Datacloud: Expanding the Roles and Locations of Information

Johndan Johnson-Eilola
Clarkson University
Potsdam, NY 13699
johndan@clarkson.edu

ABSTRACT
This presentation traces the locations and roles of computer documentation over the latter half of the twentieth-century in order to construct a model of information/knowledge space as it relates to different forms of work. The paper then provides suggestions about future forms of documentation and interface based on ethnographic research of workers in recently emerging forms of work, including nonlinear audio/video production and videogame playing. The final section of the paper provides concrete suggestions about forms of documentation and interface that will be required to support these new forms of work.

General Terms
Documentation, Performance, Design, Economics, Experimentation, Human Factors, Theory, Legal Aspects, Verification.

Keywords
Interface Design, History, Labor, Postmodernism, Research

1. INTRODUCTION
As the term "documentation" has shifted during the last several decades to include not only print-based but online formats, the role and place of computer documentation has expanded in important ways. Documentation is no longer merely a printed and bound manual set next to a computer or (too frequently) still in shrink-wrap on a user's shelf. Instead, documentation is also available in Windows help files, Web pages, and even the interface itself. Indeed, the space of documentation can now be understood as a social space, with the computer beginning to offer users methods for communicating with other people.

In analyzing these shifts, we begin to see a recursive development in which the computer absorbs social actions, fragments and flattens them only to have those actions and spaces reabsorbed into culture in various ways. Current theories of understanding computer use suggest movement toward either virtual realities or ubiquitous computing contexts (see. e.g, [1]); in actuality, though, we seem headed toward an environment in which the distinction between the two is meaningless: work and learning both happen within and across information contexts, online and face-to-face.

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In this paper, I sketch a rough history of computers as technologies for work. In each era of that history, I will focus on two aspects of how the computer is constructed and used. First, I examine the micro-context of user work and learning—that is, where, spatially, is working and learning information displayed and manipulated by users. Second, I consider the social and political implications of that spatial construction, connecting up specific shapes and processes of work to historical and developing trends in labor, economics, and politics.

2. A BRIEF HISTORY OF INTERFACES
The history of interface design will be relatively familiar to most documentation professionals, at least in broad terms. I'll spend some time here working through that history, though, in order to set up a framework for analysis.

Table 1. Historical Models of Interface

	interface	location of work and learning
50s-60s	hardwired	outside interface: education, training (few manuals)
60s-70s	punch cards	outside interface: education, training, manuals, courses
70s-80s	command-line interface	outside interface or at second-level deep in interface: education, training, manuals, courses, man pages
80s-90s	graphical interface	into interface: shifting toward **limited** interface (surface)
90s-00s	spatial online (begin datacloud)	interface expands beyond physical boundaries to allow social (online) communication
00s and beyond	spatial/hybrid, information-saturated workspaces	boundaries of interface break apart to support movement (including arrangement, eddies and flows) not only social/online but also local microcontext

2.1 Hardwired: Apprenticeship Learning and Work
Historically, an interface was the physical connection of two devices, an articulation in the strictest sense of the word—a hardware register interfacing with an output device such as a teletype. Computers, at the earliest stages, were "programmed" by actual rewiring them.

The key aspect here for our discussion is the location of knowledge about how to use the computer—in other words, the location and structuring of technical communication. In these devices, users learned to program and work with the computers based on apprentice-type relations: you worked with an expert person, who, over time, taught you functional skills.

Importantly, that knowledge and use was also embedded in real social contexts. On one hand, there doesn't seem to be anything odd about this microcontext, apart from the retro nature of the haircuts and apparel of the workers in Figure 1. On the other hand, as we begin to move toward other models for information/work space, we'll begin to notice some very slow but profound changes in the shape of those spaces.

Figure 1: Face-to-Face Learning

I'm being nostalgic about apprenticeships here, obviously—I'm not calling for a return this situation, but instead a reflection on how this microcontext relates to other situations.

