The problem with taxonomies, like models, is that they draw attention to specific features and hide others. If we design technology to fit certain taxonomies of interaction or function, the work practice must be embodied within those taxonomies. Work practice is dynamic, unpredictable, and rapidly changing with the incorporation of new technologies. Most commercially available collaborative technologies address only one or a few of these models of collaboration. Because we cannot think of tools without an underlying purpose of their use (Brown et. al. 1989) the development of collaborative tools is restricted to only those purposes that can be specified. For every new use that specifies an unmatched demand, the market for collaboration technologies rapidly responds either by extending existing technologies or inventing new tools. The demand on the organization is either to retrofit work processes to fit existing technology or customize technology to fit existing work processes.

To meet the increasing demand for customization that could support a wider range of interactions between and within organizations and their customers, some collaborative technologies take a more socially oriented approach based on the structure of interactions. The operative models of interaction found in the workplace were formal, informal and ad hoc. (Spellman interview)

- *Formal* interactions have a predetermined time, place, attendees, agenda, such as weekly team meetings, presentations or briefings.
- *Ad-oc* or crisis based interactions are triggered by an event or opportunity and require impromptu assemblies for interaction. Alvin Tofler and Henry Mintzberg describe *ad-hocracies* as "fluid organic and selectively decentralized structures that spring up to smother problems or pry open opportunities" (Schrage 1991)
- *Informal* interactions occur spontaneously wherever and whenever chance and opportunity meet. Informal interactions can (and are equally likely) be social in nature or work related. The typical image we have of informal settings are hallway conversations and at the coffee talk.

Rather than supporting individual isolated models the emphasis is to support all the models because the degree and formality of interactions vary in complexity, urgency and importance and unpredictably flow from one to the next.

> "Ideally these architectures should support collaboration at any time at any place and at any level.... They should support the cascade of serendipitous personal interactions that turn into informal collaboration that turn into formal meetings, that turn into ongoing relationships that turn into results." (Schrage 1991)

Emerging theories on sociological nature of work is beginning to impact the direction of the virtual workplaces. Recent research initiatives such as wOrlds Orbit Environment[19] are developing collaboration frameworks that support the evolution of work practice for work groups. Like CVW, Orbit aims to create an

environment that allows seamless integration of people, information and tools to support a wide range of social settings (from structured to casual interaction) in a variety of work practices (administration, coordination, concentration).

Supporting different types of interactions does not necessarily improve the effectiveness of collaboration technologies. While the technologies may increase the convenience and frequency of communication, to be more effective, designers favor more contextual approaches. In this endeavor, designers of collaborative technologies and workplace designers face many of the same issues in the design of work settings to fit work practice. The assumption is that by leveraging the environment in which collaboration occurs, many of the technical issues of electronically mediated collaboration can be relaxed. Dynamics of interaction, and workflow could occur more naturally because we can rely on conventions familiar in the physical workplace settings. Initially improvements of effectiveness suggested a trade off in efficiency. By incorporating more and more of the physical context into the technology, the technical constraints of bandwidth and network access created more spatial and temporal dependencies. Time and location independence were secondary to high bandwidth, multi-sensory connections. Technologies became more specific to the time and place contexts *already existing* in the workplace, like the conference room, and the personal desktop. To improve effectiveness meant improving the connectedness of an organization to share *more* context across time and space that approximate existing models of interaction. Again the problem was that the models were changing rapidly with each innovation. Without and a reliable prediction of future work requirements, collaborative technologies would have to design flexible systems that could adapt and be adapted to emerging work practices.

The response was to create virtual workplaces in which the framework of collaborative services could be offered (and expanded) within an environment that set a context for collaboration. Collaborative environments include the software and hardware necessary to deliver the services for interaction and render the social context for interaction. The software includes a user interface through which interaction occurs and a set of services supported by the framework[20]. The technical challenges of the virtual workplace is to overcome the limitations of the physical context. Because participants share a virtual workplace from multiple remote contexts, asymmetries will exist between their respective social and physical contexts. Shared audio and visual space must be negotiated in their physical boundaries. Bandwidth and network limitations constrain access to the virtual workplace (Wells 1995). The social challenge is to provide contexts in which social conventions for behavior can be mutually negotiated and preserved. In physical spaces we have access to behavioral cues, such as gestures, body language and spatial cues such as closed doors. Issues as fundamental as privacy and awareness must be reconsidered in the virtual workplace.

> "Creating an environment that stimulates the relaxed intensity that marks effective collaboration is a craft, not a science. It requires both an aesthetic sense and a grasp of functionality The architect must be able to design formal tools for informal collaborations and informal tools for formal collaborations." (Schrage1991)

In creating shared contexts two distinctively different paradigms pervade research in Computers Supported Cooperative Work : those in which users project themselves *into* a shared artificial context and those in which contexts are projected *onto* other contexts. The theoretical division between the two paradigms runs throughout the information technology industry: at one extreme are technologies that pull people and experiences into computers (Virtual Reality), at the other extreme are technologies that push computers into the background (Ubiquitous Computing)[21]. Before diving *into* virtual environments, it is helpful to diverge momentarily to understand what can be gained from approaches that project *onto*.

Projecting Onto

Mark Weiser who first coined the term Ubiquitous Computing, described the relationship between, humans, computers and the workplace in the visionary article, Computer for the 21st Century, 1991. "By pushing computers into the background, embodied virtuality will make individuals more aware of the people on the other ends of their computer links. This development may reverse the unhealthy centripetal forces that

conventional personal computers have introduced into the life and the workplace" The unhealthy centripetal forces that Weiser is referring to are manifested in the windowless office and the computer addict detached and increasingly isolated from the environment and society.

Augmented Realities (also referred to as Computer Augmented Environments) approached the same model from a slightly different angle. Augmented Realities overlay digital information on the real world. Implementations have included visual and auditory enhancements that share context information among distributed teams[22]. Other research approaches are exploring graspable objects (Ishii & Ulmer 1997) combined with ambient media (Wisneski 1998) that connect information and people through interfaces familiar in the physical environment.

Moving away from the extreme of Ubiquitous Computing, the research in communication tools that link together remote physical spaces have revealed important considerations that are taken for granted in face to face interactions. When remote spaces are linked over time, social relationships, and group identity have been attributed to a sense of *telepresence*[23] of remote collaborators. Experiences with mediaspaces, that use video and audio connections over long periods of time, have shown that social conventions in physical space do not necessarily translate in mediaspaces[24]. Other research[25] has raised important social and psychological issues when using electronically mediated collaboration such as gaze control, degree of engagement, representation resolution, coordination, privacy and surveillance.

Research and criticism has shown that the lessons we are learning about space from computer mediated environments are not only recasting what we have learned in physical environments but also what we are looking for. Buxton[26] distinguishes between interpersonal space "the collective sense of co-presnece between/among group participants" that serves to mediate communication, and task space "a co-presence in the domain of the task being undertaken" that serves as a shared workspace. The medium of shared task space in collaborative environments "shifts from a display of results to a shared awareness of process". When collaborating in a shared task space you can see the results of your participation. In effect, the space becomes a mediator for collaboration, where comments and criticism can be directed at the task space rather than at one another. Concepts and ideas can be externalized in words and symbols and manipulated as objects in space[27].

> "It may be that the imperative for collaboration overwhelms the territorial desire for privacy and personal space. (the same holds true in physical space) The collaborative architect recognizes the inherent tension between shared space and personal space." (Schrage 1991)

Under the onto paradigm, space is still as we know and understand it. We speak, act and behave in ways that are familiar using social conventions that are understood and negotiated through interaction in the physical world. We can evaluate workplace technologies as to how well they support existing patterns of interactions in the physical environment. In contrast, many of the assumptions of collaboration in physical work space[28] are at front and center in the virtual workspace environments.

Projecting Into

Virtual environments are not new to the workplace. Computer Scientists have been using MUDs and computer mediated communication since the early 1980's [29]. Architects have been using CAD and virtual reality software to simulate and predict designs for the real world. Knowledge workers have been working in their virtual desktop environment since the introduction of the windows metaphor in operating systems in the early 1980's.

Based on patterns of use, two doctrines of virtual environments are distinguishable: those that use virtual environments as a tool to support activity in physical space and those that occupy virtual environments as a place where activity occurs in virtual space [30]. The functionalists view, considers their environment like a tool, as a resource whose value is in its capacity to support work activity. The tool cannot be appreciated

without an understanding or need for the activity it supports. The second view, considers environment as a place in which we inhabit. The place cannot be understood without an idea of what is in it. The virtual workplace like that of our physical workspace contains people, information and tools.

Historically, organizations classify their virtual workplace into three types spaces based on the services they perform (Spellman interview). *Information spaces* are where businesses store, index, and retrieve information. Here you find directories and file systems, databases, and archives. *Collaboration spaces* are where they interact. Here you will find communication tools like email and VTC, and places like chat rooms, and bulletin boards. *Process spaces* are where businesses plan, monitor, evaluate and adjust business processes, ideally on the fly. Here you will find planning, analysis and memory tools and task objects[31].

The first 'place-based' collaborative virtual environments, called MUD's were colonized for recreational, social and educational purposes[32]. As these environments became populated, patterns of communities emerged with distinguishable styles and ethics. In his book *Virtual Communities*, Howard Rhiengold describes social MUD's as "communications soup in real time, with a flavor of improvisatory theater....MUDs are about who is in the same place at the same time and how they interact, its more of a hangout than a publication, more like a game board than a bulletin board." The important characteristic of place based systems was that they supported synchronous interaction in persistent environments that allowed users to partition the environment and create and share objects that remain in the environment between sessions.

In persistent virtual environments people socialize, build and maintain relationships. They make things to interact with and places to interact. Technology does not make places, people do. In *Pattern Languages* Christopher Alexander describes a theory of place making that is based on not only on qualities of space, material and form but on patterns of use and experiences. In designing place-based collaborative systems, Paul Dourish and Steve Harrison (Dourish and Harrison 1996) maintain that the qualities of "placeness" cannot be built in, but can be supported if not encouraged.

> "The sense of place must be forged by the users; it cannot be inherent in the technology itself....Placeness is created and sustained by patterns of use; its not something we can design in. On the other hand, if placeness is what we want to support; we can design for it."

They distinguish the difference between space and place. "Space is the structure of the world, its the three-dimensional environment in which objects and events occur, and in which they have relative position and direction." Place however, is a "a communally-held sense of appropriate behavior, and a context for engaging in and interpreting action". They hold that "appropriate behavioral framing" is not a property of the space rather it is a set of "mutually held and mutually available, cultural understandings about behavior and action" that is a property of place. A "behavioral setting" is both a product of both the physical environment and its behavioral characteristics imbued by its inhabitants.

> "Describing a behavioral setting requires at least an understanding of what people generally do there, how people know what is expected of them there, how norms of behavior are established, which attributes of the physical environment tell potential users what is expected of them and what the environment is like. The behavioral setting can be seen as a social physical unit. The more common word –place—has a very similar meaning." Robert Barker *Ecological Psychology* 1968 (Ziesel)

Developing the infrastructure for collaboration has taken two different technical approaches that reflect the two user orientations described previously. The first is based on making existing tools collaborative by the addition of services[33] to an already familiar interface and application. The advantage, from a user perspective, is the added value and low learning curves to an already familiar tool. The second is based on making a framework for collaboration by the implementation of collaborative services in different environments (Spellman interview). Both approaches make use of existing technologies wherever possible[34]. On the one hand this reduces development time, and provides scaleability of a 'plug and play'

framework of available services. On the other hand this imports some of the assumptions underlying implementations of those services in other contexts[35]. For example, a user in a virtual environment built on an existing MOO core is not limited to actions explicitly implemented in the MOO client interface[36] . For the experienced user of similar MOO's the client interface may be laden with long-handed multi-step command-action sequences. For the newcomer, actions and commands not implemented in the interface are in essence not known, limiting the space of potential actions to what is explicit in the interface. Other contexts for collaboration in virtual environments resist spatial characterization common to most place based systems yet retain place-like qualities. Dourish and Harrison give examples as "spaceless places" that exhibit "placefull navigation" based on the activity of others[37] and "placefull discussion" where similar content and technology result in different behavioral framing depending on the subscribers[38]

Often spatial approaches to collaborative work environments shift the focus from supporting collaboration to developing and supporting the context for collaboration at the expense of the needs of work practice. More recent approaches to creating collaborative environments emphasize the context of the decision making process, or work process itself. In this type of system, context is determined by logistics, roles and causality. Interaction is both synchronous and asynchronous. In this sense 'contexts are synergistic with work flow' and are distinguishable by the interacting roles and stakeholders, and relevant data and tools[39].

Hybrid Systems (Dourish & Harrison 1996) or Mixed Reality (Benford et al.1996) combine physical and virtual contexts. By combining audio and video conferencing in virtual environments, hybrid spaces project physical contexts onto virtual spaces and visa versa[40]. Other research has taken an opposite approach by projecting virtual spaces onto physical spaces and visa versa[41]. The difference in starting points appear insignificant until we consider the underlying assumptions that favor one approach over the other, that is the subject of Chapter 5.

Approaching Into

Collaborative architectures are designed to support the various processes of collective creative engagement—conversations, sketches, arguments—and not to predestine or predetermine any specific set of results. The challenge is to balance the demand for flexibility and adaptability with the need for some sort of structure that supports the contexts and contents that collaboration generates (Schrage 1991).

Making places in virtual space is a process of social-spatial negotiation and 'reciprocal evolution"[42]. Over time, as we interact with one another and our environment we develop implicit rules or social conventions for interpreting and predicting the effects of our actions and behavior of others. In virtual environments, the medium in which we act and interpret is confined by the technical properties of the environment. When designing collaborative tools, the designer works from a model of the user and the actions that the user may wish to perform. The services offered by the collaborative framework form a basis for the set of available actions to perform those tasks. Those actions must then be stated in terms of the properties of the environment in which the task will be attempted. This limits the environment's capacity to support the user's needs to those activities that can be articulated within the environment. This also creates a blindness: only those activities that can be articulated can be supported (Winograd, & Flores 1987). The toolmakers dilemma is that to describe a tool, is to use a tool, and to invent a tool we must describe a tool.

Often technical mechanisms are implemented in lieu of social conventions that enforce the same behavioral principles. For example in physical space, and unlocked door is evidence of trust, although the respect of privacy and convention of knocking is preserved. Often collaborative systems build in technical mechanisms to control dynamics of interaction to reinforce a particular setting. When technical mechanisms preempt social negotiation of the participants, a conflict can be created between intended social practices and the technical affordances of the environment. If technical mechanisms preclude interruptions, then misunderstandings and or lost contributions are more likely. Often virtual conferencing or auditorium settings will implement technical mechanisms to moderate floor control[43]. Similarly, if a place based context transports familiar social conventions into the virtual environment, the need for technical

mechanisms for behavioral framing can be relaxed in favor of social agreements. Often virtual environments exploit place metaphors and event metaphors to reduce the dependence on technical specifications for behavioral framing. The trade off belies in how much technical control is assumed or intended in behavioral framing against how much social negotiation and interpretation is permitted. The more we rely on technical mechanisms to frame a social context the more we lose the ability to adapt to new contexts.

Collaborative systems leverage the social-technical dimension against effectiveness and efficiency. Those that favor the technical often gain efficiency in communication by moderating the dynamics of interaction. In this regards, efficiency is quantitative, and can be evaluated by reducing frequency and delays of interruption or tangential efforts. Those that favor the social, often gain effectiveness of communication by increasing participation. Effectiveness, in this regard is qualitative and can be evaluated by reducing misunderstandings. If how we understand is by relating incoming information to our own experiences and our present situation, then what we can understand is dependent on how we can interact in the situation.

Figure 1.e compares collaborative systems along the social-technical dimension by the mechanisms employed to structure interaction. Towards the technical extreme the dynamics of interaction are distinguished by roles and formality of the occasions such as presentations and instructional sessions. Towards the social extreme the dynamics are loosely structured and informal such as exploration and open discussions. At the technical extreme privileges are often set by role and rank, while at the social extreme they are likely determined by reputation or negotiation. Systems that do not employ technical mechanisms to control interaction rely on observation and participation to set the dynamics. Technically inclined systems either predetermine the rules for interaction or allow users to set the technical controls to fit the occasion. Social systems allow the rules to be negotiated by the users but often communities will adapt social charters for appropriate behavior.

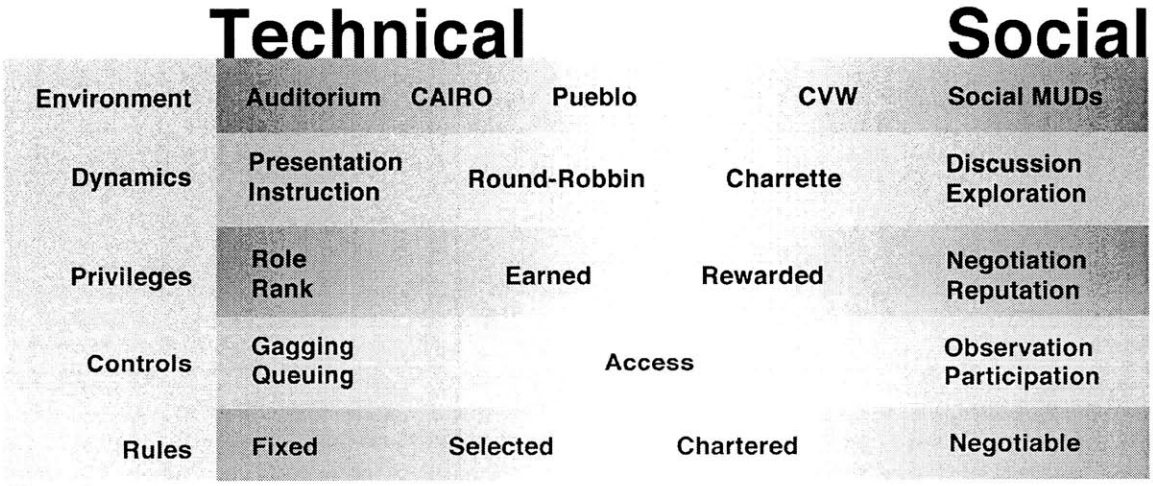

Figure 1.e
Collaborative Systems on the Socio-Technical Dimensions

Another comparative approach considers the qualities of the environment that contribute to spatial experience. The role of space and place (Dourish & Harrison 1996, Benford et.al. 1996) in collaborative systems has become a popular focus of many research initiatives and a basis for comparison. Place plays the role of behavioral setting, where experiences are invested in space by interaction with others and with the environment. Space plays the role of structuring the environment in a way that is recognizable so that we can orient ourselves and organize its contents. Both space and place rely on our understanding of the physical world to make sense of their roles in the virtual world. In collaborative systems the functional value of space has been pursued as means for partitioning content and activity, for enhancing awareness of spatial periphery, and for creating common references based on our objective understanding of physical

space. The comparative approach of spatial properties in collaboration environments all grounded in similitude with physical space. Figure 1.b plots several systems along the dimensions of Tranportation, Artificiality an Spatiality (Benford et. al. 1996)

Transportation is "the extent to which users perceive that they have left behind their local space and entered into some remote space" This characterizes the essential differences between projected into and projected onto. "As one moves toward the totally transported extreme the immediate local environment becomes less significant; and may seem that less of the physical environment is being drawn into the remote environment" (Benford et.al. 1996).

As we move to the totally transported extreme we leave behind more of our local context. To act, we rely on representations of objects and people. The degree to which those objects embody reality is the dimension of artificiality. When we communicate *with* a medium like face to face, telephone, or VTC, we do not have to represent who said what. When we see the world through our own eyes, and act in a situation our representation of self is transparent (first person). However when we communicate *in* a medium, like MOO's or virtual environments, we become disengaged from ourselves, and we act through symbolic representations. The way in which we are represented to ourselves and to others is not transparent (second or third person)[44]. Because physical existence prevents complete disengagement from local context, the degree of transportation between participants is asymmetrical in any collaborative environment. Local variations in social context, technical constraints and individual perception will bear on the degree of transportation.

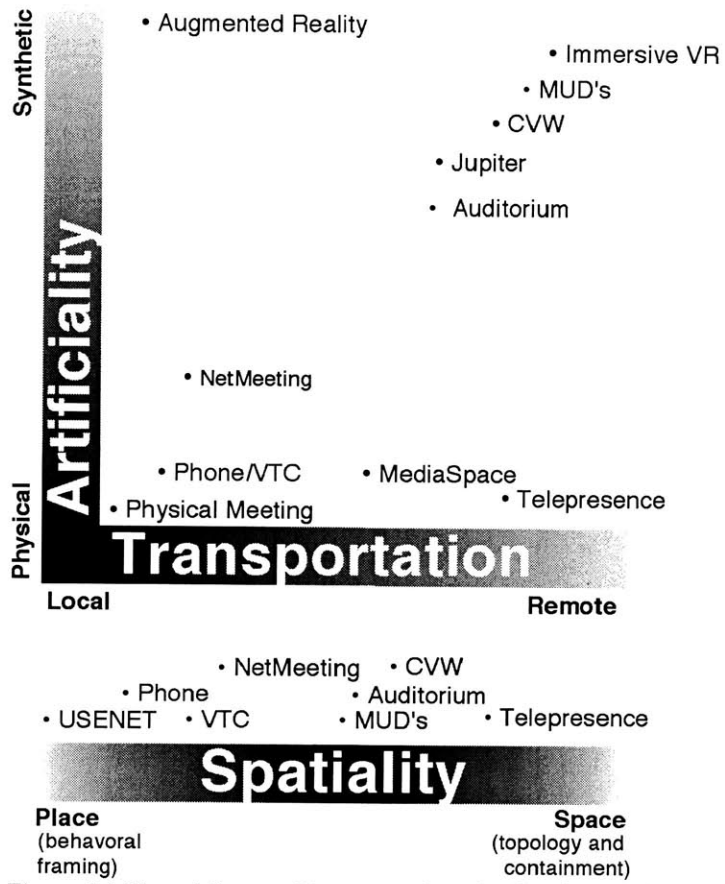

Figure 1.f Shared Spaces: Transportation, Artificiality, and Transportation From (Benford et. al 1996)

Artificiality is "the extent to which the space is either synthetic (independent of external reality) or is based on the physical world". At one extreme is video conferencing where all information about context is being drawn from the real world. At the other extreme is Augmented Reality and Virtual Reality when information is synthetic and is used to generate virtual space or overlay on physical space.

We can measure artificiality along three dimensions: behavior, representation, and perceptual modality. Along each dimension we relate the environment to the real world. Do objects and people behave as they do in the real world, according to the same rules and laws of nature? Are objects and people represented for what they are or are they symbolic of some other phenomenon? Are our senses of perception engaged as they are in the real world or do they serve other function? How do we discern artificial from real? When representations and behavior embody reality, we act and behave according to patterns in the physical world.

As one moves to the toward the totally synthetic extreme we rely on behavior and representation to understand our actions and possibilities for further action. If the way we perceive and engage the environment differs from the physical world, we look for patterns of behavior and representations. Over time, if objects respond to an action in a like manner we adapt implicit rules of behavior that enable us to predict the response of future actions.

Collaborative Virtual Environments, MOO's, and immersive virtual reality systems tend toward the totally transported and artificial side. Simulated virtual environments and MUSE's (Multi User Simulated Environments) tend toward the totally transported but not the totally artificial. Hybrid Systems that that combine physical and virtual environments vary along the dimensions of artificiality and transportation depending on what media are in use at any time

Spatiality is the degree to which the system supports basic spatial properties such as containment, topology, distance, orientation an movement. At one extreme is spaceless places (Dourish and Harrison) such as BBS bulletin boards and process contexts such JCS, that are independent of spatial properties. Towards the totally spatial extreme are those contexts that dependency on spatial properties for navigation, topology and frame of reference such as MOO's, CVW, and PlacWare.

On to Into

The hybrid systems or mixed realities that combine physical and virtual space are not easily positioned along any of the dimensions we've been comparing. At any time, different users may be sharing a space from different positions. Technical asymmetry is created when different media is used to accesses the space. Some participants may have higher bandwidth, video and audio , others may have text only. When physical space is the medium for collaboration, technical asymmetry is created by properties of the environment such as enclosure, transparency, proximity.

Depending on our point of view, from the physical looking *into* the virtual or the virtual looking *out to* the physical, our interpretations of space and our relative positions in space vary. When we consider collaboration environments looking at the world from outside, we can position work along three polar axis: individual v group, local v global, and virtual v real (Streitz et. al. 1998). See Figure 1.g. The virtual v real axis characterizes a tendency of information, tools and people to *occupy* space, virtual or real. This differs from the dimension of transportation (Benford et al. 1996) in that moving towards one pole does not imply that other is left behind. Rather it reflects shifting patterns of occupancy, or ways in which we interact with each other and our environment. Occupancy in this case is always influenced by our partial presence in both extremes. The individual v group axis characterizes the tendency of space and technology support different degrees of autonomy and interaction (similar to DEGW). Along this dimension, spaces vary in the degree of sharing, privacy and awareness that is tolerated or desired by the activity. The local v global axis describes the shifting boundary conditions of remote versus co-located collaboration. Our position along this dimension reflects the extent that local actions influence global contexts and vise versa. Proximity is perceived by our awareness of and sensitivity to regions of influence.