Importantly, the apprenticeship model presupposes a particular economic and industrial process, one that values in-depth, long-term investments in workers, particularly in professions that value craft. The computer at this stage is not a mass-production, mass-market device but rather a specialized, vertical tool.

2.2 Manual and Textbook Learning: Dispersing Learning and Work

Where initial computer technologies were used almost completely as discrete artifacts, two parallel developments lead to different work and learning microcontexts. The size of a computer began to shrink at the same time as processing speed and complexity increased dramatically, allowing a more mutable and powerful type of work to be done with the computer. This development spurred wider adoption and relative standardization of both hardware and software, including the development of batch and interactive processing.

Within the microcontext of work and learning, the standardization allowed the development of non-apprentice learning, first with the development of software and hardware manuals and then with technology training courses. In a sense, the adoption of print-based training materials acts as a contraction of the social context of learning and working, with new users separated from existing users.

Likewise, the economics of textbooks and manuals requires a mass market, one in which education is discrete, repeatable, and marketable, with student-customers who are (a) willing to pay (or have their employers pay) for education and (b) will be able to turn that education into profit later.

2.3 Online Help 1: Buried Information

Additional (and apparently perpetual) increases in the complexity and available storage space of computers is associated with an additional contraction of the microcontext of learning and work: information about how to use the computer becomes integrated into the computer itself. This development is a gradual one, and not apparent at first glance. Figure 2 shows a contemporary command-line interface nearly identical to the "buried information" model of this phase.

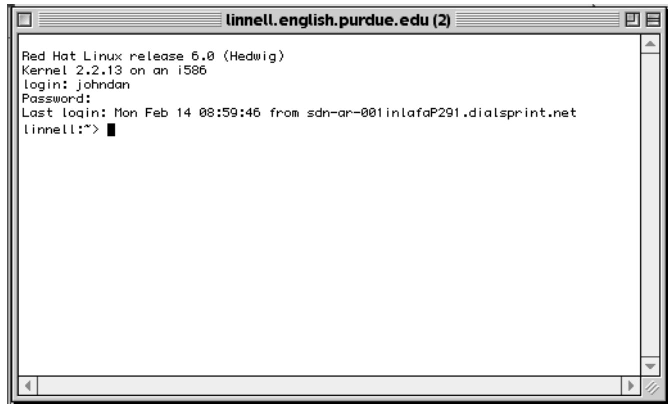

Figure 2: Command-Line Interface

When I said that some knowledge about using the computer became embedded in the computer, I didn't mean that using the computer suddenly became obvious. For example, on our linux server the command prompt gives me precious little information about how to use the system.

But if I know enough about how unix and linux operate, I'll know I can type in "man" (user's manual) page command to get help on system commands. From an expert users standpoint, this is great because if I have a general working knowledge of how the operating system works, I can bootstrap that knowledge by reading online help. But I have to know (a) what the man command is, and (2) the name of a command to connect up to—in this case, the "chmod" command, which is it's own little technological hell.

Of course, I have to have something to bootstrap with, which typically meant doing something **outside** the computer interface—taking a course, working with another expert user, buying a book, etc. For new types of microcontext do not completely erase previous ones—people continue to work in apprenticeship systems and use print manuals to this day [2]. The history I'm constructing here is an uneven one with numerous overlaps. Indeed, the deep-information model probably also requires the existence of earlier models in order to acculturate, at the very least, novices who will need assistance even getting to the point where they can use the deep information. The deep information model serves as a marker of market maturation, in a sense—the size of the market for learning how to operate this particular type of computer is robust enough to support not only apprentice-based learning, but a growing variety of learning types. In addition, it consists of a large enough group of intermediate to expert users to support the development of learning/working material for those specialists rather than a one-size-fits-all approach.

Figure 3: Online Help in Linux Man Page

At the same, the microcontext of deep help systems affords a particular type of learning for particular types of users. The structure of the man page, for example, is oriented around very concrete, functional uses: a one-line definition of the command followed by a synopsis of command syntax possibilities is at the top, allowing users to drop from the command-line (surface) to the slightly-deep definition and synopsis. In order to browse more in-depth information, users are required to stay "at depth" for a significantly longer amount of time. Furthermore, man pages do not support (or at least obviously support) long-term, complex learning situations. Obviously, such long-term, complex learning takes place somewhere—but that learning is more likely scattered around the computer, in notes and texts as well as distributed on the network, with other users.

2.4 Online Help 2: Surfaced Information

As we move toward more graphical interfaces, the location of working and learning information begins to shift; learning is buried in the interface (in online help and tutorials), but increasingly the interface itself—the surface—provides users with suggestions and hints about how to work. In other words, increasingly learning and work take place at the surface of the computer.

In the screenshot shown in Figure 3, users of the Website design program Dreamweaver are given literally thousands of cultural and technical cues that suggest to them how to work.

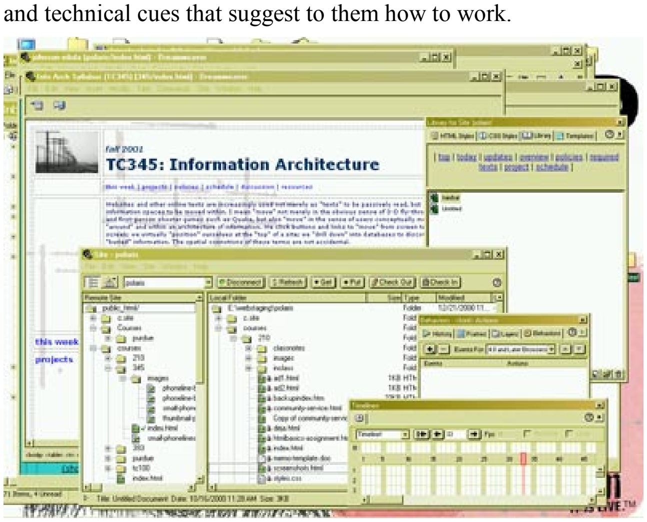

Figure 3: Surfaced Information in Dreamweaver

As information about work moves to the surface it becomes fragmented and flattened in ways that simultaneously support ease of use and discourage broad, complex forms of learning. Although traditionally such education has been dismissed as immature or "surface level" (pun intended), these types of learning are specifically demanded by some variations of just-in-time learning and project-based learning, among other areas.

In a recursive loop, the success of such interfaces in those particular work situations increases the surfacing of information in subsequent versions of interface design. Importantly, although surfaced interfaces frequently cause learning and usage problems for users in more traditional job functions, ethnographic discussed below illustrates ways that extremely information-dense interfaces are very effective at supporting emerging forms of work crucial to the rapidly growing information economy, particularly those that rely on the ability to experiment with and within complex and changing masses of information (a facility increasingly required in a range of jobs, from financial analysis to nonlinear audio/video production).

In this Dreamweaver interface in Figure 3, I'm working on the main page of my own website. Although there's a great deal of learning support available—in manuals, on the web, in users groups, etc.—most users build web pages in Dreamweaver without doing a lot of that outside work. Instead, based on their experiences of other computer programs and on experiences seeing other web pages, they muddle through the procedure based on surfaced information: palettes that offer them a range of often-used commands, menus that, by their very names suggest certain types of actions as more common than others, windows in which information that can be acted and, interacted with. In other words, the interface strongly suggests actions.

On one hand, this is a wonderful opportunity—the ease of use here provides important cues that put an immense amount of design power in the hands of people wouldn't normally have it. Although relatively speaking, HTML codes are pretty straightforward, the codes do prevent many novice users from authoring websites. So this is, in one sense A Good Thing, a democratization of technology.