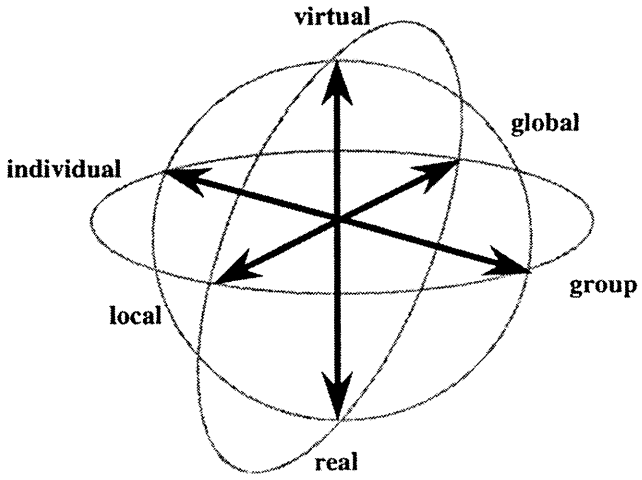

Figure 1.g Three Dimensions of Cooperative Buildings From (Streitz et. al.1998)

When we consider collaboration environments looking out from the inside, (Figure 1.h) our model of workspace is human centered. A spatial taxonomy can be distinguished by the functions that they serve in the workplace. (Streitz et al. 1998)) From this perspective, physical and virtual space is interchangeable and both are is present in each functional domain. Likewise, individual and group space are *invariants*,[45] they are constantly present and accessible without conscious effort or transitions. *Cognitve space* is where information is processed, deliberated and transformed. It is where tasks are executed and plans are made. *Information space* is where memory is stored and accessed. It is where information needed for work is packaged, indexed and accessed. *Physical space* is where we partition and allocate contexts for work. It is the structure that supports work and space that we occupy. *Social space* is where we interact with others and the organizations in which we belong. It is where we identify ourselves, in relation to others.

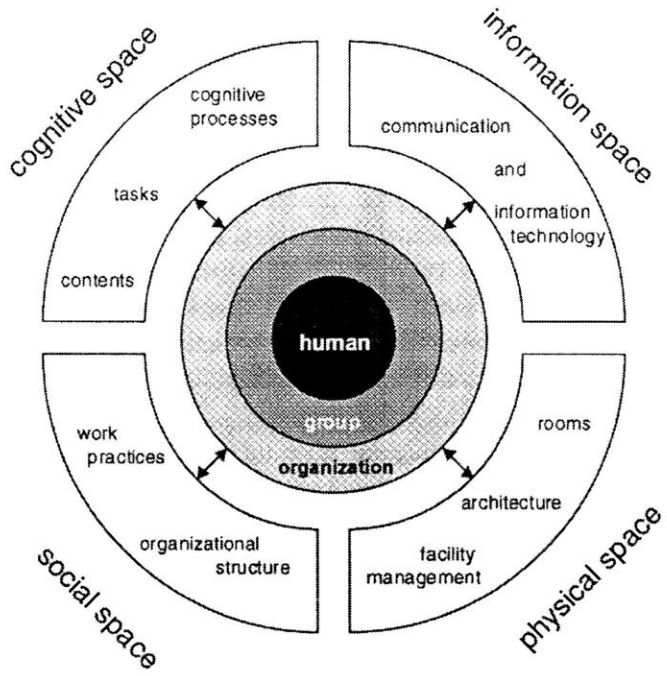

Figure 1.h Functional Model of Collaborative Spaces From (Streitz et. al 1998)

Summary

Communication technologies are radically changing the work practice. When we design and evaluate spaces and technologies for work we construct and adapt models of work practices, and workplaces. Workplaces designers are responding with new strategies and design approaches in both the physical and virtual domains. Beginning with technologies that redistributed work in time and space, workplace designers focused on efficient use of resources. The response was to connect individual workplaces and desktops. When technologies began to offer ways to collaborate by *sharing* space and time, the focus shifted towards improving the effectiveness of communication even at the expense of efficiency. The response was to create contexts that support and encourage group interaction or individual concentration. Once change became the norm, demand turned to supporting work process. Workplace design became a part of work process, and work process became the context for work. By comparing design approaches of physical and virtual workspace several conclusions can be drawn about the relationship between space, workplace and technology in light of the changing nature of work.

- Technology and space provides context for work and as such is changing our the way we collaborate and the way we perceive our environment. "the real power of technology is not just to serve as a tool or medium but to redefine the way people perceive their environments. Technology is the environment and it inevitably shapes the way people relate to one another....It offers a new way of conveying the information that underlies reality" (Schrage 1991 p137)
- Technology and space alone are not enough to improve the effectiveness of collaboration. Rich, multi-sensory high bandwidth interactions and relaxed time and location dependencies are a reality.

Collaboration depends on the relationships between people. "The issue is not automating collaboration its using technology to enhance collaborative relationships...We need to shift away from the notion of technology managing information and toward the idea of technology as a medium of relationships" (Schrage 1991 p92-144)

- Design and use of technologies and space are biased by interpretation and background and perspective. "To use technology as a medium to create collaborative environments requires us to remember that each technology dictates its own strengths and limitations." (Schrage 1991 p144) The medium conveys a message "the very medium you chose to communicate through communicates something. Calling a meeting means something different from making a phone call. Sending a memo implies something else, even a hand written memo means something different than a typed memo." (Schrage 1991, McLuhan1991)
- Technology like workplaces are not designed, they evolve. "reciprocal evolution"[42] occurs when "use is design" users interpret and change what a technology does and can do as they use it. In so doing our perception of the technology and our relationship to it changes. [footnote this is substantiated by the experiences of the CVW design team] Activity theory suggests tools used in human activity help to define those activities. (O'Day et. al.1996)

Chapter One Notes

[1] model in this sense refers to Max Blacks use of 'analogue models' to a real or imaginary construction of and idea, system or process that describes the structure of relationships in an original. The difference between a model and the original which it is modeled after is the ways in which rules are used to construct and interpret specific relations between the model and original. (Black 1962)

[2] footnote phrase first coined by Peter Drucker an influential management guru in American Business reference (Schrage 1991)

[3] Roth, (Senge 1994) and MIT's Society for Organizatinal Learning

[4] modular, flexible grid, flexible density systems Vivian Loftness

[5] footnote U. Berkeley Chris Benton, and CMU Center for Performance and Diagnostics.

[6] the distinction is minor only in the accommodations provided and advance reservations

[7] the term was coined by Shoshana Zuboff referring the integration of information technologies into work interactions between people and between people and information. (Duffy 1997)

[8] the LARC Pilot (Laboratory for Remote Collaboration) at Xerox Corporation is a research project with MIT-SPORG

[9] capturing design rational is the subject of several research projects: Cardwall (Keel 1996) MIT-SPORG, LARC Web Based Teaching Module, MIT-SPORG , Multimedia Folklore IBM CSCW 1996

[10] The Media Space: A research Project into the Use of Video as a Design Medium Harrison and Minneman 1990, that connected architects offices throughout a collaborative design project.

[11] from SPORG on dynamic coherence depends "internal compatibility and mutual reinforcement of spatial, technological, financial and organizational dimensions" (Horgen et. al. 1998)

[12] this is a partial list from (Horgen et al. 1998)

[13] (Covi et. al. 1996) Distinguishes three types of cognitive artifacts found in Team Rooms: Coordination Tools, Motivation Tools and Shared Visual Displays

[14] see for example Stone & Luchetti "The office is where you are" 1985 (Worthington 1997)

[15] see also Communication, Collaboration, and Coordination: The Three C's of Workgroup Computing, the Yankee Group, Yankee Watch March 1995 (Wells 1995)

[16] Speech Act Theory is based on request/promise, report/acknowledge offer/accept and Assertives commit the speaker to something's being the case or to the truth of the expressed proposition *Directives* attempt to get the hearer to do something, questions (requesting an speech act response) and commands (requesting a linguistic or non-linguistic action) *Commissives* commit the speaker to some future course of action *Expresssives* express a psychological state about a state of affairs including apologizing or praise *Declarations* bring about the correspondence between the prepositional content of the speech act and the reality (pronouncing a couple married) *the speech act changes reality presuppostions* the speaker

Notes continued

must engage themself, indicate that in certain situations he while draw certain consequences for actions, and is only valid insofar as the speakers offer is accepted by the hearer (Winograd & Flores 1987)

[17] see for example CAIRO (Pena-Mora & Hussein 1997), NetMeeting by Microsoft Auditorium by PlaceWare

[18] In *Groupware—Computer Support for Business Teams*, Robert Johansen's defined of groupware as "specialized computer aids that are designed for the use of collaborative groups" to which Peter and Johnson-Lenz add that support intentional group processes which excludes multi-user databases and Email that are not designed to specifically enhance group processes (Wells 1995)

[19] Orbit Environment http://www.dstc.edu.au/TU/staff/wOrlds/ Univ. of Queensland, Australia

[20] framework as the set of services offered and performed to support the interaction and create contexts such as document server, coordination, navigational tools, context partitioning. A framework may be implemented in many different environments

[21] new direction for Ubiquitous Computing reemphasizes the human position of the paradigm of Calm Technologies and more recently Information Appliances at HP, Don Norman 1998 Media Lab Lecture

[22] for example see Enhanced Factory Communications, Boeing CSCW 1992) and Collaborative Wearable Systems CSCW 1996 Carnegie Mellon

[23] Buxton 1992 working on the CAVECAT project at U. Toronto coined the term Telepresence to be "the use of technology to establish a sense of shared presence or a shared space among geographically separated members of a group" in Telepresence: Integrating Shared Task and Personal Spaces

[24] Marc Abel documented such experiments between XeroxParc and Oregon over a three year period published in 1990 in Experiences in an Exploratory Distributed Organization.

[25] Buxton et al, U. Toronto CAVECAT Project, CSCW 1996 "Experiences in the use of Media Space" 1991

[26] Buxton 1992 Telepresence: Integrating Shared Task and Personal Spaces

[27] the shared space that Schrage refers to are from experiences and reports from the XeroxPARC Collab project specifically Cognoter, Argnoter

[28] Buxton *Living in Augmented Reality: Ubiquitous media and reactive environments,* in Video Mediated Communication Erlbaum 1997, the challenge of creating shared background setting for frame of reference is critical to collaboration

[29] in 1992 Richard Bartle estimates 100,000 MUDders past and present in 1992 Pavel curtis estimates 20,000 active. (Rheingold 1993)

[30] footnote this conclusion has been drawn from literature: Science Fiction novels and movies and more recently in literature Cyberspace, First Steps collection of 14 essays Cyberspace Architectrue Design 10 articles, and from interviews conducted among users of Collaborative Virtual Workplace

[31] virtual objects such as tools and toys in virtual environments. Spellman interview task objects refer to virtual objects that assist a pre-defined process. D. Kirsh distinguishes four types of objects in virtual environments two of them particularly relevant to task objects are: Active objects that can self transform to accommodate changes in the environment whether social or functional, and Informative Objects that helps users to find information they feel would be relevant to their current activity. For a more complete descriptions see Adaptive Rooms: Virtual Collaboration and Cognitive Workflow from CoBuild 98. Other objects tools such as whiteboards, CARDWALL, carry cases, ascii art, and cookies, that remain in places and encourage interaction either social or individual, (cookies get thrown around, art exhibit opening)

[32] the earliest were adventure gaming environments known as MUD's: or Multi-User-Domains. Shortly after more socially oriented environments emerged, first in educational settings, then in special interest groups on the Internet, MOO: MUD-Obect-Oreinted MUSE: Multi-User-Simulated-Environment, more information on the history and research is available at http://lucien.berkeley.edu/moo.html

[33] in this case services refers to basic functions such as input/output, task/process coordination, document serving, etc. examples being CAD packages or Word Processors that add group editing features or databases that add multiuser synchronization or NetMeeting that packages togheter, VTC, chat, and whiteboarding in a familiar windows interface

Notes continued

[34] Object Services and Consulting Inc. (Wells 1995) describe the present paradigm for collaborative systems based on existing technologies of

- Application Sharing that includes 'group aware applications' such as shared whiteboards allowing users to both interact simultaneously and see the results of other users interactions, and 'group-unaware applications' such as shared displays that only supports single user interaction, however 'floor control' can be passed between users.
- Messaging Systems that include Email or Zephyr systems that may include instructions or rules for transmission and action-response on behalf of the sender and the receiver, examples are Lotus Notes, Coodinator (Winograd and Flores), and Active Mail
- Databases or Document Collections that support multi-user interaction and hierarchical dependencies of information or arguments. These include multi-user editors and document production systems examples are ArgNoter, NCSA Collage
- Conferencing that includes a medium for real-time communication, examples include desktop VTC, InternetPhone, MediaSpaces, MUD's

[35] "new tools are rarely designed from a clean slate. There is usually some inherited technical infrastructure (such as the MOO, Mbone) with its own imbedded assumptions." (O'Day et. al.)

[36] a MOO core is the software that manages, processes, and coordinates input and output of actions specified by users and objects and the world in which they take place. The MOO Core receives commands from users logged in to the virtual environment from a MOO client that provides user interface (usually text based) where events are both initiated and received. Tangential to the MOO core is a MOO database that tracks changes and stores rooms, objects, people, and events

[37] placefull navigation (through information) on the basis of (information derived from) activity of others. For example interest matching systems or navigating personal hotlists on the web

[38] USENET: discussion groups or bulletin boards of a similar content and technology often differing conventions or styles for use and formality of language, depending on the culture of the group that subscribes

[39] this type of system is based on work Process the example being described is from JCS Joint Collaborative Services Design Review, Jay Carlson MITRE 1/15/1998 see aslo Chapter Three

[40] for example Xerox Jupiter, 1992 was developed by, Curtis, Dixon, Fredrick Nichols, as a MOO system with a user interface that incorporates voice, text and video in a virtual office space. (Rheingold 1993) CVW (Sepllman, et al 1995) is a similar

[41] Internet Foyer combines properties of CVE, Media Space telepresence by projected a virtual foyer onto a physical one allowing real time interaction in either the virtual or physical space (Benford et al. 1996)

[42] reciprocal evolution C. Allen, Participatory Design: Principles and Practice, in (O'Day et. al. 1996)

[43] many MOO implement "gagging", that allows users to make other users actions and text invisible. Auditorium by Placeware implements cueing and floor addressing mechanisms (such as hand raising) found in typical presentation formats. CAIRO implements several floor control schemes, such as a chair persons, round robins, chalk passing, and ranked cueing that can be found in several collaborative settings such as lecture halls and conference rooms (Pena-Mora, & Hussein 1997)

[44] Many MOO's allow pronoun substitution, enabling the user to see themself as another (3rd person "users says: ") or to see another as themself (2nd person "you say")

[45] J.J. Gibson refers to "visual invariants" things that we respond to or absorb without conscious act of reading, such as a stop sign or a doorknob (Brown et. al. 1989.)

2

Working Virtual

The virtualization of work is not only changing the way we organize and perform work it is changing the rules for interpreting and evaluating our workplaces. Experiences from users of virtual environments has shown that the models from which software designers evaluate and build virtual workplaces and collaborative tools are often very different from the way in which they are perceived and used. Our understanding of a tool, like knowledge depends on our perceptions of how it is used. When designing a tool the designer works from a model of the user and the tasks that the user may wish to accomplish. Designers of collaborative tools often use the tool that they are designing in the process of design. In this way, use by design and design by use is a favorable approach (i.e. reciprocal evolution) to design exploration and evaluation. Often we discover either by accident or observation, novel uses for the tool that may not have been intended in their design[1]. As is often the case in workplace design, "reciprocal evolution" is not a conventional or feasible means for design[2]. Workplace designers do not inhabit their designs and are physically detached from the needs and requirements of the users. This need not be the case in the design of virtual workplaces. Designers and users can share spaces, ideas, and needs without the constraints of physical space, however not without the constraints of virtual space. If we consider the virtual co-design approach, the workplace professionals are analogous to knowledge corporations and workplace users are knowledge consumers that are collectively engaged in reciprocal evolution of virtual workplace making.

The evidence collected for this research draws upon observations and interviews with the development team of Collaborative Virtual Workspace (CVW) and a team Research Computing Facility (RCF) team using CVW. Collaborative Virtual Workspace is a place based environment designed to support temporally and spatially distributed work within MITRE Corporation and with its customers[3]. The responsibilities of the RCF team include maintaining, supporting, and improving computing resources for research initiatives within MITRE. Typical tasks include configuring systems, automating routine procedures (such as log on and back ups) responding to user help requests, systems diagnostics, system upgrades, and long range planning. Their physical space is relatively centralized (within visual range), except for the group leader. Most offices are separated by full-height partitions but are shared on a part and full time basis.

CVW is a hybrid system that provides a framework of services including document sharing, white-boarding, audio, video and text communications. CVW is implemented on top of a LambdaMOO [4] server that interprets and executes user requests and actions. The server queries the core databases that store user descriptions, objects (documents, notes, etc), commands and contexts (rooms). The CVW client is the user interface that is implemented in Unix and Java and can be run on a web browser. The client environment is implemented using a building metaphor where people and objects exist and interact in rooms. People can pick up and import objects, carry them in a personal case, and drop them in rooms to be shared with other occupants. In rooms, people can communicate with audio, video and text. People (and objects) move between rooms sequentially either by clicking a destination on the floor map for or by specifying a destination through a command line entry. Access to specified rooms or floors can be restricted by locking rooms.

Working virtual

CVW has been deployed since 1994 and currently has approximately 300 members (inclusive of MITRE and customers) of which about 50 are regulars users (regularly active throughout normal working hours). Ideally, the model CVW user should have convenient access to computing facilities throughout the day and a need to collaborate with others with similar access. Usage patterns (Spellman Mosier, Deus, & Carlson 1996) suggest that CVW is best suited for groups that work together full time (such as the RCF team or CVW development team) or inter-acting teams in which members belong to several different teams that use CVW (such as Model Workplaces, management teams).

Interaction

The type of collaboration that occurs in CVW varies depending on users, content and context. The familiarity, hierarchy, and competence of users to each other and the environment affects the formality and dynamics of interaction. The urgency, importance and complexity of the content under consideration also influences the formality and dynamics. Over time, contexts take on an identity whose character is a combination the content, function and personality of its regular inhabitants. Usually the character of interaction in a room frames behavior by providing visual access to the social conventions (text and actions) that render the type and formality of appropriate communication. Informal collaboration is the norm for frequent users that work together over extended periods. Informal interaction is loosely structured, multi-threaded, and highly interruptible. Ad-hoc interactions occur when an occasional visitor enters a room looking for someone or some information and engages other inhabitants in conversation. Ad-hoc meetings may occur when announcing or reporting information that may affect the group. Formal interactions do not happen as often or as effectively as they do face to face. When formal interactions do occur in CVW they usually are in combination with physical formal meetings. For example, when a team member is in a physical meeting and interacting with their team in CVW, communication may be structured to give priority to the member in the physical meeting.

Evaluation

If we consider how CVW is changing work practice compared with its physical form, we can evaluate it along the dimensions of efficiency and effectiveness. Efficiency can be measured in terms of time, resources and effort expended to perform tasks. It can also be measured against the overhead required to transform a task from its existing medium into CVW (this includes learning overhead). Because we can only measure improvements against *existing* work practices we must consider that new work practices may arise replacing existing processes or making them unnecessary. Likewise, new processes may create additional workload. Improving effectiveness means improving the quality of work practice. Quality may be measured against satisfaction, morale, or improved service or performance. Often effectiveness is gained at the expense of efficiency. Improvements in efficiency typically show rapid returns on invested resources while improvements in effectiveness require longer term evaluation.

Efficiency

Response Time

CVW provides an efficient way to find people, answers and documents. For the individual who interacts with many different teams and individuals, the useful value of CVW is dependent on how many of those teams or individuals use CVW on a regular or predictable basis. Other than communication, many groups use CVW to store and discuss collaborative documents. Often the efficiency of CVW is compared to productivity increases and personal utility. Aside from improving the efficiency of existing work process, productivity is bound by our capacity to learn new ways of working. By learning to use tools, we acquire new skills that can enable new processes and new levels of productivity. If an individual does not see immediate or short term gain, s/he may be less responsive to adopting to new work practices. CVW has been very efficient for teams that interact frequently in short episodes. Text is the most used means of communication among the RCF team. It is less intrusive to the receiver(s) workflow and requires less overhead for the sender than other conventional media like email or phone (e.g. dialing, addressing).

Because public text is persistent in a room, a question directed to one person may be responded more quickly by another. For the occasional user who interacts with many individuals, both in CVW and outside, productivity increases are realized by moving information in one medium toward action in another. For example, team member could be in a meeting outside CVW and by having access to their team they can quickly get and give information that is relevant to the meeting. Likewise, a decision that is made in a meeting outside CVW can be quickly turned to action among the team in CVW.

Problem Solving

Many users have found CVW to increase the efficiency of problem solving. Having your team at your disposal is a valuable resource for quick responses. Lingering questions and issues are visually accessible and can be referred to or answered when convenient. For systems administration work, the ability to paste in error messages or directory paths directly into a conversation makes group problem solving much more convenient than looking over crowded shoulders or regenerating error messages. Over time a work group can develop conventions for response time and choice of media that conveys the urgency of a request or action. For example, a pop-up message may suggests a greater degree of urgency than a question asked in the conversation window. CVW is a low overhead solution to rapid fire, highly interactive problem solving. Usually problem solving between team members was much more effective then problem seeking in which the problem was not clearly defined. The additional demands for resolving ambiguity between contexts when diagnosing complex problems required greater bandwidth and closer collaboration than afforded by CVW. Also systems problems often preclude network access altogether and require alternative means of communication. The two most common reasons for switching from CVW to another medium is to enable richer perceptual communication afforded by higher bandwidth media such as audio or face to face, and to provide mutual access to contextual information (such as equipment or physical tools) needed to understand a problem or description.

Effectiveness

Socializing

Informal social activity is common within effective teams (Katzenbach and Smith 1992). Frequent users joke, argue, vent, and hang-out together in CVW. In order for teams collaborate effectively they must build trust and confidence among individuals. The most effective teams move from individual to mutual accountability by taking risk together, confronting conflicts together and revealing weaknesses to each other. The barriers to effective team work are familiar to the Co-design approaches where participatory design becomes the medium for workplace intervention[5]. To deal with the pressures of work, effective teams socialize. Increased social interaction builds trust and mutual stake in group problem solving. Too much socializing can appear to be inefficient and anti-productive, too little can appear to be stiff and oppressive. Many users of CVW favor the sociability of CVW as "a convenient way to vent" frustrations without having to get up, and get out to blow off steam. As much as half of the conversation that occurs among the most effective and active teams in CVW is not directly work related. When arguments erupt, people not directly engaged will regress and turn to other activities until things settle down. When conflict escalates, interaction increases in frequency and decreases in content. Communication relies increasingly on indirect, implicit understandings that depend on social bandwidth for meaning (tone, gesture, expression, body language). Eventually, communication breaks down in text media and the conflict will resolve to other media or to physical space that afford richer social bandwidth needed to communicate meaning and emotion.

Learning

One of the most promising benefits of virtual workplaces is the ability for a team or an organization to learn[6]. Much of the research in developing tools for organizational learning has been on capturing thought and design rationale[7]. Capturing the events and interactions in organizational processes has become commonplace in electronically mediated environments. Because interactions in virtual environments occur within an electronic context, indexing actions by context information is feasible. However, capturing and indexing information and context does not guarantee its value or use. Because learning is situated and inseparable from context (Brown et. al. 1989) the challenge is to create meaningful learning situations in which knowledge can be created and assisted by memory[8]. Knowledge is created through the interaction of information within a context that is both present at hand and existing in the background and experiences of the individual. By increasing the amount of *relevant* context that is captured, and indexing it so that memory may be accessed easily from present situations the potential for learning situations that can build on previous experiences is enhanced. The dilemma is that knowledge is created in the discovery of relevance. We cannot know predict what will be relevant in one situation without the context of the other. The delusion that knowledge and context can be stored and recalled even with "full fidelity of the original experience" (Pruitt & Barrett 1994) is a pedagogical dilemma beyond the scope of this research.

The learning situations speculated by designers of virtual environments have not yet been realized in practice. Those situations where learning has been assisted by CVW have been spontaneous and ad-hoc. They have been attributed to triggers in context that are afforded by the medium as opposed to recollection of electronic memory. One example is URL sharing. In the course of an interaction between two individuals, another listener in the room may suggest and paste a URL directly into the conversation, as if to say "take a look at this" and actually show it. Another example is in complex problems that may be recurring or pending. Our understanding of complicated concepts and problems evolve with each new reference or situation, that recasts the problem in new more textured forms (Brown et. al. 1989). One participant's description of a current problem or a symptom may trigger another users recollection of a similar experience or example. Likewise, an expert that may not be directly engaged in the conversation, but maybe listening, can contribute examples or pointers triggered by the discussion that help to describe a problem or re-direct inquiry. With each recurrence or reference of the problem in different contexts a collective understanding is constructed. In any event, learning is not instant; it occurs over time with experiences that are mutually reinforced by physical *and* virtual interactions[9].

Other research in educational MUD's (Fanderclai 1995, O'Day et. al. 1996) is revealing many advantages of virtual learning environments. MUD's have increased the opportunity for learning situations to occur outside the traditional classroom and with a wider participation of outside students and experts. Communication is both more frequent and more open without the bias of personal appearance or language. Those classes that have effectively combined both physical and virtual classroom experiences have found that certain learning situations are more effective when models of one medium are not imposed on the other but instead are viewed as complimentary. More importantly, when technical control mechanism are relaxed in MUD's students take greater responsibility for their learning and build stronger trust relationships more conducive to open learning situations.

Enculturation

Learning is a social activity. When new members enter a group, they learn through observation and active participation. New members become enculturated into a group as they adapt and practice the social etiquette and behavioral norms of the group. These can be conventions for interruption, selection of media, professional language or formality of conversation. Because CVW affords easy access to observation and participation in group activity, it has been very successful in enculturating new members to the work practice. Learning is less disruptive and more efficient when newcomers can unobtrusively observe and recall social conventions and work routines, reducing interruptions to a necessary minimum.