On the other hand, it also worries me, because it's now much more likely people will create web pages **without** a broader context—without understanding anything about interactivity, about screen layout, about information design. What has happened is that the interface has surfaced a very small fraction of the learning support—the education—at the expense of broader thinking and learning. And we know from experience that if a user can "get by" with what's present, they're less likely to go further. In fact, trying to learn higher-level skills is frequently seen as wasting company time, as dissatisfaction with one's stage in life [14]. It's the Great Chain of Online Being: Hope No Higher.

Where previously work was enmeshed in a social context—and learning how to work involved a process of education over time—work now is increasingly fragmented and flattened—and learning how to work is shrunk, decontextualized so that only the very most functional aspects are visible at the surface. In effect, the interface is not simply a tool but a structure for work.

The space of learning and work has collapsed: work is no longer something visibly socially situated in a large space (an office, a classroom, etc.) but now has condensed, in many ways, into a 17-inch (diagonally measured) glass window. In addition, as that workspace has collapsed it's sucked learning right down with it. But because the pace of work has accelerated, the information space has flattened and surfaced, with users increasingly unlikely to look outside their immediate interface for assistance on using the computer—assistance that used to frequently position the technical, functional aspects of their work within a broader, richer framework. These contradictory impulses—the technological and managerial force pushing users into the interface against the user's need to break out of the interface—lead to tensions expressed in nearly every contemporary office: frustration with computer programs, anger at crashing networks, and panic about the rapid rate of technological change. While all of those tensions arise out of multiple and complex causes, the collapse of the interface remains a key factor. We—as technical communicators—have to recognize the fact that more effective documentation or even more effective, usable interfaces will not, in themselves, social, cognitive, emotional, and economic problems situated in both micro- and macro-contexts and the breakdowns among various aspects of the two.

2.5 Interface as Communication: Tunneling Out to Other Users

The previous sections illustrated a general trend in computer-supported learning that tends to isolate and fragment work from pre-existing social contexts. Learning how to use a computer, for example, moved gradually from face-to-face apprenticeship models to computer-contained models in which the computer itself provided education. During the last decade, information about using the computer has undergone a subsequent shift, with networks socializing the interface. In socialized, networked interfaces, users have access to learning information in an increasing number of spaces: not only depth (tutorial) and surfaced information (menus, toolbars, tooltips) but also access to other users.

As I mentioned briefly at the beginning, I see the possibility for re-contextualizing work through interfaces. The internet (WWW, MOO, email, etc.) is both a cause of the problem—because it collapses space—but also a possible remediation, because it may provide us ways for resituating work into a social context, by thinking of work as a process that goes on over time, as fundamentally communicative.

I'm going to draw on graphical-MOO interfaces to illustrate how the learning and work adapt to flattened spaces. If you're not familiar with MOOs, they're virtual environments in which users move around and interact with objects in a metaphoric space—you can type commands like "go north" and as you move north, you'll see textual or visual descriptions of a new place, just north of where you previously were. The earliest MOOs and MUDS were developed and used by Dungeons and Dragons types to enter into fantasy worlds and do virtual battles with monsters and, later, each other. The old Zork software is a starting point.

Currently, though, MOOs are much more complex and generalized and have been used extensively in computers and writing as well as law, second language learning, and more. The version of the MOO software we're using is Cynthia Haynes and Jan Holmevick's enCore exPress, an open source MOO core that includes extensions that give it a graphical interface rather than a command-line interface [4].

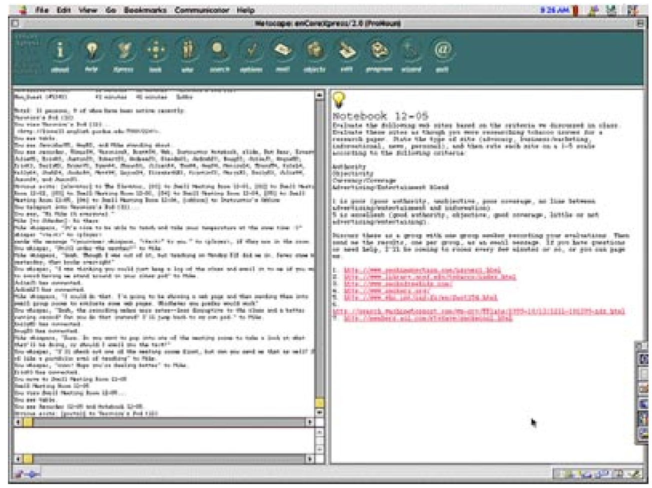

Figure 4: Socialized Work Interface in MOO

In this example, if you squint very hard, you can see the MOO being used in a technical writing course, where students working in semi-private team room are working on a report for a client who wants their website upgraded.