Virtual Work space

For the experienced MUD user, CVW is instantly familiar. Many of the common MUD commands that were imported with the LambdaMOO are available through the command line interface and not the graphic user interface (GUI). For any user familiar with windows based applications CVW's GUI is both intuitive instantly recognizable (See Figure 2.a). Most experienced users prefer the command line interface over GUI. By minimizing CVW and interacting through the command line, screen real estate can be preserved with full functionality of the GUI. From a development perspective, interface improvements that incorporate more of the MUD commands may mean sacrificing some performance (space and/or usability) or delaying the addition of alternatively useful features. Often new users resist the command line interfaces in favor of the GUI and ascribe usability improvements to its development. Future development plans for CVW (Spellman et. al.1996) include improving instrumentation (event archiving) and support for contexts and conferencing; extending workflow capabilities by enhancing the support for roles; adding features to better indicate degree of engagement, availability and interruptability; and increasing searching and navigating capabilities. Many of the user responses to the CVW environment reinforce the need for many of the planned improvements.

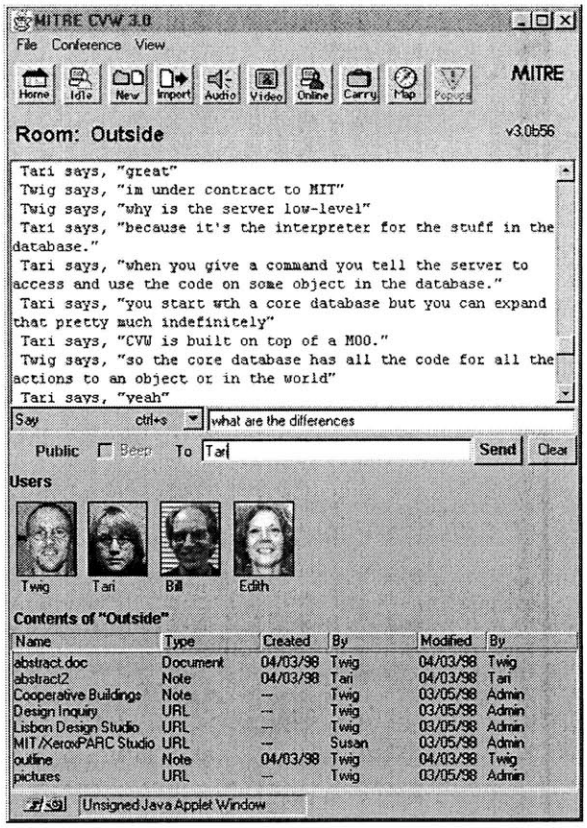

Figure 2.a CVW Client GUI

Several of the important characteristics of CVW distinguish Place-Based systems from other collaborative systems. Each of these characteristics shift time and space dependencies creating new possibilities and challenges for work practice. (Spellman et. al. 1996)

- *Persistent* environments exist whether anyone is in them or not. This is in contrast to session-centric models where actions and documents only exist relative to an interactive session. Persistence supports asynchronous as well as synchronous interaction. A question can be addressed to a room, and anyone listening (active in that room), can 'hear' and respond accordingly. Unlike interactions in physical space (such as face to face, VTC or telephone where the degree of engagement and expected response is more obvious by convention), the initiator of an interaction must assume a relaxed responsiveness of the participants. Over time, the conventions for interruption and availability and response time are socially negotiated and adapted as the norm.
- *Location independence* allows users to interact regardless of physical location. With the addition of wireless infrastructure, and mobile computing, location independence is becoming increasingly possible. Although this provides a degree of freedom to the user (restricted to accessibility of computer resources), social constraints and physical constraints are asymmetrical between locations of access and must be negotiated in physical as well as virtual space.
- *Location transparency* allows users to interact without others knowing their physical location. However, physical location is often desirable and useful context information indicating availability or interruptability. In some instances, the absence of location information between shared audio spaces can make a private conversation unintentionally public[10]. Additionally, CVW supports asymmetric collaboration so that some users can be communicating with audio and video while others in the same

room may only be using text. This is typically the case where either the availability of resources, or social context differs. For example text is often less intrusive than audio or video in certain social contexts in which individuals users interact in both the physical and virtual spaces.

- *Statefulness* allows users interact with each other and documents in a context. This provides the opportunity for ad-hoc interaction in a content rich context. In effect statefullness integrates the strengths of document-centric and session-centric collaborative frameworks. Often users collaborating on documents together or sharing reference materials may strike up a conversation (either social or work related) when they share the same time and same place contexts. Moreover if users collaborate intermittently, they can leave notes or messages (Pop-Ups) in a room with the documents.

Other characteristics specific to the CVW environment reiterate several of the social and psychological issues in other CSCW and workplace research. Awareness, privacy, orientation, representation, and workflow have been foremost concerns in Telepresence[11] groupware (Wells, D. 1996) and place-based systems (Spellman et al. 1996).

Orientation

The *floor map* allows users to visually comprehend the extent of 'world' through a building metaphor that is divided by floors and rooms. The visual map provides a way-finding device that helps to orient oneself in the world. The map provides an easily recognizable means for spatial navigation and content organization. The floor plan layout is consistent throughout the building. Technical limitations make flexible plan alternatives unattractive for the added value it may provide. The typical layout consists of 6 equivalent rooms off a double loaded dead end hallway. At one end a larger room acts as a lobby where all vertical circulation between floors occur. Adjacent to the lobby is an additional room somewhat larger than the 6 rooms. (See Figure 2.b)

As in physical space, people tend to cluster related things. Similarly, The spatial limitations of implementation create need for space-content management of the virtual workplace. Typically new users request a block of rooms or an entire floor. Later adjacent spaces may be occupied by other groups. When a group expands and requests new space adjacent to their existing space, a space allocation problem is created.

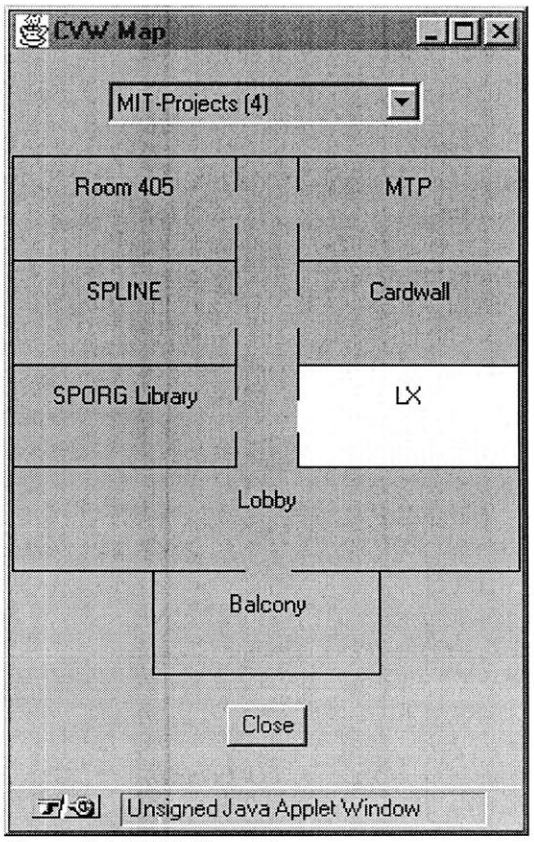

Figure 2.b CVW Floor Map

In physical space, designers and occupants often name rooms which conjure an image of an associated behavioral setting[12] such as den or bedroom. In turn we attribute specific standing patterns of behavior to patterns of environment. Recognition of where one is, influences our prediction of what may happen next, how we evaluate the consequences of our actions, and limit our perception of available actions[13]. Our understanding of the layout of our environment and the range of behavioral opportunities existing is fundamental to our selection of those activities in which we engage (Lang 1987).

Orientation is the ability to position oneself both socially and physically and is a major contributor to an individuals feeling of security (Lang 1987). As people use maps to navigate in their environment, they acquire, store, encode, recall and decode information about the relative location and attributes of the environment[14]. Over time, experienced users decreasingly rely on the floor plan map. Users can set their log on entry to a predetermined home room (or personal office) and move between rooms by specifying a destination on the command line, thus avoiding the map altogether. They form a 'cognitive map' of the world that functions as a guiding schemata[15] to navigate and orient oneself physically and behaviorally in their environment.

> "We view cognitive mapping as a basic component in human adaptation and the cognitive map as a requisite for human survival and everyday behavior. It is a coping mechanism thorough which the individual answers two basic questions quickly and efficiently: 1) where valued things are, 2) how to get there from where he is." Roger Downs and David Stea, 1973 (Lang 1987)

Although research has shown that the cognitive maps often favor similar characteristic of the environment, the ways in which people form the "guiding schemata" are prejudiced by individual background, motivation, status and prior reference location. The ways our behavior is influenced by our use of representational maps (virtual map tools) and metaphors of the environment is discussed in greater detail in Chapter Three: Workplace Metaphors.

People navigate CVW either to find people or information. A list of online users provides locations and current active/idle status (see Figure 2.c). Room names can also provide some indication of either the people or the content. Similar to most MUD's (and in keeping with the spatial metaphor), circulation is sequential. by indicating where you wish to go you, you move through rooms, passing by objects, and people and stop only upon arrival at the your predefined destination. If watch your location change in the text window passing through the spaces to your destination, you may notice other users in passing. Although this increases the opportunity for chance encounters, under the current implementation a user can only move to predetermined destinations. This can make an entry awkward in which a user enters momentarily, then turns around and leaves to catch someone they might have passed. Moreover, the element of 'chance' is reduced when the encounter is predetermined destination.

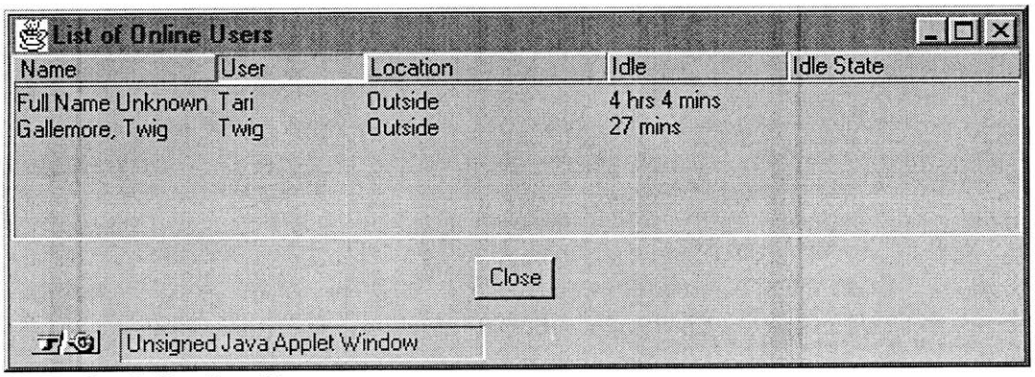

Figure 2.c Online User List

Visibility

Because navigation is most often to find people and/or content, the environment needs to support both. In doing so, navigational tools must consider the issue of granularity. How much information is needed to navigate effectively? How much information about a context should be available before privacy becomes an issue? When too much context information is provided, then navigation becomes impaired by information overflow. When too little is available, then navigation is open to false conjecture.

> "For every gain in granularity of description [of work] their may be increased risk of surveillance. In the name of legitimacy [of work] and achieving public openness, an increased burden of accounting and tracking may be incurred. The phenomenon is one of trade offs an balances, not absolutes and clear boundaries." (Leigh-Star & Strauss 1997)

The desire for legitimacy and visibility of work (by co-workers and management) needs to be considered in the design of work environments. People desire that their efforts be visible to management as a measure of their performance. When people work together or independently, visibility of work is imperative for coordination with co-workers as well as a predication of efforts within organizational goals. Among the challenges, are the level of visibility that can be supported by the environment or by the work (some cognitive work, like thinking, does not produce action or artifact). To what extent is making work visible a burden or benefit to the worker in terms of articulation of its value and as legitimate work? Making work visible involves a degree of risk that can inhibit collaboration if it means exposure of uncertainty to the scrutiny of peers or management[16].

Cognitive Flow

Collaboration can be messy and can appear disorganized on the outside. When an individual or group becomes cognizant of their outward appearance to management, informal communication becomes more formal and considered. Although this may provide more structure to communication flow which may be helpful for an observer trying to comprehend the state of work (status, issues, topics), it may inhibit work flow and hide other more pressing issues. With management present, people are less likely to expose problems which they are responsible for solving or have contributed in creating.

Throughout our working days we are constantly adopting our workflow to the tasks at hand and the people with whom we interact. When we work, we adjust our workspace, and our workflow to accommodate interactions. Often the "state information" is lost in the adjustments. The state information can be an arrangement of stacked papers, or open books, or a pad and pen in your hand. This information is not only important to the task currently at hand but also may be valuable state information to other collaborators indicating what you are working on, or the direction of your thoughts (Kirsh 1998). Similarly, an intense conversation between coworkers can be interrupted by the entrant of another, losing the cognitive state of the conversation. Workflow is often disrupted to bring a late entrant up to date. In a persistent virtual environment if activity is logged, a late comer can review progress and status with minimum disturbance. In CVW, persistence supports workflow transitions with minimal loss of state information.

Privacy

Event logging that records actions and/or conversation in rooms can be useful in some working situations and disruptive in others. Recording activity can be valuable; providing insight to decision rationale or to collect user feedback statistics. Statistical feedback however, must be weighted against available alternatives to the user. The fact that someone uses a command frequently does not mean that that any particular command is useful or the most desirable alternative.

Logging can also be interpreted as a breach of privacy. Concerns for privacy in the workplace remonstrate the decontextualization and misinterpretation of information outside of the context in which it was understood. The need for privacy personal space and territory is fundamental to basic human needs of identity and esteem[17]. In the workplace, if personal space is not respected productivity can be impaired[18]. The need for awareness of activity in the workplace is fundamental to collaboration. Activity can be changes in information, location, or behavior of workspace participants[19]. Who is where, who is doing what and where are we going? Awareness includes activity at the center of attention as well as the periphery (Ishii & Ulmer, 1997 Wisneski et. al. 1998). In highly collaborative work, to be aware of others' actions usually means that others are aware of our own actions. The extreme of asymmetrical awareness is surveillance. Our awareness of others' awareness of our own actions influences our actions and openness. We behave according to the way in which we understand the effects of our actions (and interpretation) on others[20]. People are more reserved in front of a camera; even more so if there is uncertainty as to why and

how their actions are being recorded. Some users of CVW who are seasoned users of digital communication consider everything in electronically mediated environments public domain; for them privacy in CVW is rarely a concern. Concerns for privacy that affect the openness of communication are more evident in situations with active listeners than passive recorders. Active recording devices have been incorporated into CVW so that conversation and actions in a room can be recorded but not without forewarning everyone present that they are being recorded. The greatest impact on the flow of communication is the occasional presence of management or unfamiliar visitors who park themselves in a room as if to listen in without much participation.

Ownership

Access control lists allow users and groups to restrict access to rooms or hallways. In effect this provides a degree of privacy or ownership. In keeping consistent with the metaphor, if access is restricted from a hallway or floor all rooms within are also restricted. Access can also be restricted through ownership of documents and objects that can be shared by groups, as read only, or hidden (as in a personal carrying case, described below). To a degree, access control can be used to create private territories such as floor or combination of rooms, that can be owned by a group. Technical controls such as these are some examples of the social-technical dimension in CVW, that is prone to misinterpretations such as employee trust versus client confidentiality.

Personal *Carrying cases* allows people to import, pick up and carry objects in their possession. Objects that one has in their carrying case cannot be viewed or modified by anyone other then their owner; in effect they are personal possessions. Using conventional LambdaMOO commands, a user is able to see the contents of another users carrying case, so that objects are only perceived as hidden from the inexperienced user (who's actions are limited to those available through the CVW interface). All object documents must first be imported into a carrying case before being dropped into a room or moved between rooms. This provides persistent personal space in the environment where one can keep documents not ready for release or only of personal interest.

Availability

Idle status services provide important state information about users' degree of engagement[21]. By indicating the time since a users' last action, one can determine the active state of other users. Activity does not necessarily indicate availability, nor is it a good indication of interruptability. An idle state message can be declared by users to acknowledge availability, ('out to lunch', or 'in meeting'), however, this often goes unused because benefit is mostly to others and because physical distractions are usually spontaneous and unpredictable. One of the more popular reported uses for the video tool was awareness recognition of others' focus of attention. Using video, one can easily determine the degree of engagement and availability (assuming that the users are within the visual field of the camera).

Pop up messages allow users to page other users by sending a message directly to a pop-up window on the receiver's desktop (see Figure 2.d). This often indicates a greater degree of urgency and can be accompanied by an audible alarm if deemed necessary. Moreover pop ups are persistent, requiring the action of receiver remove them. User can send messages, that will appear (similar to Post-its) regardless of the receivers engaged state. If a user is not logged in, the message appears at their next log in. Because pop-ups require a receiver response to clean up or restore display space, they can interrupt work flow, which in turn demands a degree of mutual consideration for their use. The appropriate use of idle state messages (like pop-ups for getting attention), is an example of mutually accepted social conventions.

Although social conventions for interrupting and indicating availability are adopted among a group, they often differ between groups. For teams that typically work together in one room, the room in effect becomes a social boundary. For teams that interact across multiple rooms switching between social contexts can be slightly disruptive to individual and group work flow. Over time and with extended use, different social contexts take on a the character and identity of the people who inhabit them.

Although CVW provides an convenient efficient way to reach co-workers, it also creates an additional medium for the individual to manage. With the proliferation of communication tools in the workspace, an individual can now be interrupted in multiple ways. With each new medium, a group adapts social conventions for its use. The choice of medium alone communicates a level of urgency, importance or commitment that can differ between work groups or social and professional backgrounds. For example one group may use Email for all scheduling correspondence and another may use CVW. For individuals accustomed to managing high levels of interruptions (such as the case with RCF), the addition of a medium can be at times an 'assault on your senses' or at other times a less intrusive and more appropriate means for certain communications.

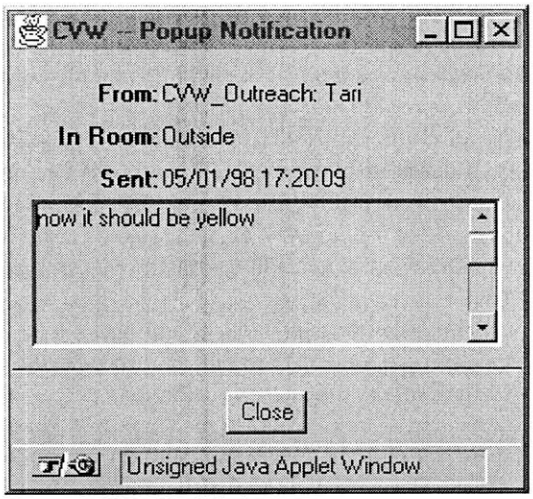

Figure 2.d Pop-Up Window

Persistent representation of people and objects in a room context, allow users to see the contents of a room and direct actions toward people (thumbnail images) or objects (object text list)[22]. An added feature, proxy representations, breaks the physical space metaphor, allowing users multiple representations, often helpful for participants needing to collaborate in multiple contexts. Managing multiple contexts can easily become complex and overbearing. For some users, an alternative context is needed in which the individual working with several teams will settle on one place that is accessible to all relevant teams. Although the user cannot monitor activity in rooms in which they are not present, they can interact with people in other rooms using private or point to point communication such as Pop-Up or Say Private. When needed the users can move to a common room for closer (more frequent) interaction.

In physical space, upper level managers are in and out of meetings with people in the virtual and the physical workspace. Typically unannounced visits tend to be brief direct interaction, and then on to the next meeting. In persistent virtual workspaces, a manager can drop in and remain all day. If they use proxies, they can station themselves in several contexts over extended periods. The presence of management often changes the dynamic of interaction making it more formal and reserved. Similarly, in physical space we may chose a medium by the level of commitment it commands. If someone calls you on the phone and you pick up, there is implicit contract that you are going to respond and that someone at the other end is listening. In persistent virtual spaces, utterances linger. There are no obvious contracts for a response, however over time social norms may be adopted.

Summary

Working virtual is changing the way people work and the way they perceive their work place. People work, play, joke, argue, and hang out in the virtual workplace. Through reciprocal evolution, people learn by use, by chance and by participation; designers often find new uses and interpretations that were unanticipated. In many ways virtual workplaces facilitate new possibilities for work practice and preclude others. Work in persistent virtual environments is in virtual time and requires new conventions for the dynamics and structure of interaction. When we evaluate improvement only against *existing* work practices, we preclude the potential, therefore limiting the development of new practices in the virtual workplace. People orient themselves spatially and behaviorally in the virtual workplace according to the properties of the environment, and the content and people that inhabit its spaces. Contexts with recurring patterns of behavior, begin to take on a character of its occupants that distinguishes it from other contexts. The social and technical limitations of physical space often create asymmetries in shared virtual spaces that affect the medium we use and the structure of our interactions. Group awareness and personal privacy are in constant tension. The barriers to effective teamwork in virtual workspaces are similar to those in physical

workspaces but the attributes of the virtual environment require different approaches toward their resolution.

Chapter Two Notes

[1] Michael Reddy described this dilemma as the Toolmakers Paradigm in which people are partitioned and isolated in different worlds with different materials and properties but can pass messages between them describing tools that are useful in their world. When someone interprets a message, builds it with local materials and uses in their isolated world they find that it either is useless or has some use that was not intended by the sender (Reddy 1993)

[2] however the Co-Design approach does advocate an approach that integrates design of workplaces into the work practice, similar to a use by design by use e.g. reciprocal evolution

[3] MITRE is non-profit organization that serves government contracts for research, development and consulting in information technologies, http://www.mitre.org

[4] LambdaMOO was developed by Pavel Curtis at XeroxPARC the LambdaMOO server software interprets typical user commands and queries MOO core databases. CVW has several core databases, the standard MOO core that stores context descriptions, and standard MOO object descriptions (messages, people and other objects) the document server stores documents and other objects that are imported into the MOO, and the directory server stores people descriptions and access control groups

[5] in the Co-design approach each party reveals their concerns and interpretations of others. To reach consensus for intervention they must overcome cultural, political, language, and professional differences. source: LX Teaching Module MIT SPORG work in progress.

[6] much has been written about organizational learning especially as a result of changing nature of work in the knowledge organization see for example Senge author of *Fifth Discipline* and Director of Systems Thinking and Organizational Learning at MIT http://learning.mit.edu/ and many papers by George Roth http://ccs.mit.edu/roth.html.

[7] see for example Multimedia Folklore Raison D' Etre Project by IBM CSCW 1994

[8] Creating learning situation that make use of electronic memory tools is the subject of ongoing research workplace making at MIT-SPORG. The LARC Teaching Module teaches workplace making in learning situations that use a web based tool for capturing and recalling experiences of workplace making http://descom.mit.edu/lx/.

[9] an example learning situation among the RCF team was 'configuration drift' that was addressed to the group in a meeting and reiterated by reference to examples in CVW when symptoms occurred.

[10] this had been the case when audio was multi-cast, but the current upgrade of CVW supports point to point audio connections to allow private connections in addition to multi-cast connections allowing room conferencing (provided every user enables audio).

[11] Buxton et. al., U. Toronto CAVECAT Project, CSCW 1996 "Experiences in the use of Media Space" 1991

[12] (Perin 1970) in (Lang 1987)

[13] (Kaplan 1973) in (Lang 1987)

[14] (Tolman 1932, Moore & Golledge 1976) researched the use of maps in physical environments from (Lang 1987)

[15] (Neisser 1977) described cognitive maps as a set of images (guiding schemata) that include "elements" obtained from direct experience, imagination or indirect knowledge from others. The elements include impressions about the structure and organizing principles, appearance of a place or its relative location, its function and its values. From (Lang 1987)

[16] see for example LARC Teaching Module, one of the barriers to collaboration has been exposure of uncertainty to peer scrutiny. Rather than confronting problems of uncertainty, people focus on research findings to avoid being attacked for their lack of competence.

[17] (Hall 1959, Goffman 1963, Lyman and Scott 1967, Skaburskis, 1974, Sommer 1969) from (Lang 1987)

[18] (Evans and Howard 1973) from Lang 1987 and (Becker and Steele 1995)

Notes continued

[19] implementations in groupware applications have included remote cursors, multiple scroll bars, low frame-rate video U. Calgary Greenberg & Roseman CSCW 1996

[20] Heidegger from (Winograd & Flores 1987)

[21] degree of engagement is "the relative attentiveness or interaction of a participant with the focus of attention. Several factors contribute: anxiety of the listener, patience threshold of the listener, interest in the discussed topic, social and cultural norms of the participant" (Hussein 1997)

[22] in the Java implementation actions on objects are available by mouse-clicking on the object

3

Workplace Metaphors

Metaphors are a way of looking at things that are unfamiliar in terms that are familiar. Scientific thinking is a way to look at obscure things and through logical processes of inductive and deductive reasoning explain what we see. Metaphors are everywhere, from academic theory and scientific application, they influence thought and behavior. (Lakoff & Johnson 1980, Black 1962, Ortony 1993). In architectural design[1] and computer interface design[2], metaphors frame the way in which we think and describe our design intentions and the way in which we evaluate our design proposals. Workplace metaphors such as DEGW's Den, Club, Hive and Cell describe patterns of interaction and autonomy that frame design strategies. The pervasive desktop metaphor and command-line conversation metaphor are such basic metaphors in human-computer interaction that they assumed invariant. Metaphors become invisible when we use them without thinking or recognizing them[3].

In his book *Architecture as Metaphor* Kojin Karatani uses the metaphor of architecture to describe the process of constructing meaning through communication in which the rules evolve through dialogue between designer and client/user[4].

> "No architecture exists out of context. Architecture is an event par excellence....Architecture, in other words, is a form of communication , and this communication is conditioned to take place without common rules because it takes place with the other, who does not follow a commensurable set of rules." (Karatani 1995)

Communication like architecture cannot separate design from use, action from interpretation, tool from function, because they are mutually dependent and do not exist without the other. This dialogization (Wertsch 1997) has troubled metaphoric thought that struggles to separate meaning from metaphor. Meaning in metaphors arise through reciprocal evolution, as they are used recurrently in different contexts, they recast meaning on themselves and the domain they are intended to edify. Metaphors become invisible when their meaning becomes internalized and inseparable from their use.

Architecture is an expressive medium, its power is in its capacity to effectively and unambiguously express the values and ambitions of those who promote and inhabit its spaces (Duffy 1997). When discuss metaphors, it is important to distinguish between metaphor and image. Metaphors conjure up images. Unlike metaphors, images are not bound to another domain. However, we often use metaphors to explain images.

> "A metaphor gives concrete substance to an impression that is difficult to express. Metaphor is related to a psychic being from which it differs. An image on the contrary, product of absolute imagination and owes its entire being to the imagination. ...At the most, [a metaphor] is a fabricated image, without deep, true, genuine roots. It is an ephemeral expression. It is, or should be, used only once, in passing. We must be careful therefore, not to give it too much thought; nor should the reader think too much about it....Contrary to metaphor, we can devote our reading being to an image, since it confers being upon us. In fact, the image which is the pure product of absolute imagination, is a phenomenon of being; it is also one of the specific phenomena of the speaking creature." (Bachelard 1969)

Consider the metaphor *the house is a machine for living*[5] likewise we could consider *the workplace a machine for work*[6]. For the Modernist Movement in architecture this conjured up images of machines streamlined and unornamented. Under the Modernist metaphor, the 'house machine' was evaluated for its performance and efficiency. Postmodernists rejected the modernist machine metaphor and images in favor of contradiction and juxtaposition of symbolic forms of past and present. In effect, Postmodernists were reacting to the deeper meanings of Modernist theory that were reinforced and buried within machine like metaphors. What Modernism viewed as a clean, efficient, well oiled machine, Postmodernism saw as useless, frivolous junk. Metaphors, like tools, can have entirely different meaning and use in different contexts.

The distinction between image and metaphor in Modernist and Postmodernist thought reveals a difference between surface meaning and deep meaning of metaphors[7]. Surface metaphors often mask the deeper meanings that generate them. Surface metaphors map the structure of one domain to another. In the case of CVW, a model of a physical office building is mapped to the virtual workspace. We can understand the structure of the virtual workspace by mapping it to its physical domain through the surface metaphor of buildings floors, and rooms. A deep metaphor is not easily mapped because the two domains are viewed as dueling ends. For example virtual and physical or group and individual are deep metaphors for space and collaboration in the workplace. Deep metaphors are the motivation for surface metaphors and are the underlying source of incompleteness and break downs.

Surface Metaphors

Metaphors, like models, have structure. The structure of metaphors allow one concept to mapped to the structure of another in terms of a target domain and a source domain by identifying internal consistencies in their respective internal structure. For example, a physical workspace can be mapped to a virtual workspace by using the structure of office buildings. By mapping metaphors at a super-ordinate we maximize the possibilities for internal mappings in either domain (Lakoff and Johnson 1980). Deep metaphors resist mapping and depend on surface metaphors to relate otherwise dueling domains. For example, to map between virtual space and physical space a surface metaphor such as building can be used. The implication of the structure in surface metaphors is that by drawing attention to specific features of one domain (in this case the topological properties of physical buildings as spatial containers) other features are hidden such as the place-like behavioral properties that distinguish an office buildings from a hotel (Alexander 1977, Dourish & Harrison 1996).

(Lakoff & Johnson 1980) described a taxonomy of metaphors that are pervasive in language and thought. The three general types, Orientation, Ontological and Relational, are distinguishable by structure and purpose. *Orientational* metaphors provide a basis for positioning ourselves in another domain, typically space and time. They are used to structure and organize concepts. By sharing internal structures across domains orientational metaphors are mapped at a super-ordinate level that is coherent throughout a system, rather than in isolated incidents. For example: forward is always understood to be the direction you are heading, and up is always considered over your head. *Ontological* metaphors provide a basis for objectifying our experiences or concepts. They allow us to treat concepts as objects in order to categorize, quantify, manipulate and analyze them. For example: the house is a machine, or your thoughts are fragmented. *Container* metaphors are ontological metaphors. Container metaphors allow us to apply the properties of inheritance and inductive reasoning across domains. Fore example if A is in B and B is C then A is in C. The notion of territoriality is the quantification of personal space within a boundary. Similarly we can describe actions contained in an event. The relative position of the action in the event is an orientational metaphor while the event is bound by a container with a beginning and an ending. The properties of inheritances, allow us to act and think in one domain as we could in another. *Relational* metaphors provide a means for understanding behavior between domains. They allow us to describe causality and purpose. For example: drowning in work or dragging your feet describe action or behavior in one domain in terms of another.

Temporally structured metaphors

Experiences and memories are structured as events or series of events. Events have a structure that is distinguished by beginnings and endings[8]. Mutual engagement or direct interaction are not requisites for shared experience, but event structure and mutual presence is. In physical space, when we consider shared experiences we typically think of synchronous events such as a face to face meeting, or a conference call. If two people experience the same event at different times, the experience can shared asynchronously (e.g. seeing the midnight Rocky Horror Picture show at the local Cineplex). However without a shared social context that includes the mutual presence of the other, conflicts[9] and discrepancies between experiences are more likely to be attributed to and dismissed as time dependent references, than by mutual negotiations of interpretations of context.

In persistent virtual environments, interactions occur asynchronously and remotely. Because the medium is persistent, asynchronous events are experienced as if they were synchronous. Experiences are recorded asynchronously in physical time but shared synchronously in virtual time. Virtual time is not necessarily sequential. Assuming this, shared experiences rely on a mutually accepted context assumed by the medium and our models for its use. Conflicts arise from discrepancies between contexts in which an event is experienced asynchronously. Resolution of conflicts, is more likely if the context is understood through socially dependent references, than by appeal to the facts. We will return to resolution of conflicts and breakdowns in Chapters Four and Five.

In many ways temporally structured metaphors are characterized as spatially structured metaphors. By orienting and positioning ourselves temporally, events can be structured spatially. Experiences occur within events. Events are then arranged sequentially and have relative proximity to one another.

Spatially Structured Metaphor

Space provides structure to the environment. It is where objects exist and events occur and have relative position and orientation. Spatial metaphors function as ontological, relational and orientational metaphors. Because we assume a common understanding of the spatial structure and behavior of the world (e.g. the laws of nature) we can describe experiences, things, and behavior in relation to that structure. We tend to relate things spatially, associating things by their proximity or by arranging them by association. Likewise, we partition things spatially by defining boundaries between activity and content based on distance and adjacency. In collaborative environments, our sense of who is where, and doing what is important to how we structure our own activity spatially. Privacy and awareness structure our spatial behavior[10]. The metaphors used in the design of collaborative virtual environments are intended convey features that illicit behavior of physical space into virtual space.

Conversation space

In physical space, our capacity to interact is limited by properties of the space for interaction. When we converse remotely our spatial behavior adapts to the constraints of the media we chose. In face to face conversation we negotiate meaning and interaction with body language, gesture, tone of voice, and distance. We move closer to see things more carefully and interact more privately. In remote conversation, we use whatever means the media afford. If gesture and expression are not available we rely more on tone of voice or conversational cues to emphasize meaning or intention. If audio and video are not available, we rely on narrative cues, punctuation and response time. We negotiate meaning by forming images of the others context filling in what is missing and needed to complete the picture. The selection of one medium over another conveys certain assumptions of context information. If someone telephones, we assume that they are not conveniently nearby and that our conversation is private. If someone pages us we assume that the message is urgent and will require subsequent action.

All interactions are synchronous to the extent that our actions are framed by the way in which we perceive them to be interpreted by others. When we converse in text, we 'compose' our utterances and actions, knowing that they will linger in the conversation space. The deliberation of composed speech is reflective

action. We engage in internal dialogue between ourselves and the receiver(s) (Wertsch 1997). Physical space is persistent, things in physical space are stable and remain in place until moved or acted upon. Utterances and interactions in physical space are not persistent (unless recorded), however traces of interaction do remain such as the configuration of furniture or equipment, and the use of visual aids such as white boards or documents. In highly interactive conversation, once words are spoken and new concepts introduced, they can become increasingly distant and remain only within the capacity for the conversation to support the thread.

In persistent virtual environments, the limitations of physical time and space shift. Interactions can reach further and last longer. Because utterances and the traces of interaction in the context are persistent in many virtual environments, a wider range of asynchronous and synchronous collaboration can be supported. In persistent conversation space our capacity to support multiple threaded conversation is increased. Additionally the capacity to think ahead and reflect back on the conversation is widened considerably. In face to face conversation, we are limited to how far ahead from where the conversation is to where we are able to think, and maintain sense of the present conversation[11]. The asynchronous granularity of text based conversation spaces limit the interruptability and increases the distance we can look ahead. We can play out thoughts and scenarios in much greater depth and refer back to previous thoughts that would otherwise be lost.

The Web

The metaphor of the World Wide Web, and the Internet is a metaphor of connections and nodes. The virtual workplace is network of conversation nodes and workflow is a network of committals and action-responses within the organizational processes (Winograd & Flores 1987). Michael Schrage describes the work space as a node on verbal, textual, and computational "network of interactions". As a result of collaborative technologies, the virtualization of workplaces is reconfiguring and decentralizing the nodes of work activity into organizational webs of transaction spaces. Knowledge work is interaction-on-demand through interconnected networks of social relationships[12] that cannot be distinguished entirely along on organizational boundaries.

Personal Space

Our space of potential interaction is constrained to the range of our sensory fields: the limits of audio, visual and perceptual space. We move closer to objects to see them. We back away from loud noises. We demand personal space as the liberty to control or at least influence the interactions we are confronted with in our environment[13]. In physical space we employ technical and social conventions to limit interactions, such as closing a door, or moving away from confrontation. Acceptance of the social convention and appropriate behavior relies on our ability to negotiate common understandings of the physical constraints and to construct shared meanings that communicate intentions. In collaborative virtual workspaces, the space of potential (Winograd & Flores 1987) for interaction is limited by access, availability and awareness. Access is limited by social context and technical resources. Availability is determined by the degree of urgency, the focus of attention and the presence of others. Awareness of others influences our behavior and constrains personal space to the limits of our perceptual fields. In virtual spaces, physical perceptual fields are insufficient. Peripheral awareness and privacy are negotiated with technological means and social convention to describe and limit the extent of personal space. When considering enclosure and openness in virtual environments, the issue of trust, confidentiality, and privacy are foremost. Technical implementations include access control lists, hidden files, and encryption. In physical environments, openness is mitigated with visual and acoustic separation and implemented in fenestration, partitioning, transparency.

The personal computing paradigm was built on top of a metaphor of the individual workspace, a model of the physical individual office. Group-aware tools (Wells 1996) extended the PC paradigm to incorporate shared task space and mutually accessible tools such as shared telepointers, multiple scrollbacks and group annotation[14] in which several people could interact with a tool that otherwise functioned as a personal tool. The groupware approach to collaborative tool making endeavored to make personal space group space.

Ironically the demand for collaborative technologies in shared physical workspaces inverted this approach. Increasingly shared spaces such as conference rooms became places for individuals to connect into shared virtual workspaces and access group tools. Because groupware was based on the PC paradigm of remote, individual, connectedness to a shared virtual task space, when it began to appear in shared physical spaces the model of collaboration space was recast in both physical and virtual workspace approaches. Meanwhile the demand for more personalized and customizable virtual workspaces continued to find metaphors in physical space such as Lotus eSuite WorkPlace[15] and AltaVista Forum's Office Library. As our models and use of personal workspace change with the new technologies, the metaphors with which we use to guide the design and interpretation of such will likely be questioned and recast.

Information space

The content - space metaphor is pervasive on the web. Muriel Cooper[16] coined the term "information space" expanding the metaphor of 2dimensional space to 3 dimensions. By extending Information Landscapes in 3dimensional space, scale, proximity, perspective and surprise, bear upon the information experience[17]. The City of News takes the structure of information as a basis for creating memorable experiences that can be cognitively mapped to an image of the city[18]. Other spatial metaphors such document libraries or archives suggest more familiar structures for indexing, searching and retrieving information based on subject, author or chronology. Although these spatial contexts provide a persistent space where documents can be shared asynchronously, they do not typically provide a context for synchronous collaboration (except by the extension of collaborative tools such as chat or VTC accessible from within the context). The information spaces are document centric providing categorical contexts based on content. They are oriented toward personal interactions with information as opposed with other workers.

Contextual Metaphors

From the assembly line to the Club to the virtual office, metaphors have been a basis for describing contexts for work. Chapter One described some of the current design approaches for physical and virtual workplaces. In response to the changing demands of work, facility managers adopted workplace metaphors such as Hotelling, Free-Addressing and Hot-desking, that underscores the redistribution of workspaces brought about by information technologies that are based on a paradigm of personal computing. Collaborative software designers created Email, VTC, and communication applications to connect individual PC's. Once connected, workplace designers turned their focus to patterns of interaction and occupancy, and DEGW introduced metaphors such as the Cell, Den, Hive and Club to communicate key characteristics of space and work. The virtual workplace designers turned to shared tools and shared space such as groupware, and collaborative conferencing tools that took as their precedent the models of existing work practices. Once the workplaces were connected and many new possibilities of work began to emerge, the focus turned to the process of work. Process Architecture began to integrates workplace making into the work process itself. Collaborative software design began to consider the roles, relationships and processes in the virtual workplace. The set of services that collaborative systems provided were not enough to improve workplace performance. The demand turned toward developing contexts to support collaboration that were integrated with the work processes

Contextual metaphors combine spatial and temporal structures to construct a context for work within organizational processes. The context metaphor attempts to add meaning to the virtual workplace by cueing social conventions familiar in physical work settings. The most commonly used context metaphors are work *places* such as offices and conference rooms and work *occasions* such as meetings and presentations. When we consider space and time as resources that, if managed well, reinforce business processes, and organizational goals, then the way in which we structure the processes depend on the relationships between work places and occasions. More recent direction for virtual workplace metaphors are focusing on contexts for work process.

These three metaphors, work places, work occasions and work processes are the basis for most of the research in collaborative virtual workplaces. Place based metaphors draw upon contexts of our physical work places such as team rooms, conference rooms, offices and auditoriums. Event based metaphors draw upon contexts of work occasions, such as presentations, conferences, or brainstorming sessions. Process based metaphors draw upon work flow procedures such as decision making or customer relations.

Place-Contexts

Building Metaphor

CVW is an extension of metaphor from physical to virtual workspaces. The workspace metaphor for CVW is an office building with floors, rooms, hallways, people and documents. The assumption is that because we are familiar with using physical office buildings, we will understand common spatial properties in the virtual office building. CVW is a container for work in which the surface metaphor of building is mapped and the properties of containers apply. Office buildings are containers for rooms. Rooms are containers for people and documents. Carrying cases are containers for objects, (documents, notes) that can be dropped or passed into rooms. Documents and people are containers of information. By convention of the metaphor we can easily understand the structure of containment in virtual workspaces in relation to that of its physical counterpart.

In CVW, one of the primary intentions behind the building metaphor was behavioral framing. By piggybacking social conventions of the office building into the virtual environment, many of the behavioral conventions could be brought in with the metaphor. The hope was that this would relieve some of the burden of programming behavioral mechanisms and relax the social-technical dilemma. The challenge of designing collaborative software is that interaction is not only between human and computer but also between people working together.

The resolution to which a metaphor describes a context is a balance between flexibility and ambiguity. When metaphors are mapped at a super-ordinate level the possibilities for internal mappings are flexible and maximal. In the case of CVW, the super-ordinate level mapping is the office building. However there are many types of office buildings and many types of rooms within office buildings, many of which may not serve the needs of the virtual organization. If the resolution of context is rendered too fine, providing specific and unambiguous settings, the environment will increasingly constrain the variety of work activities that it can support. Underlying the use of contextual metaphors is the assumption that the properties of behavioral settings can identified in physical spaces and mapped to virtual spaces. The position of a contextual metaphor on the social technical-dimension depends on the degree to which the virtual context will rely on technical mechanisms to frame behavioral settings.

In Architecture, the notion of type is used to connect architectural instances to a larger set of architectural and cultural ideas. For example an enclosed-partitioned office plan carries different connotations of trust, interaction and autonomy than a open office plan might. The interpretation of architectural type varies across cultural, social, historical and political context. With every instantiation of a type, all prior examples associated by that type are confronted, fused, and recast[19]. The same is true of metaphors. As the office building or conference room or meeting place is instantiated in the virtual workplace and the physical, our models of office building, conference room and workplace are questioned and recast.

Floor map

Maps are representations of places, they enable us to recognize our location in space relative to the world. We use maps to predict what may happen where, and evaluate the consequences of our actions (relative to space). To the degree that maps indicate the extent all possible action within the limits of the world, maps bear on our perception the set of available actions[20]. Our understanding of the layout and the range of behavioral opportunities that are available in an environment, is prerequisite to our selection of those activities which we chose (Lang 1987).

Floor maps refer to rooms by name, which in turn conjure up images of associated behavioral settings[21] such as lounge or war room or bed room. We attribute specific patterns of behavior to partitioned contexts in the environment. In this respect, maps orient behavior spatially. Likewise, if by direct observation and experience, we associate standing patterns of behavior to spatially partitioned contexts, we create a cognitive map based on behavioral settings (e.g. see Chapter Two: Working Virtual). We may refer to nodes or spaces in our cognitive map with names or images that conjure up individual or shared understandings of behavioral settings. As mechanism for structuring behavioral settings, we could evaluate the map metaphor in its capacity to support, sustain, encourage and adapt to standing patterns of behavior. Formal properties, such as size and shape of regions defined on the map convey information as to the degree of enclosure or relative proportions of spaces, possibly indicating purpose or activity. Spatial arrangements can also indicate organizational hierarchy or process.

Often representational maps are forsaken for cognitive maps. Although cognitive maps may function alike in the way in which we use them to orient ourselves spatially and behaviorally, they are schematized[22] and distorted by memory and cultural background. Research has shown that cognitive maps of our physical environment are a function of individual experience and that differences correlate with gender, status, location and duration of residence, and transportation[23]. As individuals and groups becomes more familiar with their environment, the distortion between individual maps decreases[24]. Much of this can be attributed to the stability that we assume in the physical world. In the knowledge organization's virtual workplace change is frequent and unpredictable, as room names and teams are constantly reconfigured to meet new demands. For experienced users who rely on cognitive maps and the command line interface, as opposed to representational maps, to orient and navigate the workplace, it is quite likely that they may have very different views of the extent or character of the organization's virtual workplace.

Event Contexts

Events contexts are temporally structured and sessional. They have a beginning and an ending and a definite duration. Events can be isolated single interactions like a phone call or a trade show or a presentation. Events can also be serial like weekly project meetings or academic and professional courses.

Event-based contexts are metaphors for work occasions. The event context provides a structure for interaction that relates to familiar temporally framed social contexts. These contexts form the basis for behavioral framing to fit an occasion in the virtual workplace. Often they are characterized by the degree of formal structure of communication that is distinguished by dynamics of interaction. The models of interaction can be broadly characterized as formal, ad-hoc and informal without imposing a specific context. Although this affords a high degree of flexibility for interaction, without a social context or technical mechanisms for managing communication flow, interactions can become chaotic and ineffective. By employing an event based metaphor, collaborative systems can structure the dynamics of interaction in accordance with understood conventions for physical work occasions. One of the most significant means of structuring event contexts has been the mechanisms for passing control of the floor between speakers such as in conferences or presentations[25]. In event contexts it is important to distinguish collaboration from coordination. Many event context focus on the coordination of group effort and the structure of interaction as a means of improving collaboration.

The conference meeting among the most common interaction metaphors in collaborative technologies. Conference meetings typically have a formal structure that is easy to identify in many work contexts. Meetings are not persistent, they are bounded by the duration of interaction. The participants, agenda, and time is typically known in advance. When a meeting is finished, actions and decisions may have been recorded but most of the context spcecific to the occasion is lost. Microsoft's NetMeeting[26] combines several existing collaborative technologies into the PC windows metaphor. The current implementation includes video teleconferencing, text chat, shared whiteboards, and application sharing. Floor control is negotiated by the participants selection of media, and the conventions they establish for their use. NetMeeting has no spatial context metaphor other than the familiar Microsoft windows interface.

Equally familiar, the presentation format is becoming increasingly popular in both sessional and persistent models for collaborative systems. Presentation formats are typically well structured with a pre-determined start and end time, and well defined roles of the audience and presenter and occasionally a moderator. Some persistent environments such as MOO's often hold events in which a guest speaker may present a lecture or lead a discussion. Typically, these events are held at a place such an Auditorium or Town Hall. In physical space, seating arrangement, speaker podium and room shape provide cues to behavioral settings where conventional means of floor control are understood. Because access to these cues is limited in virtual environments, managing floor control is a key factor in the social technical dimension that will determine the success of collaborative efforts. Two essential elements for managing floor control in group interactions are degree of engagement and focus of attention (Hussein 1997). In physical space, gaze, gestures, body language and tone of voice provide visual and audio cues to control the floor. Some collaborative systems use virtual surrogates for these mechanisms such as flashing faces or colors and cursor gesturing[27]. While these afford some degree of social negotiation, others favor technical mechanisms for floor control such as queuing and polling[28].

Another commercially available event structured context is for web based presentations is Auditorium by PlaceWare[29]. A speaker or facilitator, performs multimedia interactive presentations on stage and responds to audience questions. The audience can whisper to other members in their row in effect supporting sub levels of less formal interaction within the framework of the presentation metaphor. The technical mechanisms for flow control (such as a question queuing) are set by the presenter, and are relatively transparent to the audience under the assumption of a presentation format. Often a presenter may be assisted by an active moderator who fields and queues questions from the audience. A member of the audience virtually raises their hand to ask a question by directing a text message to the speaker, which other audience members do not see unless the speaker makes the questions and responses visible. Presentations are logged for later playback for those who cannot attend. Audience polling mechanisms allow group feedback and consensus building. Because dynamics of interaction is controlled by the presenter Auditorium tends toward the technical extreme of the social technical dimension.

One of the successes of PlaceWare has been its use of the place based metaphor, the Auditorium. In addition to the main presentation space of the Auditorium, several break out rooms are provided for less formal interaction through text conversation (see Figure 3.a) that is not constrained by the audience-presenter roles. In break out rooms several people can share a private conversation space during presentations, and after presentations. The GUI provides a visual representations of participants positioned in floor plan diagram that can be distinguished by color and position. Because the Auditorium metaphor is sessional (although presentations can be saved) and limited to the duration of the presentation (plus related breakout session), it is an event based metaphor rather than place-based.

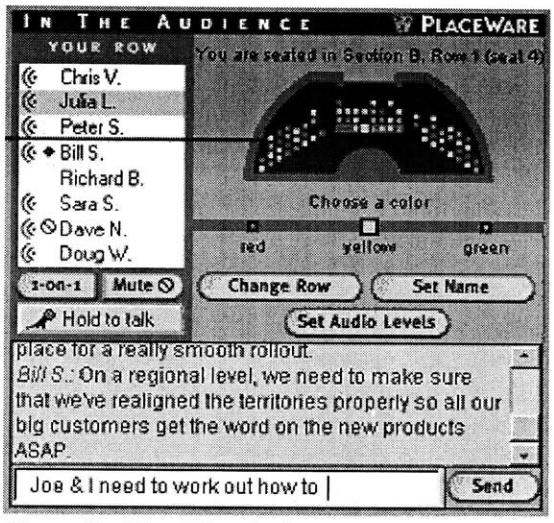

Figure 3.a PlaceWare Auditorium

Process Context

Process based contexts are metaphors for work processes. They provide a basis for objectifying and structuring work processes in time and space. The underlying patterns of interdependencies between decisions and sub-processes of the work practice form the structure of process contexts. In a process context, decisions are made based on information from and affecting other contexts. Processes contexts

serve specific functions within an organizational system of service or product delivery. The system is set by goals, objectives and the services or products it delivers. Building collaborative systems based on process metaphors requires the externalization of these goals and how they relate to work processes. The most difficult challenge in creating process contexts is modeling the network of interdependencies in a way that individual contexts are aware of and distinguished from the organizational system. Being aware of the interdependencies is essential for the process contexts to see both the system as a whole and as individual parts that impact each other and the system[30]. Complex decisions can easily become overburdened with contextual information on their impacts in other contexts. The trade off is enhancing systemic awareness without overly complicating the decision process. By leveraging decision analysis tools and automating inputs and outputs in process contexts, some of the cognitive burden is reduced.

The emphasis in collaborative systems that employ process-based contexts has been to reduce systemic delays and feedback loops[31]. Communication technologies have reduced delays due to time and space limitations. Consequentially, remote collaboration increases the possibility for systemic delays that arise from discrepancies between different distributed contexts. The focus on process contexts in virtual environments is to create shared contexts within an organization so that location and movement is contained within workflow processes.

The resolution of a process context is its position relative to the dependencies and impact on the system. A sub-sub process context is a much finer grained context than one that establishes organizational goals. Process contexts are nodes in a plan or checkpoints in a process. Process contexts can be distinguished from one another by their inputs and output, thier position within the larger organizational system, and the roles active in fulfilling its purpose.

Roles

In process contexts the roles are the actors that operate within a contexts in which the rules are defined by the interdependencies. By analogy with the Co-Design approach, roles are the players or stakeholder within the game[32]. Roles differ in degrees of power, risk, and level of involvement in a particular context. Additionally the people that fill roles may differ in social, cultural and professional background. These differences[33] often carry conflicting interests, and interpretations of a context that can create barriers to collaboration (Horgen et. al.1998). These conflicts are further complicated when members of an organization play many different roles in many different contexts.

In physical space, people are people. Roles and rank are distinguished by physical appearance that may be supplemented with badges or uniforms. Anonymity is uncommon in physical interaction; and when exercised it is practiced either by deception or obscuring perception. In virtual environments people are representations. Avatars are virtual incarnations of people. Representations can be people, roles or artificial agents with programmable behavior. Anonymity is common and often an expected courtesy or right of privacy. Identity is often mistaken by deception or accident[34]. In process contexts, false identity is primary concern for organizational security.