In this example, users are meeting in a virtual classroom and discussing their plans for a recommendation report written to a realworld client who wants a revised website. During their discussion, they're both talking (or typing) back and forth but also entering text onto a virtual blackboard that will act as the starting point to their actual report.

We're not doing anything radically new here—I'm sure more than a few of you have used MOOs or their less-spatial cousin, instant messaging programs. In terms of the microcontext, there are several important developments in interfaces such as this. First, as with Dreamweaver and other contemporary interfaces, what was once a depth-based model of learning and a sequential model of interaction is now a surfaced space. Early MOO programs—and many still in use today—work under the Telnet protocol, which is closer to the command-line interfaces. In an enCore eXpress MOO, learning about the interface is surfaced, in the form of always-present, onscreen buttons for standard commands, menu headings, and visible representations of people and objects within the MOO as icons. At the same time, the surfaced interface is wrapped around (complexly, recursively) a deeper space; in a somewhat ambivalent way, the MOO embraces both the push toward surfacing information at the same time as it attempts to develop a deeper, navigable space of social information. The microcontext begins to turn itself inside out.

Such interfaces are the latest in a developing attempt for the computer to not merely be a *support* for learning and work, an artifact or tool, but to become a complete *environment* for learning and work. The increasing use of such spaces (and parallel but different developments in instant messaging, avatars, etc.) belong to an economic shift away from the production of industrial objects—cars, clothes, ping pong balls—and towards the production of symbolic information ([5-7]). Such people work within "information ecologies" that themselves come to resemble—occurring within, across, and alongside the more familiar, concrete ecologies of our communities and parks.

3. SURFACING REALITY: VIRTUAL REALITY AND UBIQUITIOUS COMPUTING

In Jay Bolter and Richard Grusin's wide-ranging discussion of new media, they posit two opposing ways to understand new media: virtual reality and ubiquitious computing. In the former, designers attempt to create an online space so real that users work as if they were in a real space, as if the computer were not mediating reality. In the latter, designers explicitly forefront the mediated nature of the interface, layering and overlapping information in complex ways. In terms of the examples discussed above, the MOO interface belongs to a proto-VR category while the Dreamweaver interface belongs to the ubiquitous computing realm.

Increasingly, however, the distinction between the two is difficult to draw. In the brief history sketched earlier, the interface begins to absorb, spatialize, and flatten information about work and learning. Without descending too far into literary theory, we might position such forms of working and learning as a symptom of postmodern capitalism as described by Frederic Jameson or the new order of science as described by Jean-Francois Lyotard—both of whose slightly wacky pronouncements implicitly if not explicitly affirm analyses and predictions by business and labor theorists including Robert Reich and Peter Drucker, among others. Increasingly, users in such spaces—both micro- and macrocontexts—work and learn within visually and structurally dense, often frankly and intentionally chaotic spaces. They multi-task, they surf, they filter, they push and pull data streams. To such users, the distinctions between surface and depth makes little sense. In fact, the often-held separation between online and IRL ("In Real Life") is itself fairly tenuous, with relationships developed online spilling over into the "real" world, with information at the surface or at depth in the computer moving back and forth to PDA, web-enabled phone, video monitor, stereo, and more.

3.1 Interface Breakdown: Working the Datacloud

One strand of research I'm involved in looks at how people learn to work with complex information spaces, such as the one shown below. The screen, from ProTools, a professional-level nonlinear audio editing program, has become an industry standard application for music professionals. In the winter and spring of 2001, I began working the David Dies, a graduate student at the Crane School of Music at SUNY Potsdam. David works extensively in ProTools; during the sessions I observed, David was composing a commissioned work for CD and trumpet. The project consisted of two main parts: a electronically authored, recorded CD as well as score for live trumpet. In other words, the artist plays trumpet from sheet music over/against the CD. David composes the CD itself in ProTools, relying on several MIDI keyboards connected to the workstation running ProTools. Once the audio tracks are in ProTools, he spends an enormous amount of time manipulating—cutting and pasting, applying filters, multi-tracking, and rearranging various aspects of the online information—in order to arrive at a "final" (or one possible "final") piece of music that is then burnt to CD.

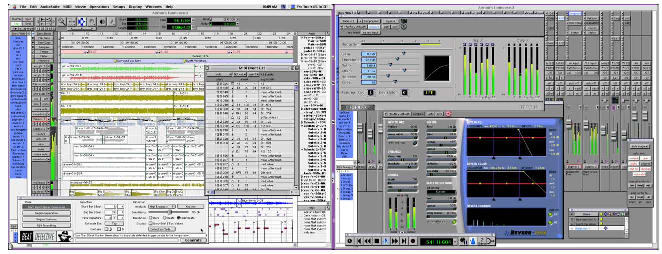

Figure 5: Dense, Surfaced Information in Avid ProTools

Although this screen is interesting to me simply because of the sheer amount of surfaced information present, what was striking was the ways that information about David's work was spread not merely across two screens, but around his immediate work environment. At times, he strides around the room with a notebook, making and referring to notes about filters, keyboards, and structures (Figure 6).

Figure 6: David Dies moving around workspace

In other sessions, he worked primarily at the ProTools computer workstation, although in many instances he alternated between typing on the computer keyboard and playing notes on the MIDI keyboard that served as a workdesk for the computer (Figure 7).

During a single, two-minute section of one session , Dies moves from focusing across both computer screens, his watch, a handwritten notebook, and both a computer keyboard and a MIDI keyboard. The boundaries of the interface have functionally collapsed here: information is not contained merely within the interface (or even spread among many interfaces among internetworked connections). Information spills over the edges of this interface, with Dies working within an information environment that grows out of, includes, and is affected by information and actions both within and without the interface.

Figure 7: David Dies working at ProTools Workstation

David Dies is not unique in working across interface boundaries. Indeed, in some pilot interviews conducted with users in my department on campus, I discovered that nearly every user developing relatively complex communications worked within a dense information microcontext that contained extensive information both within and without the interface.

Brent Faber, a colleague in my Technical Communications Department at Clarkson University, for example, provided an in-depth interview in which he organized his workspace into five connected functional spaces, each possessing different but overlapping functionalities. For example, in addition to commonly understood information spaces such as bookshelves and computers, Faber works extensively with both a information-work table (consisting of stacks of notecards and books; Figure 9) and a large whiteboard. During the interview, Faber explains that he uses the whiteboard to hold what he thinks are emergent, partially formed but potentially very important ideas (Figure 10). He keeps these ideas on the whiteboard for days or weeks, where he uses the omnipresent display to cue thinking and rethinking over time. Eventually, he transfers the ideas from the whiteboard to two separate, simultaneously active workspaces: a chalkboard that holds a rough timeline of his ongoing research and publication projects as well as a computer file, usually in WordPerfect, the he uses to begin drafting a research article, book chapter, grant proposal, or other communication. These processes are neither neat nor linear.

As forms of work, the work conducted by both David Dies and Brent Faber requires support for extremely complex, contingent, and data-driven activities spread over a wide space (both virtual and concrete). Conversely, workers completing more routine tasks require less space (both virtual and concrete) in which to arrange and manipulate their information.