I/O

Processes have inputs and outputs. Roles interact with information in a context to produce some output that functions towards some organizational objective. The information is relative to the context in which a decision is made or a task performed. The roles in the context employ tools and professional judgment to analyze and manage the information relevant to the purpose of the context. Information can include any details or consequences that are known to be relevant to the undertaking. This information may be constraints, variables, or the steps needed to take action. It can be impact analysis of other contexts or known consequences of specific actions. The outputs are the decisions and actions that are created as a result of the process being performed.

The roles of a context act as agents responsible for bringing organizational objectives, and goals to bear on a context. The approach to designing collaborative systems has been to build in these objectives, whenever

feasible, by strategically positioning contexts where roles confront relevant information when appropriate, and by making just-in-time agreements that produce new information necessary for action in other contexts.

The challenge of implementing the process context is representing relevant information and roles as well as recognizing the whole system. Awareness is important not only of the local context but also of the patterns of interdependencies between contexts. Some collaborative systems allow what-if scenarios to be played out. Others may use orientational metaphors that position a process context within a matrix or decision tree, so that the participants in a context have can locate themselves relative to the organizational system.

Coordinator

Coordinator, developed by Terry Winograd and Fernando Flores is a process based collaborative system on a metaphor of the organization as a "network of conversations". In Coordinator, a processes context is derived from the Speech Act Theory in which the role of initiator specifies illocutionary force to which a recipient is committed to a response (e.g. report-acknowledge, question-answer). Coordinator functions effectively in reducing miscommunication in work processes where intention and action can be clearly identified. Coordinator employs technical mechanisms, such as form requests that require a speaker to specify illocutionary force. By automating much of this process, organizational objectives can be structured into process that are composed of speech actions. Automation include associating deadlines, steps required, or necessary approvals with speech action contexts. Underlying Coordinator is an assumption that most work processes can be reduced to action-responses.

CVW

At a super-ordinate level, CVW is a metaphor for the collaboration process between MITRE, as a R&D organization, and its clients in the government sector. CVW is structured to tighten interaction between MITRE and its clients as well interaction within MITRE between divisions of expertise. As a process metaphor, CVW can reduce systemic delays in collaboration that may arise from finding the right expert for the right problem at the right time. The roles in this context are the MITRE knowledge worker, versed in a domain of expertise, the project manager or division leader who interfaces between MITRE experts and the government domain, and the government agent collaborating with MITRE on a specific problem.

The floor plan in CVW supports this process if we consider the layout of typical office spaces on one floor (see Figure 3.b). Internal teams of experts inhabit the six offices off the corridor. The teams may be experts in different domains that may be related spatially by inhabiting the same floor. Different floors can have different domain groupings. For example one floor may have offices for language translators from around the world. Each room may represent a different national language and contain relevant documents where the attending resident translators can typically be found. Another floor may have economists, or foreign dignitaries.

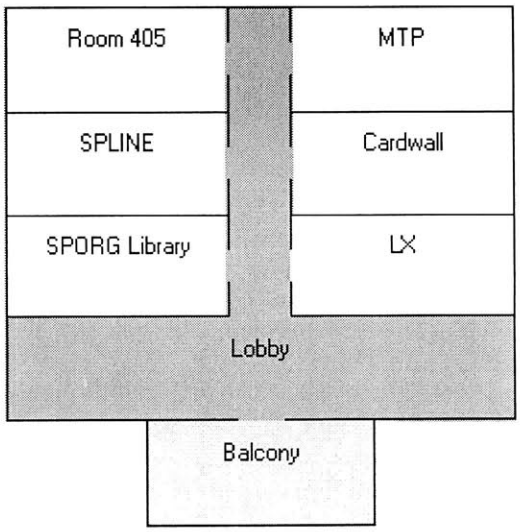

Figure 3.b Process Context Metaphor

At one end of the corridor is the lobby where a MITRE project manager or division leader may regularly attend. By constraining circulation between floors only through the Lobbies, anyone (or role) stationed in the lobby can monitor people coming and going. The project manager can receive clients and take their requests and inquiries and initiate an interaction with the appropriate in-house expert. By restricting access to corridor at the lobby, the separation between back office experts and front end directors can reduce workflow disruptions and retain a necessary measure of security.

Directly adjacent to the lobby is an additional team room or conference room providing an additional context with added degree of privacy for interactions between experts, and clients without the interruption of passerby's. Once the project or division leader has initiated an interaction between client and expert (or an team of experts from different domains), they can pick up relevant documents and move into the adjacent conference room for continued interaction. Confidential documents remain within the context of the back-office expert. Documents generated by the collaboration or relevant to the project can remain secure in the conference room for continued client access. If necessity dictates, an expert may create proxies that can remain in the conference room over extended projects. In this manner an expert can always be available to the project in the conference room as well as to the organization in its expert domain room.

JCS

JCS (JFACC Collaboration Services) is process context metaphor being developed by MITRE for the collaboration processes required in military operations involving multiple branches of the US Armed Forces. Because most strategic operations are a part of larger mission with goals and objectives, a context can be formed in relation to the processes needed to execute a mission according to some desired goal. The process contexts are plan nodes that contain roles (military command officers) and logistics (information necessary to the make decisions). Plan nodes may also contain tools for evaluating and simulating alternatives. Because of the formal structure of military operations, the processing of outputs and interdependencies can be automated to the degree that they are known.

Summary

Metaphors are pervasive in language, thought, architecture and collaborative systems. The structure of metaphors allow us to describe and interpret what is unfamiliar in terms of the familiar. Many virtual environments employ context metaphors with spatial and temporal structures that can be mapped to physical places and events. Temporally structured metaphors have a beginning an end and a duration. They are often mapped to spatial metaphors as a sequence of actions in time-space. Spatially structured metaphors allow us to position and orient ourselves and form a basis for the extent of possible actions in the environment. The most common workplace metaphors for virtual environments are Place-based, Event-based, and Process-based. Event-based metaphor are temporally structured and are usually based on well defined work occasions with clear mechanisms for setting the dynamics of interaction. Place based metaphors are spatially structured and help to frame behavior and social context based on familiar types of spaces in the physical world. Process-based metaphors are modeled on workflow and depend on well defined roles and decision making practices.

Chapter Three Notes

[1] intentions of architectural form or function are often described in metaphors such as 'guts of a building' or a 'machine for living'

[2] The Art of Human Computer Interface Design, Addison Wesley 1990

[3] J.J. Gibson called these "visual invariants", Heidigger, "readiness-to-hand", John Seely Brown the "periphery" source (Weiser 1991)

[4] Karatani likens Architecture as Metaphor to Wittgenstein analogy of game "where we play and—make up the rules as we go along" (Karatani 1995)

[5] "house is a machine for living" : LeCorbusier

[6] "workplace is a machine for working Vischer

[7] (Don Schon 1993) distinguishes surface from deep metaphors that are not explicit in the language of metaphors but operate as imperative dualism's such as natural/artificial. Surface Metaphors are what we commonly mean and use in language

Notes continued

[8] "various aspects of event structure including notions like states, changes, processes, actions, causes, purposes, and means are characterized cognitively via metaphor in terms of space motion and force" (Lakoff 1993)

[9] Don Schon frame-conflicts are discrepancies which constrain or frame a situation based on stories people tell, and are biased by social context and subjective characterization. They often cannot be resolved by appeal to facts because people can interpret the same situation entirely differently (Schon 1994)

[10] (Dourish and Harrison 1996) describe these primary behavioral framing features of space as Relational Awareness and Reciprocity, Proximity and Action, Partitioning, and Presence and Awareness

[11] Andy Lipmann referred to this "Limmited Look Ahead" from an interview by Stewart Brand 1997 in the Media Lab. Penguin Books.

[12] Knolwedge transactions patterns of work resemble the social atmosphere of Clubs (Duffy 1997)

[13] (Rapoport 1977) in (Lang 1987)

[14] GroupSketch, GroupKit, GroupWeb U. Calgary (Greenberg & Rosemann CSCW 1996)

[15] Lotus eSuite WorkPlace e http://esuite.lotus.com

[16] when she was with MIT Media Lab Visual Language Workshop

[17] Small, D. Navigating Large bodies of Text, IBM Systems Journal, Vol. 35, No. 3&4, 1996

[18] City of News is an ongoing research at the Media Lab http://www.gsd.harvard.edu/~gsd97kh3/WorkInProgress/CITY_OF_NEWS.html

[19] Guilo Carlo Argon AD Dec1963, Rafael Moneo On Typology, Oppositons 13. 1978

[20] (Kaplan 1973) in (Lang1987)

[21] evidence of this was researched by (Perin 1970) in (Lang 1987)

[22] Stea and Downs refer to "schematization" as the process in which individuals for cognitive maps

[23] this research was don by Kevin (Lynch and Appleyard 1969) and reported in (Lang 1987)

[24] research conducted by RogerDowns and David Stea in *Image and Environment: Cognitive Maps, and Spatial Behavior* reported in (Lang 1987)

[25] CAIRO is an implementation of floor control in distributed collaborative design, it is brainstorming, conferencing and presentations models of collaboration see http://ganesh.mit.edu/hussein/cairo.html and (Pena-Mora & Hussein 1998)

[26] NetMeeting is currently available free at http://www.microsoft.com/netmeeting/features/

[27] e.g. CAIRO Pena-Mora, & Hussein, GroupKit Greenberg, & Rosemann)

[28] e.g. PlaceWare and some educational MUD's)

[29] PlaceWare is located at http://www.placeware.com"

[30] Peter Senge calls this Systems Thinking and is one of the most important functions for an organization to grow and learn (Senge 1994)

[31] reducing systemic delays is a driving force in organizational management. They arise as a result of discrepancies between individual views of the system that are unaware of the impact of their actions on the system (Senge 1994)

[32] the Game Metaphor is used as a context for Process Architecture where the players are workplace professionals, user occupants, facilities managers, corporate managers, owners, contractors, regulatory officers and neighbors (Horgen et. al. 1998)

[33] these differences are rooted in personal style that determines how people frame and solve problems and relate to other people, backgrounds that impose attitudes, often prescribing or biasing reactions, and professional orientation that impact values and interests (Horgen et. al 1998)

[34] gender switching is very common in virtual communities and in some environments may be as much as 20 to 30 percent of the population Rheingold Virtual Communities

4

Breakdowns

Metaphors are asymmetric and partial and inevitably breakdown (Lakoff & Johnson 1980). The power of metaphors to systematically describe a concept in one domain in terms of another creates a dilemma. Because metaphors highlight certain aspects of one concept, they suppress others. Otherwise the concepts would be indistinguishable. Metaphors are only partial mappings between domains. Because metaphors are usually mapped at the super-ordinate level to maximize the possibilities for internal mappings, they also increase possibilities for inconsistencies between domains.

When we use metaphors, we are attempting to describe things from another perspective, providing another frame of reference. It is by experiencing concepts from different perspectives that we associate meaning to them and construct an understandings of their context for use. We may use multiple metaphors to describe a concept, each drawing attention to specific features and hiding others. Likewise, each new use of metaphor can reveal new meanings to both the target domain and source domain[1]. For example:

Architecture as machine: *House is a machine for living. (Corbusier)*
Office is a machine for working(Vischer).
The office is up and running.

Mind as machine: *I'm a little rusty today.*
I'm having a breakdown.
I'm running out of steam (Lakoff and Johnson)

Each instance draws upon the mechanical nature of machines to reveal some aspect of the target domain (architecture or mind). However in these examples *architecture as machine* takes a different perspective on machine than *mind as machine*. The *architecture as machine* describes how architecture may function like machines, whereas the *mind as machine* describes how the mind may dysfunction like machines. We do not interpret *machine for living* to describe the dysfunctional tendencies of a house. The purpose here is not to compare architecture and mind, but to illustrate that depending on our frame of reference the intended use of metaphor can take on different meanings. More significantly, each new occurrence of a metaphor in different domains adds to our understanding of the source domain, in this example machine. By reversal, a *machine as architecture* is a complex system of interrelated parts that function together to serve some purpose. Likewise, *machine as mind* is a fragile and expendable organ.

The meaning and contexts for which we understand them depend less on facts about the domains we try to understand than on the systems of structures that we use to describe and interpret them[2]. The way in which we frame a problem or a perspective of the world can often constrain the set of potential solutions that are perceived. Counter perspectives or "frame-conflicts" (Schon 1994) can only be resolved by coordinating and reconciling conflicting descriptions. Frame-conflicts can arise because individual differences in background, experience, and values cast different perspectives on context. Conflict is more likely to occur when access to the shared context is asymmetrical as is often the case in virtual environments. Resolving the conflicts cannot be accomplished by appeal to fact, because conflicts are often embedded in the contexts in which the metaphor was interpreted. For example a person who uses CVW only during a face to face meetings to contact with their team may interpret the use of pop-ups much differently than one who uses CVW regularly throughout the day. Conflict resolution is often directed at resolving inconsistencies in contexts due to structural dependencies created by the metaphor. For example, in persistent environments,

indexical references (now and then, this and that) are often used as if the event (temporal structure) was synchronous; however, because events are experienced asynchronously one does not necessarily have access to indexical references. What is often overlooked is that our use and interpretation of temporally structured metaphors presupposes contextual symmetry of remote asynchronous experiences that is rarely case in persistent environments.

If meaning and intention can be externalized, then why can two people see the same facts and interpret them differently? If meaning cannot be externalized then how do two people of different contexts arrive at a similar conclusion? From an objectivist position, meaning can be captured by recording and indexing events and objects within a context which can later be recalled in full fidelity of the original context. Breakdowns in communication can be attributed to distortion or noise in the process of transmitting meaning. From the constructivist position, meaning is constructed through mutual negotiation of concept and context and breakdowns in communication can be attributed to frame conflicts[3].

The Silent Game

The constructivist position may explain many sources of conflict when metaphors are used to establish a context for collaboration. We conducted an experiment that exposed frame-conflict in metaphors using a Concept Design Game (Habraken & Gross 1987, Horgen et al 1998). In the Silent Game (See Appendix B), two players exchanged turns building an unspecified artifact out of Lego blocks. They communicated to each other through intentions embedded in the artifact without speaking. By constraining the context to silence, we can consider how people negotiate understanding, make agreements, and follow conventions without explicit statements of formal rules or vision of the artifact. Debriefing revealed that one player was building toward some vision of an artifact and the other player was building according to the 'rules' conveyed in the form of the artifact. The player building a vision took a strategic approach that depended on communicating the vision. The rules were flexible as long as they supported the vision. The player building according to 'rules' took a pragmatic approach that depended on evaluating moves against some set of fitness criteria based on the 'rules' of interpretation.

When people describe what went wrong they draw attention to salient features of the present situation to explain their actions in order to set the direction for resolution of differences. In the silent game, the players emphasized specific features of the artifact or instances of the implied rules. Often in collaborative environments these are misdirected at features inherent in the structure of metaphor that further constrain resolution such as inconsistencies in mapping one domain to another (Schon 1993). For example, an event structured metaphor may break down when flow control does not go according to social convention prescribed by the event. Similarly a spatially structured metaphor may breakdown when awareness in one context means compromising privacy of another (in the case of group awareness and personal privacy). In each case collaboration can be encumbered rather than encouraged.

Evaluating Metaphor

If we were to evaluate a metaphor by its capacity to support multiple mappings, or its capacity to avoid breakdowns we would quickly find that such an approach would be too simplistic and self defeating. The power of metaphor is to understand an unfamiliar domain in *terms* of a familiar domain. Because our understanding of things is limited to the terms that we can describe and interpret them with, when we encounter new things, we must either add new terms or modify the meanings of existing ones. If there is a close mapping to a familiar domain we may be able to understand many things in the unfamiliar domain. In this regard, the metaphor is efficient; we are able to understand more with less effort. Similarly, if there were few conflicts between the domains, then we could consider the metaphor to be a good fit. In either case we have not necessarily improved our understanding of the unfamiliar domain. In the first case, although we may have discovered similarities between the domains, we have actually only reiterated the familiar without understanding what is unique about the unfamiliar domain. In the second case, when we find a good fit, we have not discovered anything new, we have only reinforced our use of the terms or metaphors that we use to describe things.

A more appropriate approach is to consider how effective metaphors are at generating or revealing meaning. Metaphors generate meaning where they break down. To understand an unfamiliar domain in terms of another, we have to ask why are we comparing the domains to begin with. A more fruitful approach considers how metaphors generate new possibilities or discoveries. In this approach we begin with breakdowns, we know metaphors are partial and inevitably breakdown. We look for evidence of breakdown, and from what frame of reference does the breakdown occur. When we interpret metaphors we usually look for similarities. We seek clues and test hypothesis. This kind of creative inquiry leverages metaphors to generate new perceptions, meanings and explanations (Schon 1993). Taking this approach two types of breakdowns are clear[4]. Either metaphors operate differently than the domain from which they were mapped creating a *Disruptive Breakdown* or they open new possibilities for understanding about the domain to which they are being mapped creating a *Generative Breakdown.*

If we consider how metaphors constrain (our perception of) the "space for potential"[5] action, we must question how this space is formed in virtual environments. Is it because the metaphor suggests that only those actions available in the source domain, (in this case, physical space) are available in the target domain (virtual space)? If so does the space of available action depend on our our understanding of action in the physical space? Does our understanding of the functionality of the environment determine the set of available actions? Is there a difference between the source domain (physical space) and the target domain (virtual space) along the social-technical dimension that precludes or favors one action over another? When our perceptions are constrained by the metaphors that describe our environment, what possibilities for action are being hidden? Are the only those models of collaboration that metaphor is mapping the ones supported by the environment? The dilemma is that we cannot anticipate action that we do not think is possible.[6]

Disruptive Breakdowns

Disruptive breakdowns typically reveal conflicts or dissimilarities between a target domain and its source domain. Many conflicts are acceptable if the they can be justified with sufficient value added. Other conflicts can become barriers that contradict the intentions of the metaphor. If barriers are permitted to mature without confrontation, they can obstruct or stalemate exploration of meaning. In the case of workplace metaphors for virtual environments, they can disrupt collaborative effort.

If we evaluate metaphors against existing models of interaction we can distinguish properties of metaphors that may reveal the sources of disruptive breakdowns. If we assume an objectivist position that breakdowns can be attributed to distortion in the process of mapping between source and target domains, we can gauge several dimensions: Expressiveness, Naturalness, Action Mapping, Transparency and Flexibility (Hussein 1997).

Expressiveness is the property of a metaphor to express an intended action without introducing unintended meanings. Because tools become meaningful only through our perception or discovery of their use (Brown et. al. 1989), when we represent tools (or potential actions) using metaphors, the affordances[7] of the tool determine its perceived uses and consequently available actions. As we learn to use a tool we associate meaning to the tool and the representation becomes less important; in fact it becomes transparent when we only think of the tool in terms of its use. Representation of tools creates an asymmetry between experienced users of virtual environments and novice users. For those less familiar with virtual environments, the affordances of representation set the possibilities for action. For those more familiar, their experiences in other contexts set the possibilities for available actions. Over time, representations become biased toward experienced users. For a novice user of a word processor, the difference between open/close and start/quit may appear ambiguous, however to an experienced user of word processors, the difference is transparent. In virtual environments the affordance of an object or tool is not always obvious because the tool may not have a real life equivalent function. In process contexts the expressiveness is an indication of the region of influence of a decision or how well the system is represented within a decision node.

Naturalness is the property of a metaphor to conform with conventions of interaction in the source domain (in this case physical space). For example, if floor control in physical space is passed by hand raising and concession, then does a similar convention of cueing and response operate in virtual space? In PlaceWare Auditorium, an audience member can 'raise their hand' by addressing a question to the presenter. The presenter determines whether to allow questions to be fielded as they are asked, allowing floor control to be passed as it would in physical presentations or to avoid interruption by queuing questions as they are asked for later response. If the dynamics of interaction in physical space are determined by behavioral cues, what are the cueing mechanisms in virtual space? The naturalness of place based metaphors can be measured against how they conform to the social and physical properties of spatial behavior. Movement through space in CVW is sequential, not because a limitation of the technology, but to comply with the spatial metaphor. If a hallway is locked, all the spaces accessible from that hallway are unreachable. Unlike Auditorium, interaction in CVW is not controlled by technical mechanisms, rather when an utterance is made it is instantly fielded in the room as if it was spoken. (Of course whether or not it is heard depends on who is listening.) In process contexts, naturalness is how well the context fits the requirements of workflow or role identification. How are the results of a decision reported and disseminated throughout and organization?

Action Mapping is the property of a metaphor to transpose action in one medium to action in another. How do we perform actions such as speaking, writing, sketching, and standing in virtual environments? For example, face to face conversation in physical space is transposed to text conversation or audio conferencing in virtual space. In text based MOOs and expressions, gestures and emotions are typed using "EMOTE" commands. To whisper you do not lower your voice or lean towards someone, you "SAY PRIVATELY". In CVW, you can direct speech and action towards someone by mouse clicking on a thumbnail representation of the person in the room. This has the same affect of specifying a name to whom you are addressing on the command line interface. We may try to get someone's attention by mouse-clicking on a representation of them, or by 'poking' them in conversation text. When using video or audio for communication, actions are not transposed they are transmitted as they are performed without mapping. In physical space proximal behavior is a means of communicating that does not easily map in virtual environments. For example, we may indicate that we do not understand with body language by moving closer, or that we need to leave by gradually moving away or looking at our watch.

Transparency is the property of a metaphor that make it visible or noticeable. When we design collaborative contexts with metaphors, we are attempting to leverage the "space of potential" for collaboration. We work with a model of effective collaboration in physical space and transport it into virtual space. When activity in one medium is transposed into another, we negotiate the rules of translation. In physical space, availability may be indicated by a closed door but in virtual space, an idle message or idle time. Rules of interpretation are transparent in a medium and only become explicit when they are violated or are explained to newcomers. When we learn the rules of interpretation we cease to be aware them. When rules are transparent, we are free of the cognitive burden of processing them[8]. In this regard, the effectiveness of a metaphor in translating rules is the degree to which we are aware that the rules exist. More importantly, does our awareness of rules, or lack thereof, interfere with efforts for collaboration?

In the dynamically coherent workplace spatial transparency can enhance awareness of activity of between co-workers. Awareness is often perceived in conflict with privacy. Spatial transparency is different from metaphoric transparency by what is revealed: activity in the environment or operative rules of interpretation. In both cases, however transparency can be effective if used to leverage our awareness of the periphery. Most technology assumes a limited model of the work environment to the task at hand. Collaborative work requires a more comprehensive model of the environment. More effective collaboration environments recognize a broader model that engages the periphery. When we collaborate with others and the environment we are constantly moving in and out of the periphery switching the center of attention. Mark Weiser describes a fully engaged periphery as "flow state" familiar to athletes in the 'zone' (Weiser 1998). When we consider how metaphors generate creative inquiry, it is when we move between domains or between frames of reference, switching between and reversing center and periphery. "Situational

awareness", or awareness of the periphery and the perspectives of others relative our own, is necessary for effective collaboration and workplace making (Hogren et. al.). A key to creating situational awareness is the transparency of context and the transparency of metaphors used to describe it.

Flexibility is the property of a metaphor to support the dynamic nature of collaboration and multiple asymmetric perspectives. The efficiency of the metaphor is its capacity to support changes in workflow with minimal disruption between states. It is important to distinguish flexibility of metaphor from flexibility of interaction and flexibility of context. Flexibility of the metaphor can be measured as the ease in which a metaphor can be mapped to multiple domains (such as the prior example of architecture as machine and mind as machine). Flexibility of interaction is the ease in which we switch between modes of interaction, such as from autonomy, to one on one conversation to group interaction. Flexibility of context is the ease in which we move between contexts or adjust our contexts to fit the needs of interaction[9].

The principle in Human-Computer Interaction is that the environment should adapt to the users rather than users adapting to the environment. When we adapt our environment to accommodate shifts in work flow we risk losing valuable state information. A large portion of our work activity is not directly task related[10] but is valuable state information to collaborators as an indication of progress, or status and direction. When workflow changes from one activity to another or to an interaction with a co-worker, we adjust our environment often at the expense of valuable state information. For private interactions, we may close a door or move to another room at the expense of access to peripheral information that is both valuable and disruptive. In hybrid systems, such as CVW, the dilemma can often dissolved by shifting media or using private messages while remaining in the original context. However when a high level of interaction is needed, users may wish to move to another context so that the state information generated by interaction can be preserved. Plans for CVW include developing instrumentation and logging based on task activities instead of room activities. Place-based and Event Based contexts often distribute flexibility spatially. In PlaceWare Auditorium, interaction is moderated with technical mechanisms in the presentation hall and social convention in the break out rooms. Similarly, in the process context of CVW people may step out into a lobby or team-room for extended interaction without the 'noise' of the more populated rooms.

The most common approach to increasing flexibility is either to provide more options for different collaboration contexts or to make contexts more interchangeable and malleable. Efficiency can be measured as the effort needed to move between different contexts or to adjust an existing context. When the environment does not support the needs of an occasion, reparation is first to adjust the environment, then to adjust behavior, or seek another place for interaction. The cost is time and effort and/or constrained communication.

Breakdowns are easily accepted in one domain if they add sufficient value to another or afford new possibilities that do not support parallel mappings. The Proxy notion in CVW breaks the spatial metaphor by allowing users to interact in multiple contexts at the same time. Proxies are an acceptable trade off between naturalness and flexibility. Adhering to the spatial metaphor is less valuable than supporting multiple contexts of interaction. The shared web browser is another feature of CVW that was a trade-off between breakdowns. If the model is a briefing or a presentation, then URL sharing that allows someone to control browsing (or switch slides) is acceptable, even if it affects everyone in the room. However if the model is group work, where each individual is working on personal tasks in a shared space, a shared URL may be an unwelcome annoyance. Similarly, text may not afford the full richness of face to face conversation and can be a contributing factor in many communication breakdowns, but it does afford other benefits such as persistence and low intrusion in audio or visual space.

Roles

Breakdowns in process context metaphors occur when roles or information are interchanged between contexts that circumvent organizational processes. Often people play multiple roles or exchange roles in work time-shifts. Role management can become especially challenging when different people play the same role at different times or when the same person plays multiple roles at the same time. Matrix organizational

structures often complicate role management and increase the potential for disruptive breakdowns. For example, consider an organization with many teams and many leaders. A leader of one team may instruct another team to take some action, without acknowledging the other teams leader. As a result, resources could be misallocated, or unavailable for another context. Because the environment allows easy interaction across teams, and because organizational command chains are often based on roles, breakdowns of this nature are frequent. They create confusion and place additional demands on resource management. If recurrent breakdowns occur they can reduce confidence in leadership and create systemic delays in feedback loops (Senge 1994) thus acting in contradiction to the intentions of the collaborative system.

If we are evaluating metaphors against models of behavioral settings that we know, then we are destined to see conflicting breakdowns when social conventions are misinterpreted or not available or mutually accessible. However, by evaluating the new possibilities afforded by shifts in these settings, we may arrive at a different conclusion. Behavior may be less biased by physical appearance, language, or role/rank hierarchies in a medium that hide those details (Fanderclai 1995). By shifting the focus new meanings and possibilities can be explored. Although many barriers to collaboration in physical space are reduced in virtual space, others are amplified. In order to realize the potential of collective creativity, barriers must first be surfaced and negotiated (Katzenbach & Smith 1992, Horgen et. al. 1998).

Generative Breakdowns

Generative breakdowns typically reveal new meanings or relationships between the target domain and source domain. We cannot measure the effectiveness of a metaphor only by its capacity to generate new possibilities or mappings to otherwise unfamiliar domains. The more useful value of generative breakdowns are to reveal the underlying deeper metaphors that may be constraining our inquiry and understanding. Then we may be able to resolve frame conflict by restructuring our inquiry, consider alternative perspectives and visualize the space of potential.

Place-Based metaphors

The generative value of place-based metaphors are their ability to conjure up images. A metaphor may relate an image of past experience to the present situation, that can question either the past or the present. When we schematize images of past places or experiences we create cognitive maps that we use to orient our selves spatially and behaviorally. The clearer the image can convey the intended behavioral setting across the field of different backgrounds, the more effective the image. This may appear, on the surface, to reduce the power of metaphor to its capacity to create clear unambiguous images. However the effective metaphor produces multiple images that support cultural and social variations, within socially negotiable margins, *and* simultaneously leverage the variation to generate new meaning.

Places are distinguished by the patterns and associations that the inhabitants imbue in place. In this regard, effective places are measured by the degree to which they support and reinforce the patterns for occupying them (Alexander, 1977). Virtual place-making is not a matter of authenticity of place based metaphors, but making and establishing contexts in which meaning is mutually available, negotiable and sustainable. Effective place-based metaphors can measured by the degree to which they encourage and support meaningful associations between experience and space. This process of place making connects qualities of one place to another or to a larger pattern, (or context) *and* distinguishes one place from another or from the larger pattern (or context).

> "One measure of placeness is the degree to which a place reinforces or even defines the pattern of its context [*connectedness*]. But to be a place is also to be distinct from its context [*distinction*]. How is it possible for a place to be both "part of" and "apart from" its context?" (Dourish & Harrison 1996)

When we make places, either by experience or by design, we engage a creative tension between connectedness and distinction. We connect places to personal, social and contextual patterns by relating it to past experience, fitting it in a larger context, and arranging it for our needs. We distinguish places by investing new experience in their understanding, by juxtaposing expectation and surprise and by fusing

imagination and identity. When we inhabit virtual environments and occupy several contexts *we* are simultaneously a "part of" and "apart from" several places and events and processes.

If we recall Bachelard's distinction between image and metaphor, the creative potential of metaphors are their ability to stimulate the generative process of creating images that are a "product of absolute imagination". If the purpose of a metaphor is to leverage the imagination to stimulate creative inquiry and deepen our understanding of the unfamiliar, then an effective image connects and questions both the familiar and the unfamiliar. In the case of place based metaphors these evocative images question our understanding of both virtual and physical space[11].

Typically when we think of the workplace, we conjure up images of offices, desks, documents, and people. When we think of work we may recall images of the products we produce or the activities we engage in either alone or with others. When we design workplaces these images are invisible, we do not consciously think of them but we design with them and for them. For example, consider the personal computing paradigm and the desktop metaphor. The underlying assumptions is that tools are designed for, evaluated against and used by an individual performing a task. When we design tools (or virtual spaces) for the work, this assumption is implicit. With each new use of a metaphor (or application of surface metaphor), the more transparent the metaphor becomes. The meanings we attach to metaphors are tied to our past experiences using them. If our experiences of work entail offices, documents and meetings, then metaphors for work and will be based (deliberately or not) on those experiences. With recurrent use those metaphors fade to the background. We don't think twice about the files, folders, and desktop metaphors. Even if they are not present, they structure our thought and language about computing environments. Over time, as a metaphor takes on additional meaning the metaphor becomes an operative standard that may not fit conventional mapping but is accepted in its own context. For example a typical file menu includes commands to exit or quit an application, a start menu may includes commands to shut down.

> "One generation's realization of a metaphor can become part of the next generation's experiential basis for that metaphor" (Lakoff and Johnson 1980)

The experiential basis of metaphors for work places is not entirely unidirectional as may be implied by the evolution of successive generations. As metaphors use the physical workplace as a basis for structuring the virtual workplace reverse mappings also arise. Virtualization is a two way process, bringing the virtual workplace into the physical and the physical into the virtual. Places of work are becoming net-work places[12]. As physical conferences become teleconferences, the function of the physical conference room shifts from primarily a place to gather and meet to a place to connect and interact remotely. Similarly, as the personal workspace becomes virtual workspace, the office or cubicle become end points on a network of nodes.

When a tool is interpreted differently than intended it is not necessarily a misinterpretation of the artifact, but rather an improvisation that reveals more about the need than the artifact. When we use a dime as a screwdriver, it is not because we don't understand the use of money, it is because we understand the act of driving screws. Breakdowns of this nature are due in part by the necessity of a situation, the experience of the user, the available resources in the environment and the affordances of the environment.[13]

When a metaphor is interpreted differently than intended it is not necessarily a breakdown but a revelation of the domains to which the metaphor is relating. If we compare the process context of CVW (front office-back office) to the way in which CVW is actually used within MITRE, a very different model of work process could be constructed. Within MITRE, frequent users tend to cluster in highly active rooms such as the RCF room or the CVW development team room. Those rooms that are not usually populated tend to be used more as content boundaries for documents shared by individuals and teams that may or may not be frequent users of CVW. Most work is done in highly active spaces within CVW, as opposed to the process model of pockets of client-expert interaction. Lobbies are rarely inhabited for any extended time within MITRE. In the process context, an account executive or division leader would regularly occupy the lobby

so that clients or staff could easily find them and they would be aware of who was coming and going. It is not that the work is different in CVW, the same work is accomplished, but the way the work is accomplished is different.

If we evaluate metaphors from a constructivist position that meaning is socially negotiated, and breakdowns occur from conflicting frames of reference, then by exposing frame-conflicts we can gain insight to restructure creative inquiry. Because what we understand is based on what we already know, then how we learn new things is by relating what is unfamiliar to what is known. For metaphors to be valuable in learning situations, a priori, they either have to be unnoticed or break down. Two important characteristics of metaphors that can be leveraged in generative breakdowns are incompleteness and asymmetry. How this can be done in virtual environments is the subject of Chapter 5: ReWorking Place.

Incompleteness
Because all metaphor can never be fully mapped without being a replica, they are incomplete. By asking what is missing, what needs to be added to complete the picture, we generate possibilities from which meaning can be derived. Incompleteness opens the space of potential for a metaphor to generate meaning.

If we recall properties of the dynamically coherent workplace, incompleteness encourages change and adaptability toward completion. When we converse, an unfinished utterance is an invitation for interjection or further consideration. When we sketch space plans, an open shape may encourage closure if we are trying to define enclosed spaces. But if we are trying to define direction or boundary, we may be inclined toward much different action. The different responses impart important clues that reveal alternative frames of reference and possibilities. Completion (or continuation) requires assertion of some aspects and suppression of others. In physical space, form, material or extent can create a perception of incompleteness (Horgen et. al. 1998). In the workplace overlapping spaces and blurred boundaries encourage interaction and place-making through social negotiation of boundary and conventions for interaction. Unfinished surfaces appear temporary and invite completion or modification especially when contrasted with nearby finished surfaces. A change in material, or color, that implies extent or boundary (without enforcing it with spatial enclosure) may be interpreted as a path or an edge, with associated spatial behavior or intervention.

The qualities of incompleteness in physical workspaces do not map to qualities of incompleteness in CVW. In physical spaces, incomplete forms such as hallways that open up beyond or along their path encourage movement and exploration through space. Open foyers welcome customers and visitors and provide a pleasant place to linger. Hallways and Lobbies in CVW are no different than other rooms in terms of perceived space although the floor map does make a graphical distinction. People don't move through hallways on their way to other rooms, instead they are moved through them. Although this seems to support the metaphor of spatially constrained movement, it does not reinforce the metaphor of spatially *perceived* movement.

Collaboration in virtual workspaces often illustrates incompleteness in action, intention and thought. In virtual spaces an open file or an unfinished note may be left in a room suggesting a work in progress needing further action. In persistent text conversation, incomplete sentences linger. An utterance can be as simple as question mark, hyphen or .... Similarly, an unnamed room in CVW can indicate an unfulfilled resource or opportunity for occupancy; or a dead link can indicate an unfinished thought or a proposed direction.

Asymmetry
Because metaphors are incomplete, they are also asymmetric. Asymmetry creates an imbalance that can be leveraged as creative tension between two domains. Because people interpret metaphors differently in different contexts, metaphoric asymmetry is not only created by the differences between domains, it is a created by the differences between contexts and the individuals within them. When we use metaphors, it is not enough to ask what is similar, we have to ask what is different.

In physical environments, shared space is symmetrical. When we share space, we have equal access to the resources of our local environment. We can assume shared technical constraints of perceptual space (audio, visual, and haptic). We assume a shared social context by interaction and observation of others' behavior. We share a common periphery. In virtual environments shared space is asymmetrical. Technically, some people may have audio and video, another just text and another only video. Socially, one person may be in a meeting with board of directors, another sharing an office space wit a co-worker and another at home. The characteristics of different environments preclude options both socially and technically. Naturally, we assume that interaction in shared space (virtual or physical) is symmetrical unless we are notified otherwise either explicitly or by deduction. Virtual environments are more prone breakdowns from asymmetry because our model of collaborative computing is constrained by the PC paradigm. We usually assume that others are in front of a computer and managing their own desktop.

Interpretation and evaluation is asymmetrical. In the collaboration settings, conflicts often arise from differences in social, cultural and economic background. Differences can be from professional orientation, personal style, psycho-sociological state, and presence of others. When these differences are not confronted they can create barriers to collaborative work. When they are confronted and leveraged in the creative process to share multiple perspectives of a problem we can widen the possibilities for richer and deeper inquiry.

If we consider the individual at the center, personal space is contained by increasingly public spaces as we move outward. When we consider public space at the center, this model is reversed. Because we can reverse our position without altering the structure, there is structural symmetry. When we consider space in virtual environments the structure is inverted and again the symmetry preserved. Shared spaces, which are windows into virtual environments, are contained within personal spaces, which are windows on the personal desktop. Spatial mapping is complete because the structure of the metaphor is symmetrical. However, we must be careful if we extend rules for structuring public and private space to the construction of virtual space. We are mislead by metaphor if we consider the patterns of human interaction in public and private spaces are transposed into virtual space by virtue of structural consistency. If we are to create virtual environments that support asymmetrical models of communication we need a different approach that recognizes the asymmetry and interdependencies between physical and virtual collaboration.
We are undervaluing both physical and the virtual space by preserving structural symmetry in our construction of spaces for interaction. Before we can build virtual workplaces we need to understand how we work in virtual spaces. To understand collaboration in virtual space, we have to interact in it. The space of potential lies between building the environment and living in the environment. It is because we separate the two that we can only see one or the other, and not both together.

Summary

Metaphors inevitably break down. The power of metaphor to generate new possibilities and new meaning can just as easily constrain the space of potential for action, interpretation and inquiry. Metaphors are prejudiced by our experiences using them, with each recurrence they become increasingly transparent and begin to take on meanings of their own, even if they do not map to their source domain. We become aware of metaphors when they break down. Disruptive breakdowns operate differently then the domain from which they were mapped and usually reveal structural inconsistencies. Disruptive breakdowns can be evaluated by their expressiveness, naturalness, action mapping, transparency and flexibility. Generative breakdowns generate new meanings and deepen inquiry into both the target and the source domain. Because they are asymmetric, they can reveal different frames of references and inquiry can be restructured around frame-conflict resolution. Because they are incomplete they invite completion by drawing attention to what is missing.

The Evaluation Matrix (Figure 4.a following page) lists the primary criteria for evaluating Place, Event and Process context metaphors in virtual environments. The first section is criteria for evaluating the properties of the environment conveyed through metaphors discussed in Chapter One : Modeling Workplaces. These

are the dimensions of Transportation, Artificiality, Spatiality, and Socio-Technical. The last two sections list the criteria for evaluating Disruptive and Generative Breakdowns in workplace metaphors discussed in this chapter. The matrix can be used when a breakdown occurs in the metaphor as means of stimulating inquiry and recasting alternative meanings. It can also be used in the design process to compare qualities of the virtual environment and to leverage metaphors towards generating meaningful virtual places.

	PLACE	EVENT	PROCESS
	dimensions of environment		
Transportation	Presence of physical context Degree of disembodyment	Presence in occasion Degree of thrownness	Level of engagement in task. Automated workflow
Artificiality	Synthetic environment. Physical resemblance of representations or behavior	Autonomous agents Information events Genuine occasion	Knowledge management 'Informated workflow'
Spaciality	Cartesian space. Containers. Topology. Connectedness and distinction.	Spatial Behavior. Movenement. Social encounter. Space defined by event.	Workflow movement. Role Shifts. Production line
Socio-technical	Behavioral framing social cues. Atmosphere. such as auditorium Technical mechanism such as gagging, queueing	Dynamics of interaction, floor control frame behavior such as presentations. mechanism are negotiated or technically mediated	Roles and rank determine dynamics of interaction. Behavior set by role relationships
	disrutptive breakdowns		
expressiveness	Affordances. World view Representation of objects, ideas. Social physical cues.	Available actions. Social behavioral cues.	Regions of influence. Interdependencies.
naturalness	Conformity to spatial behavor such as movement, access control	Familiar dynamics of interaction. Floor control, Gesticulation.	Fitness. Cognitive workflow. Workflow transitions. Process Management.
action mapping	Proximal behavior. Perceptual and expressive actions such as writing, sketching, speaking.	Attention getting. Recognition. Body language such as poking, mouse-clicking, hand-raising.	Role identification. Syncrhonization. Input-output actions.
transparency	Visibility of metaphor and "situational awareness".	Rules for interation. Identified breakdowns.	Awareness of the system. Procedural rules.
flexibility	Capacity to support different activties. The ease of transitions between contexts.	Ability to support different types of interaction. Transitions between interaction modes: such as informal to formal.	Adaptability to new work processes and roles. Transitions between decision contexts.
	generative breakdowns		
asymmetry	Access to social and technical resources. Contextual and interpretational variation.	Access to social and techincal controls. Variaton of social settings.	Roles and rank heirarchies. Sub-level task resolution, and granularity.
incompleteness	Ambiguity. Maleability. Personalization. Exploration Path, enclosure, extent.	Continuation. interjection. Action, intention, thought.	Known options. Limited resources Improvisation, feedback cycles. Market dynamics

EVALUATION MATRIX

Figure 4.a Evaluation Matrix

Chapter Four Notes

[1] the target domain is the concept that the metaphor is being mapped to, and the source domain is the concept that it is being mapped from (Lakoff & Johnson 1980)

[2] it is quite possible for two people to describe the same phenomenon with conflicting facts. For example one person may describe the moon moving across the sky, another may describe the moon as stationary and the earth spinning, (Goodman 1988) attributes this to differing frames of reference

[3] these two positions are described as Conduit Metaphor and the Toolmakers Paradigm (Reddy 1993)

[4] lecture notes on the web for Metaphor in Multimedia Information Systems http://wwww.comp.it.bton.ac.uk/~lp22MMMetaphor.html

[5] Simon referred to a 'problem space' as the area in which we search for solutions in the wider area of all possible alternatives

[6] "Domains of anticipation are incomplete, no system or set of alternatives can guarantee success. It means we must design with flexibility to encounter other unanticipated breakdowns." (Winograd & Flores 1987)

[7] Affordances are the properties of an object that reveal what can and cannot be done to or with the object. Perceived affordances are what the user *perceives* can be done, and through perceived affordances we know how to work devices that we are unfamiliar with (Norman 1990)

[8] Ubiquitous Computing advocates that this cognitive freedom is an opportunity of creating a more fully engaged periphery. Calm technology views the periphery as a resource that can be tapped using "ambient awareness" (Weiser 1998)

[9] in CSCW research the transparency of transitions between media, tasks, interactions, or contexts is often referred to seamlessness (Ishii & Ulmer 1997)

[10] (Kirsh 1998) refers to "cognitive work" as activities that reduce cognitive load of work, such as arranging objects or documents to cue sequential action or to highlight important categories. (Leigh-Star & Strauss 1997) refer to this as invisible work

[11] (Turkle 1984) describes the computer as an "evocative object" that raises questions between who we are in nature and what we might become through our redefinition of self in the virtual domain

[12] (Mitchell 1995) describes how the virtual world is increasingly shaping the physical world, the banks to ATMs, Bookstores to bit-stores, stacks (of books) to servers

[13] "It is possible that we might either accidentally or intentionally endow a machine (or computer program) with essential qualities that we do not anticipate. ...There remains the possibility that a computer program could operate successfully within a domain totally unintended by its designers." (Winograd & Flores 1987)

5

Re-Working Place

Super-Ordinate level mappings are useful because they maximize the possibilities for internal mappings. The structural consistencies of surface metaphors provide a familiar framework from which we can easily orient our thoughts and actions. On the surface, the structure is transparent and does not require conscious effort to be useful. As we explore an unfamiliar domain through metaphors we shape our understanding around the structure. Interpretation and action is limited by the structure, without it meaning could not be formed. If we wish to leverage the capacity of metaphors to generate new meanings we have consider the structure of metaphors and the foundations on which they are established. In the design of workplaces, metaphors are structured on two fundamental interdependent concepts: space and work. Space is the means, work is the methods. Space is where and when; it is the context, the technology and the structure needed to support action. Our models of space structure our understanding of privacy, security, awareness and presence. Work is the how and why; it is the purpose for interaction, and collaboration, and the structure needed to pursue intention. Our models of work structure our understanding of organization, communication and collaboration. In Chapter One, the design approaches of workplace making and workplace technologies began from different founding principles and moved towards convergence of space and work. Workplace making began from an orientation towards space that is moving towards work. Workplace technologies began from an orientation towards work based on models collaboration and communication that is moving towards contexts for work as place, event and process.

When we begin from an orientation towards work or space we construct models, consciously or not, that form the basis for design and evaluation of workplaces. The metaphors we use in the design process are deeply grounded on these models. Those that generative their own solution set limit the space of creative inquiry(Schon 1993). The challenge in designing and evaluating workplaces using metaphors is to break through the surface metaphor to reveal the foundations that are structuring our approach. The two fundamental models operating beneath the surface of workplace metaphors are work and space. Models of work, (e.g. collaboration, interaction, communication) are usually polarized around properties of independence and interdependence: individual work versus teamwork, personal space versus shared space, and personal computing versus collaborative computing. Models of space, are polarized around properties of perception and reality: virtual and the physical, the artificial and natural, and the center and periphery. Because these polarities in deep metaphors usually appear as either-or situations[1], we are compelled to favor one or the other. Marvin Minsky described this polarization of the world as Dumbbell Theories:

> "Such divisions all have flaws but often give us useful ways to think. Dividing things in two is a good way to start, but one should always try to find at least a third alternative. If one cannot, one should suspect that there may not be two ideas at all, but one, together with some form of opposite. A serious problem with these two part forms is that so many of them are quite similar, which leads us into making false analogies" (Minsky 1986)

Because we are naturally inclined to favor one extreme over the other, our prejudices are transparent and form the basis for which we construct meaningful interpretations from surface metaphors. To see through

the mask of the surface metaphors we have to confront prejudice and explore its role in the interpretation and pre-understanding of meaning.

> "We can become aware of some of our prejudices, and in that way emancipate ourselves from some of the limits they place on our thinking. But we commit a fallacy in believing we can never be free of all prejudice. Instead of striving for a means of getting away from our own pre-understanding, a theory of [language] interpretation should aim at revealing the ways in which that pre-understanding interacts with the text." (Winograd and Flores 1987)

Pre-understanding and interpretation are complicated by any combination of several factors in the work and workplace making. Differences in social and cultural background, professional orientation and work responsibilities can create pre-understandings. Interpretation can vary according to presence of others, psycho-social condition and physical context. Frame-conflicts arises within a group when individuals favor opposing ends of an either-or dilemma. Breakdowns often arise when multiple surface metaphors are employed that bias conflicting ends. For example, a collaborative tool may employ a place metaphor where users share a virtual space. However, because the personal computing model favors the individual, user expectations are biased towards individual control that focus on issues of privacy and awareness, and social-technical trade offs.

As many have argued, neither extreme can exist without the other and neither can be understood without respect to the other. (Kreickegaad in Cumming 1961, Heidigger in Winograd & Flores 1987, Wittgenstein in Karatani 1995). What is important for the use of metaphors when create meaningful places and occasions for work is our awareness of the extremes and our position with respect towards one or the other. If we use conflicting frames and breakdowns in surface metaphors as clues that signal either-or situations, we can expose the structures of metaphors and reframe inquiry. If two people can interpret the same reality (facts) entirely different as in the case of the Silent Game or the Toolmakers Paradigm how then do we create and support understanding that is both alike and different?

If we plot places and occasions for work along the dimensions of space and work (Figure 5.a) we can see that as we move away from physical and individual oriented workplaces we increasingly rely on metaphors. When we design shared virtual work spaces we are constantly in tension with the structure of metaphors that favor the model of personal physical workspaces. Towards the group work extreme, metaphors tend to favor physical models of conferences. Towards the virtual space extreme, metaphors favor the personal desktop, a product of the personal computing paradigm. As we move towards shared virtual workspaces metaphors are increasingly susceptible to breakdowns not because of misfit, but because they are evaluated against existing models based on the structure of physical, individual workplaces.

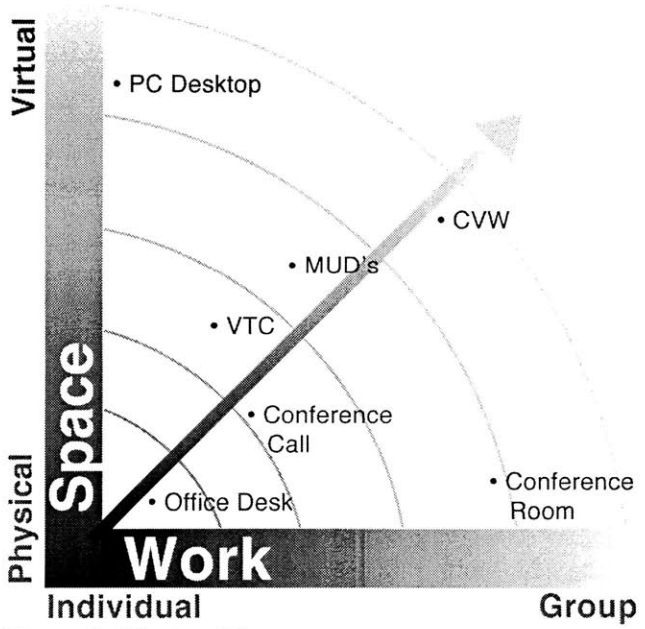

Figure 5.a Work and Space

Individual-group WORK

If we consider current workplace strategies such as the virtual office or the open plan environment, preference is given to the individual worker. The flexibility of Open Planing and telecommuting support different spatial configurations of interaction between individual workers. If the objectives are to improve collaboration and encourage teamwork then why do strategies favor the individual? Why do organizational incentive programs reward individual achievement and improvement over collective accomplishments? It is not surprising that collaborative technologies began from a position of connecting individual desktops. But it is surprising how much that model has constrained the view and design approaches to collaborative technologies.

Designers of physical workplaces and virtual workplaces are facing the same the problem but from opposite sides. From the virtual side, the approach began with the needs of the individual and the personal desktop, then to connecting individuals and now into creating contexts for shared spaces. From the physical side, approaches began with organizational and building needs from which the distinction is made between space for occupancy and space for services[2]. Occupancy and services are then further sub-divided into departments and zones, then public spaces that connect and are shared by individuals and groups. The individual and personal space and services are the end of the chain. Design is not one directional or sequential as this may imply, it always moves between a model of the individual and model of the organization, between connectedness and distinction. Depending on the center of focus and the metaphors we employ some features come forward others move to the periphery. Our awareness of the periphery is fundamental to an integrated design approach.

When we use metaphors, rather than focus on consistencies between domains we need to be equally aware of inconsistencies and ask what is different about the domains. What is it that we cannot explain metaphorically? How can this change our perspective of what potential is being suppressed? Metaphors draw attentions to those features and structures that are similar across domains. Naturally when we interpret metaphors we look for those consistencies rather than those differences. By looking for the differences we are forced to decompose the metaphor, looking for cracks in the surface metaphors. To see the cracks we have to consider different contexts in which the metaphor does not hold. By doing this we begin to see the world from different perspectives in different contexts. Through our re-descriptions of these perspectives we confront our relation to the context, and recast ourselves in other roles. It is by this "frame-restructuring" (Schon 1994) that we uncover the deeper meaning that constrain generative inquiry.

> "The key to much of what we have been saying in the preceding chapters lies in recognizing the fundamental importance of the shift from an individual-centered conception of understanding to one that is socially based. Knowledge and understanding do not do not result from formal operations on mental representations of an objectively existing world. Rather they arise from the individual's committed participation in mutually oriented patterns of behavior that are embedded in a socially shared background of concerns, actions, and beliefs. This is a shift from an individual to a social perspective—from mental representation to patterned interaction permits language and cognition to merge. Because of what Heidegger calls our 'thrownness' we are largely forgetful of the social dimension of understanding and the commitment it entails. It is only when a breakdown occurs that we become aware of the fact that things in our world exist not as the result of individual acts of cognition but through our active participation in a domain of discourse and mutual concern." (Winograd and Flores 1987)

Roles

Virtual environments that do not support existing conventions for role distinction and enforcement are most likely to reveal insights as to how virtual roles and perspectives are established. Many educational and social MOO's have confronted the social-technical circle and are restructuring the role relationships of teacher and student in virtual space. (Fanderclai, O'Day et al., Rheingold). Research has revealed more

open communication occurs without visual or personal bias and increased frequency of learning situations between students and with remote collaborators. Rather than seeing role restructuring in virtual classrooms in conflict with traditional classrooms, they are seen as complimentary extensions of the other.

Privacy
Privacy is not a spatial issue it is a behavioral issue that is structured by our spatial models. There is no privacy in virtual space other than convention adhered to by social standards. Utterances and actions are not temporal, they persist. We could design mechanism so that text conversation is erased or encrypted, but that does not preclude anyone from taping a conversation or sniffing a password. There is no absolute privacy except the unspoken word, or unexpressed emotion. Our notion of privacy depends on social conventions to which we objectify with constitutional laws that reinforce social values. However legal action is antithetical to the freedoms of virtual space. Instead, people build relationships and communities which are based on trust and mutual respect (Rheingold 1993). That is not to say that violence and betrayal do not occur, but the mechanisms for establishing and enforcing social "laws" are much different.

Restructuing

Collaboration is a collective effort of individuals in creating or producing something that is too big for any individual to achieve alone (Schrage 1990). How does a collaborative system that favors the individual, reach its collective potential? How does an individual and a team become aware of this dilemma?

The breakdowns in the surface metaphors employed in collaborative environments demonstrate the inclination toward the individual and physical underlying our use and interpretation of metaphors. In place based contexts, the PC paradigm, the virtual desktop (Windows), the personal office (E-suite), the carry case (CVW) are spatially structured containers for work that favor an *individual* model of work. Many of the collaborative technologies in shared physical spaces also favor the PC paradigm where individuals control the space. The Collab Project at Xerox, broke this model by creating a shared space with equal access and multi-user synchronous interactivity[3]. In collaborative environments when we do not have access to the spatial cues (furniture, lighting accents, etc.) and behavioral cues (gestures, gaze, etc.) we naturally look for other signs that we can map to our experiences and behavior in the physical environment. When mappings are not available or breakdown we negotiate social conventions through observation and interaction. Similarly if we get lost we look for things that are familiar or ask others for assistance. If we are still disoriented, we will ask why are things not familiar. We remember places by what is unique about them not by what features are similar to other places. Externally, the RCF room is like every other room in CVW. However what makes it memorable is the intense and often playful character of interactions and objects[4] that give it personality.

If we consider the event based context such as the conference (CAIRO), or presentation (Auditorium), each rely on social and technical conventions for moderating flow dynamics (floor control) between *individuals.* They are models of interaction that we are familiar with in physical work occasions. Surface breakdowns occur when we do not have access to familiar social conventions. Many collaborative environments have favored technical mechanisms to moderate flow based on traditional models of physical interactions such as hand raising and response queuing. Technical solutions that favor individual control mechanisms are modeled on roles and rank relationships that are familiar in physical situations. Even the more social approaches such as audience polling are based on conventional roles of the voter (those affected) and the pollster (those affecting). However if we distinguish events by the dynamics of interaction and ask what are the possibilities in virtual events, we begin to realize that models based on interactions in physical space are constraining our approach and evaluation of virtual interaction.

In process contexts, roles and interactions are decomposed into individual responsibilities and actions within a bigger process. The focus of process based collaborative systems has been reduce systemic delays that are caused by the individuals. In this regard the process based systems prescribe an approach that sees the individual as the source and solution to the problem. A partial blindness is created by an individually

centered model in which awareness of the system and the interdependencies between individuals and other contexts is moved to the periphery so that needs of the specific process can be met. If the process context precludes systemic awareness then the capacity for an organization to grow and improve is considerably reduced.

When we decompose the surface metaphors for collaborative contexts we inevitably will ask why collaborate anyway? Why limit personal capacity and productivity for group effort for which benefit is uncertain, un-rewarded? What is it that is "too big for any individual to achieve alone"? If we consider that our actions and interpretations are defined by the way in which we understand their affects on (and interpretations by) others[5] then the value of collaboration is mutual, not individual. To take action towards personal goals, we inevitably affect a world that is shared by others. If we expect our actions to take resonance in the world we must negotiate their meaning and intention with others.

One of the misgivings that an affinity towards an individually centered model creates is that by moving towards a socially centered model, personal control and privacy must be compromised. If our desire for personal space is to control or at lease limit unwanted interactions, then when is an interaction unwelcome? Individuals resist change for the fear of losing control of that which is familiar. We arrange our personal space and chose our actions in anticipation of the interactions of others. When anticipation is uncertain and our models of interaction do not apply, then we feel we are at the mercy of change. To deal with uncertainty, we consult others who might have experienced or are experiencing similar change. The effect is to counter individual change and uncertainty with group consensus and shared experiences.
The causality between change and personal control is created by our affinity toward an individual centered model of work. Concern is not for change but for the uncertainty of unwelcome interaction. In many work situations, interaction is encouraged but tempered against interruption. At one extreme we fear the isolated computer addict, detached from and threatening dehumanization of society[6]. The threat is not our concern for the individual addict, it is for losing society as we know it. At the other extreme we fear the media megalomaniac, a victim of disencarnation[7], with no personal identity, and whose actions are dictated by society. The threat is not our concern for society, it is what we are becoming (Turkle 1984).

Collective creativity exceeds the sum of individuals by the sum of the differences between the individuals. Individual learning arises in situations when our ideas and actions are accepted or rejected by others. For example, an individual is accepted in a community once they recognize and obey the 'rules' or social norms. However, the individual is only recognized as an individual by breaking the rules. In doing so, the community can reject the breach, in which the case the individual or the community has not learned anything but has reinforced its social identity and existing values. Or the community can accept it in which case the community adapts and learns by application and example.

By extension, an organization learns when an exception is accepted. We can say that the organization has learned when rules becomes transparent. Innovation is how knowledge fits into and *changes* the 'rules' or network of interdependencies within an organization. Minor innovations may improve some aspect of the network but not alter its structure. In knowledge organizations, the innovators dilemma is that the ways in which we are accustomed to learning resist the ways in which innovation occurs[8]. If we the way we learn is by breaking rules, and testing the unknown, then by exposing the rules and their relationships we become aware of the constraints framing the space of potential. In order to see the whole picture, to think systemically and affect change we need not only to understand our personal biases but to understand those of others and those of the system. Systemic awareness is not just the ability to be aware of others activity in relation to our own, but to be aware of our activity in relation to the system (Senge 1994).

Many disruptive breakdowns occur as a result of the perceived utility of a collaborative system. If an individual does not perceive benefits that at least exceed the overhead in learning and using the tool then adaptation is less likely and met with greater resistance. Conventional organizational reward systems are partial toward achievement and improvement of the individual rather than group. Personal benefit in terms of productivity gains or personal satisfaction are often viewed in conflict with collaborative work.

Teamwork requires awareness of others which is thought to compromise privacy and personal space. It requires social negotiation of process that can mean sacrificing autonomy and individual productivity. These views are rooted in a model of collaborative work processes that are familiar in existing practice. Virtual workplaces are built and evaluated against these models. A generative breakdowns is encountered when a new pattern of work that does not fit existing models brings about new work practices. When this happens the 'rules' come to the surface and the model of collaboration evolves. As an example, consider the cliché "think global act local" as it applies to virtual environments. When we act locally in multiple contexts, we may still be acting locally, but local is not constrained by rules of physical time and space. Locales become contexts for action in a global context. This shifts our perspective of global to be the range of local influences. The distinction between local and global is blurred when we act and think in the same place.

Systemic awareness is our ability to recognize the consequences of our action on the system. Breakdowns typically manifest themselves in delays that are attributed to miscommunication between individuals or interdependent teams. Deductive reasoning suggests that by improving the communication, breakdowns can be reduced. This may improve the efficiency but does not improve the potential for innovations in the organization. Because the space of potential solutions is constrained by our affinity towards the individual, we look from an individual perspective, often hiding the biases of the system. If we use the differences between individuals as a basis for modeling the system as a network of interdependencies we can distinguish individual contexts by their relationship to the system. This type of model can be built by reconciling conflicting frames not by appeal to facts but by a system that affords the mutual negotiation of differences (Senge 1994, Schon 1993).

What makes us different is what makes us valuable to the system. Our collective awareness of those differences is what enables us to think systemically. If we recall the dynamically coherent workplace "artifactual presence" encourage systemic thinking and externalization of ideas across organizational boundaries. Shared visual displays (white boards, bulletin boards) make work visible so that comparisons can be made and differences identified. Coordination documents (calendars, to-do lists) track where we are and where we are going. Motivational tools (organizational charts, project displays) identify individuals and teams in relation to the organization (Covi et. al. 1998). Their persistence and transparency in physical space is what makes them work. Cognitive artifacts are not applications that have to be started, they are effective because of their persistent presence: we use them because they are there.

When we consider shared tools in virtual workspaces, our affinity toward the individual is concerned with the trade off between privacy and awareness. The value of personal control is to reduce unwelcome interruption. If our model of work is collaborative team work or a group settings (e.g. presentations, briefings) we accept the trade off favoring awareness. If our model of work is autonomous concentration or private interaction, we resist compromising any personal control. Push technology, for example, is often branded as an annoying, unsolicited intrusion on our private personal workspaces[9]. If someone is pushing an important message or sharing a bit of humor, its unobjectionable, but when appears to be for the benefit of others, people feel encroached. Because we consider our workspaces as personal space, unsolicited information or interruption is unwelcome. In virtual environments the distinction between autonomous work and group work is intermixed but partial to the PC paradigm.

To get beyond the PC paradigm we need to distinguish between shared space and personal space. In place based contexts the distinction is based on boundaries and movement. In events contexts the distinction is based on differences in dynamics of floor control. The more public the space or event the less we expect to be able to control. In our layered model of personal to private space the individual is at the center bounded by a rational model of physical space, contained by increasingly public spaces as we move to the periphery. In the virtual world the structure caries over but the container model is reversed. Public spaces are interfaces into the virtual world and are bound by increasingly private spaces all contained within a model of the individual office or personal desktop. Personal space is controlled by closing the office door or closing the virtual window. In physical space our understanding of privacy is spatially bound by public

space. In virtual space privacy is not spatially bounded it is socially bound by our perception of the presence of others.

Roles are made by rules. Rules describe relationships and instructions for action. They are intended for people who are not familiar with a context or tool, or game. Once in use, rules are internalized and become transparent until they are recognized as being violated. Social rules cannot be taught explicitly, they are acquired through use and only understood through breakdowns. Our understanding of rules depends on social negotiation of our actions as interpreted by others. If our actions are constrained by technical properties of the environment, how do rules get formed and how do they change?

A common breakdown in process context metaphors occurs when one role acts in a context in which the rules require the response of another role. For example when an teacher issues a command requiring some set of actions on behalf of a student. When two teachers issue conflicting instructions, a breakdown occurs: what action does the student take, whose instructions take precedence? Resolution can take one of two approaches: either a new rule can be made for each conflicting situation or a new role can be created that establishes precedence between roles. Neither approach will improve the systems ability to avoid breakdowns until all possible breakdowns have been discovered. This could only be accomplished in a completely stable environment with no external or internal tension. The two solutions, add rules or add roles are biased towards a vision of a stable system and that breakdowns are undesirable. An alternative approach might consider modifications to the system that reconcile breakdowns. If roles are dependent on rules, without them, they would be meaningless. Instead if roles were defined by the different perspectives working toward some goal or objective that neither could accomplish alone (in this case teaching) we might use a different set of rules. Rather than building rules to avoid conflicting situations, rules could assume that conflicts will inevitably arise. The conflicts then are an opportunities for learning in which a rule is made, broken or affirmed. They are situations in which different perspectives confront one another and negotiate the rules. By sharing perspectives, roles switch, the teacher learns and the student teaches. Although the process may seem inefficient if measured against historical standards and teaching practices, the process in which conflict is negotiated is likely reveal greater benefits in effectiveness. Rules are then useful to structure conflict negotiation in a manner that effectively responds to the individual needs and collective objectives. With rules of this nature a process becomes more efficient at responding to change situations that are unpredictable. Roles are not then seen as power structures but as complimentary relationships and opportunities for learning.[10]

Virtual-Physical SPACE

As designers of the human-made-world the virtual is as real as the physical. When we use physical-virtual metaphors, we are structuring the virtual world by our understanding of the physical. By unit comparison, the finest grain of actions is at the atomic and bit level. Molecules are bytes. When we leap to units of consciousness, the finest grain is the cellular and symbolic level. At this level understanding depends on a model of context, function or purpose. When we leap to units of understanding the finest grain is the relationship. The dependencies between cells or between symbols creates meaning. Although we may never know the full complexity of life or cyberspace we do not need to understand it to use it. The value of physical space in virtual worlds will be realized through exploration and colonization of the virtual space. The value of theory, models and metaphors, is to explore meaning not just to structure or explain it[11]. This is not to say that theory based on exploring the physical world does not have a place in virtual space. The value of theory is its capacity to generate rules that both explain phenomenon and which we can test new experiences against. Revelation occurs when theory break down. Cellular and atomic theory provide a basis describing patterns of constancy and change. Matter is constantly changing and reconfiguring the same units into different wholes. We are constantly shedding and reproducing cells as our as our bodies grow and adapt to the environment but we retain human identity. Organizations and institutions are constantly gaining and losing people.

In the workplace, the basic social unit is the individual. Individuals make up teams, teams make up organizations. The context in which we understand the relationships between units is the work practice. Our understanding of work is based on objective descriptions of the places in which we work, the activities that we perform and the artifacts that are used or created by work. Organizational theory and workplace theory models the social (human) and technical (space, technology) relationships to fit organizational models of work practice. Fitting the pieces together to make a collective whole is a continual process of evaluating and adjusting the models of relationships. Most approaches to workplace making favor the physical over the virtual. We could trace the affinity through architecture, literature, cognitive science, all the way back to our natural existence and distrust of the artificial. Collective virtual presence is not a new concept; the Jungian notion of "collective unconsciousness", or theological notion of Heaven are objectivist positions of existence beyond the physical domain. When our understanding of individual experience in physical space is mapped to collaborative work practices in virtual space the breakdowns that occur are not a result of flaws in the models, they are a result of misappropriated rules for their interpretation. People who work in both physical and virtual space do not have dueling models of work but when we separate work into two domains we describe virtual work in terms of physical work. When we describe work space, we think of individuals in physical space. The dualism between virtual and physical and between individual and group is continually resurfacing and recasting itself in new ways. The constructivist position mediates the two by acknowledging the mutual existence both extremes: The world is composed of individual constructions of world models and the overlap between models is the basis for objective reality. The integrated workplace differentiates and overlaps individual and group work and physical and virtual spaces.

Location and position in virtual workplaces are not relative to space and proximity as they are in physical space, but are relative to needs and requirements. Movement is not through space but through work process. Depending on what we are doing and where we are going, we move synergistically between contexts as contexts move around us. Boundary and extent are not spatial properties but regions of influence in the virtual workplace. Spatial boundaries are the behavioral and social limits of action and impact. As we move towards increasing activity, regions or districts take on a recognizable identity with personality. These centers of activity are landmarks in virtual space[12] that serve as points of reference for orientation and direction.

The multi-dimensional space in which live and work is often unrealized in design approaches that are blind to their affinity towards the physical and tangible world. We experience space both physically through our senses and perceptually through the mind. The four zones of spatial experience are the surfaces that we touch and walk on (tangible interfaces), the support space buried beneath the surfaces (structure or framework), the void space that we see and hear but are detached from (distant space), and the transcendental space containing no tangible substance (mental space).[13] Each dimension is a resource contributing to our experiences of contexts. In the physical world we occupy one point in space and time. In virtual worlds we can occupy infinite points and equally many times. Cartesian Geometry that relates everything in space to an single point is irrelevant in virtual space when we have multiple origins, with undefined relations to each other.[14] We can only relate within our reach, or sphere of perception. The virtual space does not have size and scale, yet we define boundaries and cluster objects. Virtual time does not have future and past (in persistent environments) although it is often indexed to references in physical time.

Traditionally designers of physical spaces work in and from physical space and designers of virtual spaces work in and from virtual space. By occupying the environment for which we are designing we are likely to gain insight to where problems may arise, and to where enhancements can be made. To internalize the virtual workplace, we must work in virtual space. When we design space or collaborative tools, we project ourselves into the mind and environment of the user and their task. In doing so we are susceptible a double blindness created by our position. We are partially blinded by our model of user, work and context (place, event, process) especially if the models are assumed and not surfaced. We are also partially blinded by being thrown into the situation at hand from our position in virtual or physical space.

The state of being thrown[15] *in* a situation and reflecting *on* a situation seem to be dialogically opposed positions.

> "To understand meaning we have to accept both but cannot depend entirely on one. We are initially at fault in our approach if we can accept that we can have a disengaged image of self, because we are susceptible to outside interference (Taylor 1985) as we attempt to form an image of self. The meaning is of the speaker's utterance is reflected and subordinate in the outside interference of the receiver's (even if not present) voice. That voice or outside interference is itself a "thinking device" that generates new meaning or affects the meaning of the speaker. The artifact or text of speech is "a semiotic space in which languages interact interfere and organize themselves hierarchically (Lotman 1988 p 37)" Wertsch from Voices of the Mind

The voice is a medium for both reflection ("thinking device") and action (utterance). When the medium in which we act is simultaneously the medium in which we think we reduce the effort of transportation between acting in a situation and reflecting on a situation. When we reduce the effort to move between reflecting on a situation and acting in a situation, the act of transportation begins to disappear.

When we are thrown in a situation for which we must act, resolution to breakdown is prescribed, its a natural response of instinctive action. When we act in a situation we are blinded by the environment. Our vision of possibilities is constrained by the set of perceived actions available. Once a breakdown is identified, it is seen, described and treated at the surface often missing the deeper cause generating the breakdown. We act with in blind rationalism: if there is a leak we respond by plugging it. Resolution is dependent on properties of the environment, or in the case of the leak, what is available to stop the unwanted flow: tape, glue or finger. We don't stop to think why the leak has occurred or why it is desirable to stop it.

When we design and plan, we are disengaged from and projecting into the situation we are considering. When we reflect and debrief, we are out of the situation we are describing. However, when we reflect, respond, and interact with people and our environment we are thrown in the situation at hand, (in this case designing or debriefing). To explore the unfamiliar, then we must engage it, describe it then test our descriptions through re-engagement. It is a process of both projecting into and disengaging from, or stepping in and stepping out (Ackermann 1996). If we can locate ourselves somewhere between in and out, without leaving either behind, we are in a more advantageous position for reflective-action. From our positioning on the threshold between action and thought we can move resolution forward without losing sight of where we want to go and where we are coming from. In the design of virtual workplaces the position is one in constant tension between what is often framed as either-or extremes: physical and virtual, individual and group, public and private, local and global, future and past. The ideal position for an approach to designing an integrated workplace is one that is aware of both extremes. It does not have to be neutral position, as long as it does not hide or limit the capacity to develop and inhabit the complimentary extreme.

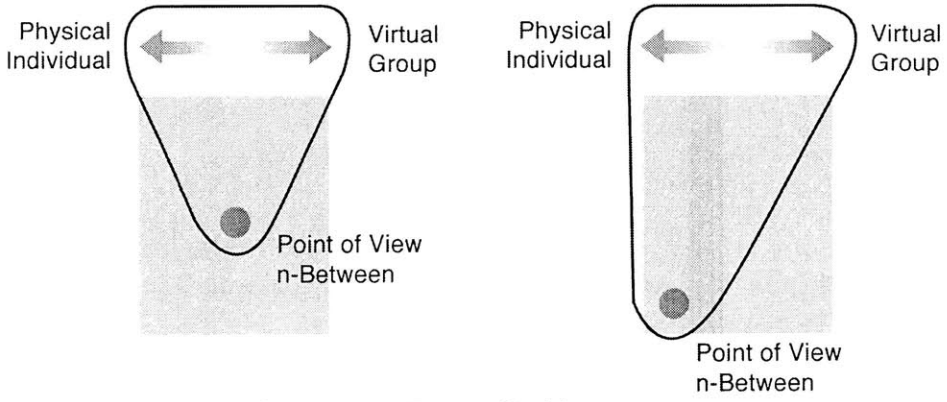

Figure 5.b Rubber Banding Between Extreme Positions

n-betweens

To leverage metaphors to generate meaningful contexts for work we have discussed an approach that begins with breakdowns to expose conflicting frames of reference. By reconciling frame conflict we are forced to jump between frames to see the likeness and differences. When metaphors generate meaning they often conceal the underlying principles that generate metaphors. These principles are often presented as conflicting either-or situations in which we favor one or the other. The metaphors that we use to design and evaluate workplaces are often biased towards one of these extremes. By extending the power of metaphors to the design of workplaces we can consider context metaphors that are posed to leverage tension created by conflicting positions. These are contexts that fully engage the periphery (Weiser 1998) so that moving between in and out is as transparent as moving between thought and action.

On-betweens are positions in the physical world that straddle domains, situations or encounters. When we stand outside an open door of a co-workers office we are in a disengaged position between interaction and autonomy. We use distance[16] and activity to define and negotiate the interface between being engaged and disengaged from interaction.

> "This sensory envelope [visual, acoustical, olfactory, and haptic] is flexible enough to enable us to articulate a whole range of different behavioral possibilities within social situations. Such as chance meetings, browsing, bystanding, butting-in, and splintering away from larger groups, all of which involve the intuitive negotiation of different levels of privacy. It provides us with layers of protection in public situations." (Dunne + Rabby 1995)

In-On Paradox

When we keep interaction at distance, moments before an interaction we are outside a situation that we are contemplating. From this external position we project ourselves into the situation to dabble in the possibilities. We are not however, disengaged from our position of contemplation. We are always subject to the situation at our current position and as such must respond in the situation at hand. Because our bodies are subject to the limitations of time and space of the physical world, we cannot completely detach ourselves from or project ourselves into a situation.

This schism between *being in* and *reflecting on* a situation is evident in the opposing approaches to computer supported cooperative workplaces. Those that project into and those that project onto are opposite directions on a circular path (Figure 5.c). At some point their directions begin to converge until they confront one another. Without an awareness of the circle, we are partially blind to the centrifugal forces between vision and reality. In workplace design this creative tension (Senge 1994) is between our models of work and the reality of work. If we relax the tension by adjusting our vision toward reality, we in effect reduce our potential to reach our goals. If we can adjust reality toward our visions, we open the space of possibilities to new ways of working. By questioning the assumptions that are limiting thought and action, we position ourselves between reality and vision. From this position we can face both reality and vision and move forward without losing sight of the other. This position is consistent with the learning situations when meaning arises simultaneously in both reflection and action. It is what Kierkegaard means by "Life must be understood backward but...it must be lived forward" (Cumming 1961). The action model of reciprocal evolution (design by use by design) is analogous to the cognitive model of design activity projecting into and reflecting on. Design, like learning, is a "dance between diving-in and stepping out" (Ackermann 1996).

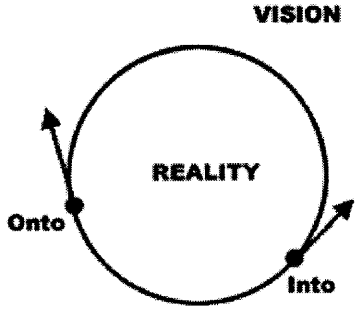

Figure 5.c Design Approaches

For a context to be in a position of the present, it is poised between future and past. Interpretation and action is left open for individual experience in the moment at hand. When we look "forward through the rearview mirror" (McLuhan 1997) we are in the present, moving forward toward the future but seeing backward toward the past. If the aesthetic (look, feel, sound) of the context can resist historical references that favor one extreme over the other, the opportunity for reflective-action is encouraged. When we do not easily identify familiar social cues of historic reference to frame our action we are thrown into a state of reflective action. To make sense of a context depends on the interplay of subjective experience and objective reality. When we design workplaces and use metaphors, we all to often focus on objective reality, favoring the individual and the physical, leaving the subjective experience at the periphery. By engaging in imaginative reflection (image generation as opposed to recollection) both the center and periphery and past and present are mutually accessible.

To act without reference to the past requires contemplation of uncertain choices and imaginative reflection of consequences. This may be resisted as an undue increase of the cognitive overhead to process a context in order to act. We can foresee how difficult it may be to orient, and navigate our way through an abstract environment without easily identifiable references to prior experiences. However we could argue that bringing this cognitive process to the foreground, does not restrict action but increases thought. Efficiency is not compromised for effectiveness. Designing a technology or an environment for a specific activity may make the intended activity more efficient in terms of time and effort to comprehend context, but at what expense? By analogy we can consider how we use search engines and libraries.

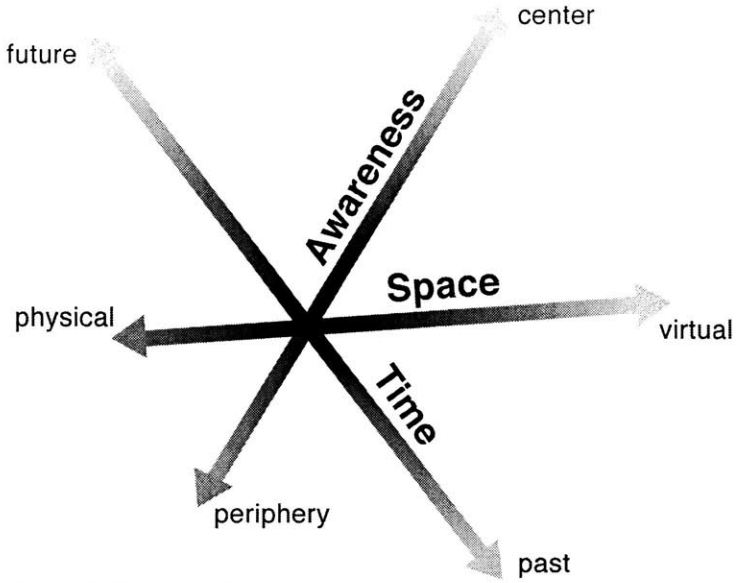

Figure 5.d Moving Between

> "Creating a technology for as specific task like searching for a book in a library may make it easier for a reader to find the book on a narrow topic by reducing the need to browse loosely related material, but losing the unexpected and unintended encounters in browsing can be much greater than the efficient precise recall. The domain of finding a specific book may be misleading to the domain of finding relevant writings on a topic. The tool [context] will change the nature in which people use a library and the materials within it. Attention to the possibilities being eliminated must be in constant interplay with expectations for the new possibilities being created." (Winograd and Flores 1987)

The activity of browsing is much different than the activity of searching. In either case however we make use of our context to determine our approach. If we are searching for something or someone, we may stop to ask others for direction or look for clues in the environment.

n-betweens are positions in the virtual world that straddle in and out. Like on-betweens they are a position in which reflective action is possible. The difference, rather than using activity and distance, n-betweens employ needs and goals to determine interaction. Location and direction are not spatially and temporally negotiated but are continually changing interpretively and expressively. When we are between objective reality and subjective experience we are in a position where creative inquiry is derived by the tension between aspiration and actuality. These positions function as one could imagine a threshold, bridge or

corridor between multiple dimensions. When we are in positions of n-between we both are acting in the situation and reflecting on the situation, between where we headed and where we are coming from. "They are bridges between body and information, experience and memory" (Lin 1995). It is as if we are standing under the proscenium arch between life in the material world and life on screen.[17]

Corridors, streets, bridges, prosceniums, or thresholds must be carefully tempered if we intend to use them as spatial metaphors in the virtual world. For one, n-betweens are n-dimensional affording access to infinite positions in infinite contexts and equally many times. In virtual space we are never entirely here or there, there is no equivalent physical world spatial n-between.

> "...the threshold is not to be characterized as a temporary position from which to assess either reality or cybersapce, but becomes a long-term meeting point, where the two worlds may themselves coincide and interact, where the hybrid realities can emerge and where architectural dreams may be satisfied in and out of reality." Chaplin 1995)

If we contrast attributes extended by the metaphor when they breakdown then we may enrich our understanding of n-betweens. Bridges span between contexts. However on a bridge, our choice for movement is limited to one direction or the other and the metaphor breaks. The purpose of bridge, to get from one destination to another, is in conflict with a position whose purpose is to linger between contexts. The corridor is a space between and connecting. It is a neutral position that does not favor any particular context. Well designed corridors often offer places for lingering like main street. Bridges, corridors and streets are themselves a context between contexts. Thresholds and Prosceniums collapse space into a position of what seems two dimensional. When we are in a learning situation, we connect several parts of past experiences (or mental states) simultaneously. The lines that connect these states are what Marvin Minsky refers to as Knowledge Lines or K-Lines (Minsky 1986). With each new situation, past experiences are attached to the present situation with varying strengths. By comparison with the corridor metaphor, our position relative to adjacent contexts determines the strength in which they bear on our present experience. When we move through the corridor or down the street, different contexts are amplified and others fade. We can lean towards one or another along the way, as if to peek in the door or peer through a window. When two corridors meet, and lines intersect we share n-between space with another. At these moments, the potential for learning and collaboration is extended with the presence of others because we are able to relate many perspectives to a singular situation. When we consider the linear movement through a corridor or down a street, the metaphor begins to breakdown. In virtual spaces we can be in multiple simultaneous positions along one or many corridors. It is even quite possible we could be peering into the same context from two different corridors. The proscenium, like the threshold are positions between inside and outside. We can occupy them alone or share them with others. If we picture the planar nature of proscenium and threshold the metaphor breaks down into another Dumbbell Theory. Instead if we consider a multidimensional threshold like the multiplex theater, we may be able to face only one context at a time but are aware and present in the others.

There is much to be gained from n-between encounters. When we meet others in these positions, we are thrown into a situation where reflective action activates collective inquiry. When our alternatives for action are shared with another and the choice for action then revealed, then frame conflict can be referenced to the situation. Self identity is defined by our relationship relative to a context (or our world view). We are what we interpret our own actions to be understood by others. We understand our choices as to how our actions are received by others and our choice for (in)action is ultimately self actualization. In virtual time and space we can project ourselves into a context without our presence being known by the context. However, when we do, our interpretations are understood through our projected presence, not the absence of it.

The physical portals to virtual space are presently the communication technologies, the phone, the fax, the computer, the PDA (Personal Digital Assistants), the information appliance[18] and graspable media (Ishii & Ulmer 1997). They are gateways to the virtual domain, but do not afford a position of n-between. When we use communication tools, we are either the sender or receiver. If we wish to move in between we have to be the recipient of our own actions. When we use text conversation we are in a position of n-between,

but an asynchronous, asymmetric one. Our thoughts and actions are not accessible to others until we deliberate and chose to reveal them. When an action resounds in a context, the situation changes our reflective state, and we adjust our possible actions accordingly. We are never completely thrown into nor completely detached from the situation.

Communication technology and collaborative environments have been dominated by functional approaches that seek to improve efficiency and effectiveness. There is little room for an aesthetics of communication. However, what distinguishes architecture from pure engineering is the position of aesthetics. Many beautiful structures have been generated from pure function, and many eyesores from pure ornamentation. Engineering is an ethical approach, there is right way and wrong way to do things that is verifiable by scientific reasoning. Art and Architecture are aesthetic approaches, verifiable by judgment and individual preference. Both approaches are expressive of some *purpose* for their creation for which they are evaluated against. What is the purpose of work, space, collaboration and place-making? What purpose is not attainable by any individual alone or by the sum of individual effort? Those that require social negotiation to find resonance in the world. If collaboration environments are to have meaningful use for the purpose of creating useful meaning then we should seek a design approach between aesthetics and ethics. When we collaborate, we create meaning by supporting individual differences of aesthetic (likes/dislikes) and simultaneously supporting group ethics (right/wrong). We leap back and forth through social negotiation, testing our ideas and interpretations against the group. The rules of evaluation come to the surface only when we break them. Once broken we open the path to creative collective inquiry. The leap from aesthetic to ethics occurs when we confront individual differences. If we accept an them we have gain new perspectives, and revise our ethical model. By rejecting it we have reinforced social values and verified existing ethics. By holding it in a position of exception we have raised our awareness of our situation and stimulated creative inquiry.

Aesthetic

When we create aesthetic experiences in virtual space, we use narratives, models, and metaphors to think with and describe our experiences. They are evocative "thought forms" that transcend and question our understanding. In terms of surface metaphors in CVW, we could imagine allowing and individual the freedom to organize their floor map according to their needs and relationships, the content would remain consistent between individuals maps but the arrangement could differ. Changes in the map would be negotiated between the needs of the individual and the needs of the group. This would afford greater flexibility for individual interpretation and expression in places that mutually accessible. Users could to act in and reflect on contexts independently in a manner that constructively supports individual workflow and collaborative efforts. Shared spaces do not need to be contained and externalized as they are in physical space as long as they are both mutually accessible and negotiable.

There are many rich examples of aesthetic approaches to positions of n-betweens throughout art and architecture. The social function of art and architecture is not to express or record humanity but to generate meaningful relations between individual aesthetic (preferences dreams) and social ethic (values, objectives).

Individual-Group

The De Stijl artists were the first to confront the individual-group schism. For them, art was an opportunity to affirm individual aesthetic and social unity.

> "De Stijl was a model for the perfect harmony they believed possible both for man as an individual and society as a whole. It thus had an ethical and even spiritual mission, performing a function analogous to that of pure research in relation to practical application of discovered principles." (Chipp 1968)

When we consider the work of Piet Mondrian, (Figure 5.e) we can see formal properties of dynamic coherence: transparency, incompleteness, and blurring boundaries. The composition is a dance in and out: between individual lines, colors and planes to varying scales of collective communities. The aesthetic experience is between episodes of individual experiences at varying density and aggregate meaning of their relationships.

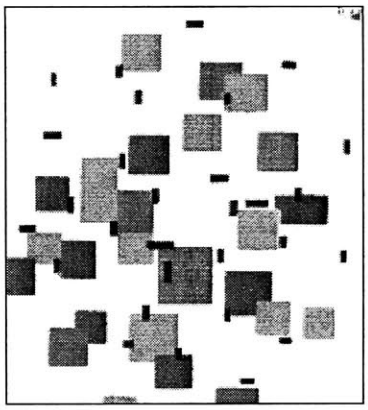

Figure 5.e Piet Mondrian
Composition en coleur 1917

The cyber-aesthetic is derived through experience dissolving the designer/artist and user/audience relationship (Larner and Hunter 1995). Its power resides in the quality of interaction it makes possible. The criteria is not left to the individual aesthetic alone but progressively derived by the "dynamics of communicated consciousness" (ethics). For example, when we linger in the town square or urban café, we are both a part of and apart from the context. If we abide by social conventions for behavior in public space we can preserve our anonymity, but when we break the rules we assert our identity and affront the collective.

Virtual-Physical

Although the Cubists were the first to render the attributes of space rather than space as a subject of re-collection, the expressionists were the first to question the "reality that is visible behind things"(Klee in Chipp 1968). For Wassily Kandinsky, (Figure 5.f) meaningful form is created when individual necessity, under the pressures of time and space, finds relationships between form(s) and inner experience(s). (Chipp 1968). In this regard, meaning is derived from the relationships between properties of context (form, time, and space) and individual reflective action (experience). The inner-necessity that Kandinsky often refers to in his writing acknowledges the quality of being thrown in the activity of perception. The role of artist and audience is one in the same: a search for meaning through experience. Experience is through movement along a space-time path that is neutral to future or past but exists in experiences of present.

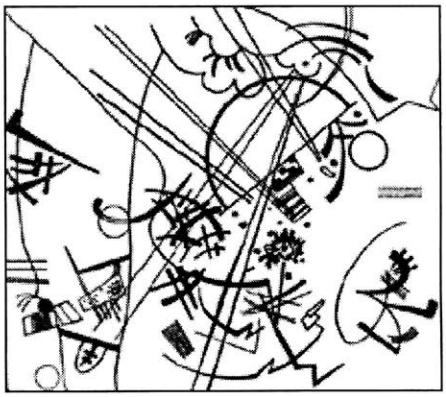

Figure 5.f Wassily Kandinsky
Small Dream in Red 1925

Hybrid spaces that combine physical and virtual presence are becoming increasingly popular. Artists and Architects are designing for experiences that combine local and remote, individual and group contexts. In virtual places we inhabit the media in which we express ourselves. In physical spaces, designers are beginning to tap the power of architecture, as an inhabitable medium of expression. Toyo Ito's Visons of Japan Exhibit in 1991 was an approach to create an experience between physical and virtual space:

> "Interaction was invested in your freedom to make personal readings and secret connections between the random and continually changing welter of urban scenes, meteorological data, clouds, crowds, and the colors of Japanese Life....A screen was made up of sheets of liquid crystal, whose transparency could be freely controlled allowed the boundaries to be blurred between real images glimpsed through the screen and virtual images projected onto it...There was also a series of objects positioned in the space, designed to allow a more personal feeling of contact, such as the Hyro which gave the opportunity to peer into the mind of a machine and see the space through the digitalised eyes, thereby almost creating the illusion of looking back at reality from the virtual side of the threshold" (Chaplin 1995)

Workplace in-betweens are shared mixed realities. Places where people are together and connected in both physical and virtual space. In these places access is mutual but asymmetrical. Individuals are both a part of and apart from the situation. These places can be private conferences or public meeting places. They are simultaneously places for socializing, exploring, concentrating and questioning. Privacy is less an individual concern when we are aware of the extent of actions bounded by physical space and virtual access. The hybrid conference room is both local and remote, it is n-dimensional and contained by occasions of interaction and extent of relevance. As the technology moves into the periphery our conventions for interaction will likely become transparent transitions between symbolic expressions and different media.

Public workplace n-betweens are becoming increasingly attractive directions for computer supported cooperative work spaces. The "information hallway"[19] and the "Internet Foyer" (Benford et. al. 1996) are recent examples that mix the physical and virtual domain of virtualizing organizations. The Internet Foyer is a hybrid space in which a space is accessible remotely from a web browser and locally through a projection onto a physical foyer. In the physical foyer, people can interact locally in physical space and remotely with the virtual participants and vise versa. Figure 5.g is a montage of a n-between. Projected on the wall of the meeting is vision for a collaborative virtual environment called The Frame, it represents a position between reality and potential. The intentions of The Frame[20] as a tool is to visually share multiple perspectives in the creation and representation of an artifact or an idea. As an environment it is a virtual space of potential between individual views where concepts are negotiated and formed into a shared understanding. One could imagine the space represented as being between individual perspectives (projected onto) the walls of the virtual space and their views of reality (projected into) the walls of the inner cube. Whether for effect or for effectiveness, hybrid realities are a step toward positions of n-between that will reveal new directions and new dimensions for work and space.

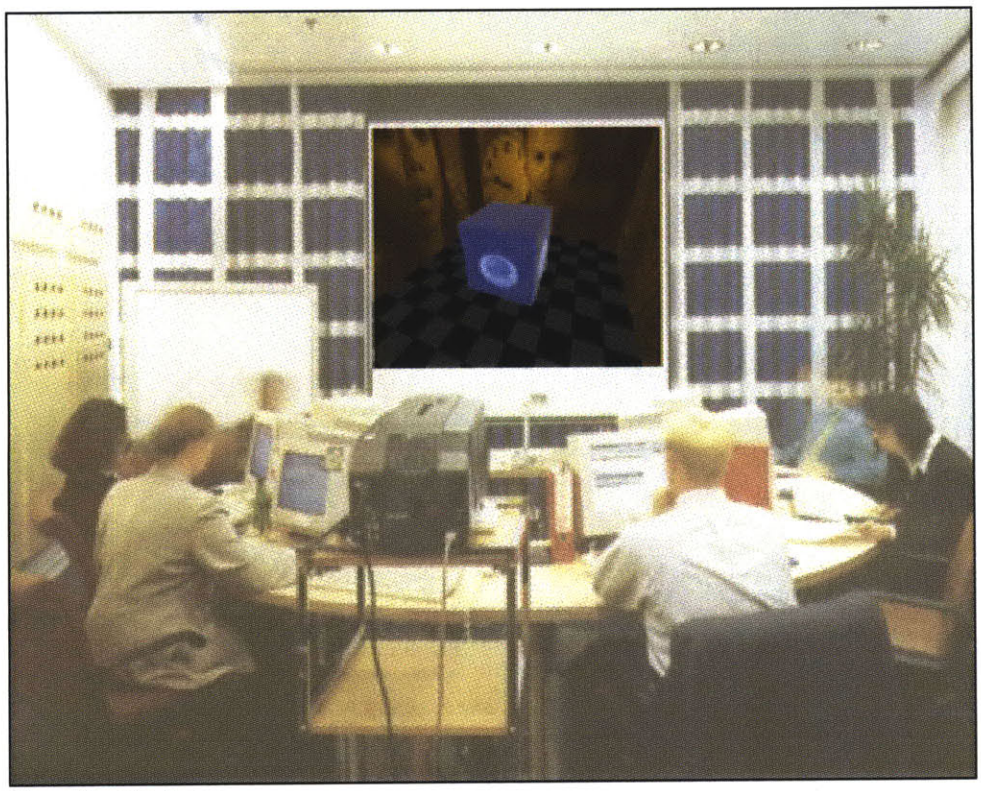

Figure 5.g The Frame
Hybrid reality in the Conference n-between

Summary

The workplace is changing faster than we can understand. We are living and working in places and using tools that are understood through reciprocal evolution. When we learn, work and socialize we express, interpret, and explore with metaphors. Our affinity for the physical and personal creates a tension when we design and interact in collaborative virtual spaces. If we wish to leverage the virtual domain in the design of workplaces we need to make it inhabitable publicly, personally and everywhere in-between. The debate between aesthetics and ethics is a positive direction that is one source of individual and shared experiences. What I am advocating is not abandonment of what we have learned through our experiences in physical spaces but an approach that enriches life between the individual and the collective and the physical and virtual.

Chapter Five Notes

[1] In his book Either/Or Kierkegaard describes the polarization of points of view characterized by contradiction if two types of which he distinguishes the *aesthetic* (like/dislike) for which reconciliation is by individual preference with little impact on others from the *ethical* (right /wrong) for which reconciliation is an uncompromising social norm (Cumming 1961)

[2] Louis Kahn distinguished "spaces that serve" from "spaces that are served"

[3] for a more complete description of Collab Project see (Schrage 1990)

[4] The RCF room has objects to play with like a plate of cookies that people can throw at each other

[5] Heidigger suggested that although existence favors the inter-subjectivity of individual experience, existence is validated only by recognition of our individual experiences in relation to others

[6] this concern is an underlying motive for Ubiquitous Computing that seeks to contribute to the decline of the computer addict by pushing computation into the background, so that we continue to live as we know best, socially (Wesier 1991)

[7] this concern for mass media that personal identity is lost when we act as a part of a mass audience we depend on electronic communication to shape society we become disembodied or disencarnated (McLuhan 1997)

[8] the innovators dilemma is pervasive in the development of new technologies. (Christensen 1997) describes the dilemma between sustaining technologies and disruptive technologies in the manufacturing, service and high tech industries. Sustaining technologies are those that improve performance of existing practices or products, and disruptive technologies redefine the product or practice

[9] Push Technology are messages, advertisements, announcements that automatically are displayed on a receivers desktop. Usually the receiver controls the sources that and level of response if any required, Some of the commercially successful push technologies are multi-casts customized to the receivers preferences. Push technology is not to be confused with person to person message systems

[10] examples of this approach to frame-restructuring has been illustrated in social policy for public housing between squatters and housing agencies in (Schon 1993) and is also discussed in experiences with educational MOOs in (Fanderclai 1995)

[11] Max Black describes theoretical metaphors as a powerful device for inquiry by describing and exploring one thing in the language of another

[12] K. Lynch suggests that we cognitively structure of places is based on *paths* as channels of movement; *edges* as boundaries that break or contain; *districts* as areas of recognizable identity and usually a discernible boundary; *nodes* as distinctive behavioral settings of intense activity often at the intersection of paths; *landmarks* as points of reference that are both external to the observer easily distinguishable. (Lang 1987)

[13] somewhat neutral position suggests that we perceive and design space in each dimension. It stands in slight contrast to Roy Ascott description of the four zones from a position in physical space in the public domain as underground, street level, sky/sea and cyberspace. (Ascott 1995)

Notes continued

[14] SPLINE by MERL is a system for building and experiencing shared virtual space that combines locales defined by Cartesian space with a world model that is defined by inter-connected locales. By defining scalar relationships between remote locales, Cartesian space can be preserved locally and globally

[15] Heidegger described the condition thrownness as it bears on understanding. Our actions and thoughts are in part determined by the way in which we understand the effect of our actions in the world . Our interactions with people and our environment therefore put us into a situation of 'thrownness' in which we are blind to reflect on the consequences of our actions. (Winograd and Flores 1987)

[16] Edward T. Hall developed a theory of *proxemics* that describes the of space as a "specialized elaboration of cultural" norms that direct our behavior in his book *The Hidden Dimension* four types of innate distances (in Middle Class Americans) are evidenced : 0-18 inches of intimate contact, 1.5-4 feet of quiet conversations about subjects of personal involvement; 4-12 feet of normal conversation and impersonal business dealings; 12 + feet of public distance of non-involvement and distance from important figures. He goes on to show how perception and use of these distances differs by background and culture for example some cultures are not disturbed by public crowding, others expect close distances in social conversation, and a third do not feel a loss of privacy even when doors are open. (Zeisel)

[17] Sherry Turkle's book by this title *Life on Screen* is about living in the virtual world and how it is transforming our understanding of being

[18] new research initiate at Hewlett Packard lead by Don Norman

[19] Prairie, developed by Anderson Consulting is a conceptual framework for virtual collaboration based on three types of needs: the individual with specific preferences and needs, (virtual offices and a user defined map of the organization); the community with common goals and interests (meeting rooms, common areas, libraries); and the organization with core missions, and shared visions (public relations foyers, lobbies, human resources lounges, social spaces) source CSCW 1996

[20] http://web.mit.edu/twigs/THESIS/frame.htm

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MITRE Interviews

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COLLABORATIVE SYSTEMS

Session-Centric

Sessional systems are not persistent (although there are some exceptions). They are usually based on a model of work occasions with familiar structure such as a presentation or phone conversation. Conventions for interaction, floor control, response time are assumed to follow the metaphor of the occasion.

NetMeeting (Microsoft) http://www.microsoft.com/netmeeting/
desktop VTC (Video Tele Conferencing)
Auditorium (PlaceWare) http://www.placeware.com
CAIRO (Information Engineering Systems Laboratory MIT) http://ganesh.mit.edu/hussein/cairo.html
Collab: Argnoter and Cognoter (XeroxPARC)
Telepresence
MediaSpace

Document-Centric

Document based systems are persistent. They are often based on a model of workflow as information exchange. Usually communication is asynchronous, however the addition of synchronous communication tools are becoming increasingly popular. The earliest models of theses systems were messaging systems such as E-Mail and Bulletin Board Systems such as USENET

Multi-user databases, Lotus Notes, AltaVista Forum
Cardwall (MIT-SPORG, Paul Keel)

Place-Based

Place based systems are persistent. Objects and spatial topology remain between log on sessions. They are usually, but not necessarily, partitioned spatially. Communication is both synchronous and asynchronous. If someone is not around, a message can be left, that they will get when they log on. Synchronous communication depends on the frequency of interaction and response time. Movement and navigation is based on spatial metaphors. Place-based systems exhibit place-like behavior in that the dynamics of interaction (social and/or technical) and formality of conversation frame beahavior.

MOO's,
CVW (MITRE)
Jupiter XeroxPARC

Hybrid Systems

Combine physical and virtual media. They project virtual onto physical spaces and physical spaces into virtual. Typically they are an either an extension of an approach that began in either the physical or the virtual. For example Jupiter and CVW extended virtual place based systems to include VTC thereby linking physical contexts into the virtual.

Jupiter (XeroxPARC)
CVW(MITRE) if Video and Audio is enabled
Internet Foyer (U. Nottingham)

SILENT GAME

Players A, B, and C are members of a design team.
They are charged with designing an artifact under the following constraints.

Sequence of play

Play begins with Player A. [7 minutes]

Player A builds with legos according to some set of rules. In this case the rules are the intentions for which the design will be interpreted. Player A must communicate these rules through the artifact.

Play turns to Player B. [7 minutes]

Player B cannot see A build, but can only see the artifacts produced by A, and Player B builds upon (responds to) the artifact made by A. Player B's object is to demonstrate an understanding of Player A's intentions.
Player B can add blocks or modify positions of placed legos but cannot remove blocks.
Player A observes B respond through modification of the artifact.
Player C simultaneously observes the processes of both A and B, and constructs a message to Player A about what is going on. Player C must communicate the message with pencil and paper.

Play turns to Player A. [5 minutes]

Player C passes the message to Player A and Player B turns over control of the artifact to Player A. Player A revises the artifact to clarify the intent based on both Player C's message and on Player B's response.

Play turns to Player B. [3 minutes]

Player B responds to the revised artifact, but as before does not see the process that A builds.

End of Game

Discussion

1. Player B describes his/her reading of A's intentions.
2. Player A describes intentions and B's response.
3. Player A describes Player C's message and how it affected A's response.
4. Player C describes the message and how it may have informed Player A.

Player B expressed frustration understanding A's intentions. B built in reaction to formal rules such as color combinations, rules of stacking and adjacencies and implied rules such as boundaries and connections and cantilevering. B thought that one of the goals may have been to build as high as possible within the constraints of the formal rules. B's approach was pragmatic: Try the rule, evaluate the rule and continue reapplying the rule in other scenarios.

Player A built to define an artifact (a helicopter). A's approach was that by conveying the vision and intent of building a helicopter, the rules would emerge as they support the goal. To that end, A emphasized specific features that identify the helicopter, such as the tail, the runners, and the propeller. A was not defining formal rules for connections or use of colors. The boundary condition that B had interpreted was intended to be the heli-pad. A's approach was strategic: Communicate the vision and the rules flexible for interpretation as long as they supported the vision.

Player A felt that C's message was on target. C was looking for an image in the artifact as opposed to formal rules. C's message suggested areas of ambiguity that A might improve, such as the helicopter tail. A's response to B's additions was to clarify misinterpretations of vision. For example A removed some pieces that B had placed that did not fit the vision of the helicopter. This in turn was interpreted by B as a territorial rule that A was suggesting "do not build there".