For example, Ryan McDougall, a Clarkson student I interviewed while he was editing images in Photoshop for the Eastman Kodak Center for Excellence in Communication website, distinguished between the work he completes for the Center and the work he completes as a student. For the latter, he occupies a very small, isolated space: the cubicle-shaped desk provides him with approximately six square feet of desk space, including room taken up by the computer keyboard and a nineteen-inch monitor. The room in which he worked—a large campus computer lab—was officially closed, he left the lights dimmed to discourage students from knocking on the locked door, hoping for after-hours access.

Figure 8: Brenton Faber Discussing Information/Work Objects in Office Space

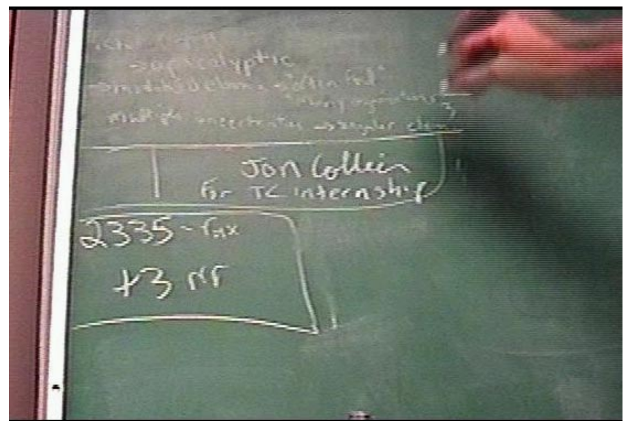

Figure 9: Faber demonstrating "big ideas" space

(The graphic in Figure 8 is relatively dark because the video camera had switched to low-light mode.) Ryan has developed a compact work arrangement in order to cope with the confines of this small space. Much of his work takes place on the screen, as he filters and edits digital images to conform to our university's style guide for website graphics

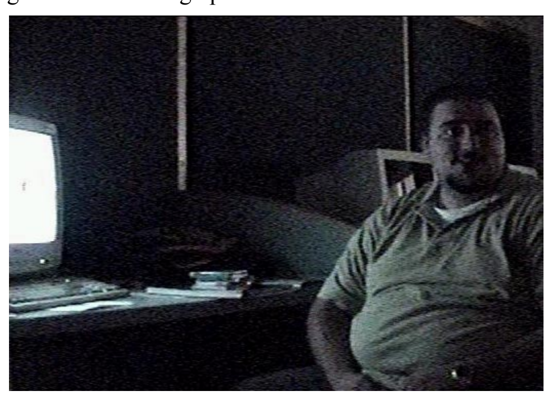

Figure 10: Ryan McDougall discussing configuration of workspace in campus computer lab

If he works with a notebook or other texts, he moves the keyboard aside, takes a specific text from his bookbag, consults the notebook to look up information or record notes, replaces the notebook into the bookbag, and pulls the keyboard back out in order to continue work. The routine nature of such work is supported adequately (if a little compactly) by the space he occupies. More complex work undertaken in his role as a student, though, requires more information and workspace, more texts, and is not done as frequently in the lab.

Such relatively complex, interconnected methods of working are increasingly common: they probably characterize, roughly, the types of work done by most of us and many, if not all, of our users. As Clay Spinuzzi notes in his study of programmers, workers in information-rich environments work with an enormous range of communication artifacts throughout their day. Adequately supporting that work—not merely at the functional but at all levels—requires that we learn ways of understanding how that work takes place. The computer interface was once a calculation device, an artifact enmeshed in a social context. During the last five decades of the twentieth century, the computer began to absorb and contain not merely the objects being worked on (equations, word-processed documents, web pages) but also meta-information about those objects, including structures and procedures for learning and working. In other words, the computer and the space around it began to absorb and then reflect back context. In many instances, the reflections have taken on significations divorced of any "original" context—the "crop" tool, for example, in PageMaker (Figure 8), emulates a physical scaling device used by graphic artists. What percentage of current users of this program are aware of earlier tool (Spinuzzi, personal communication). Not only do users of the current program usually lack the social context in which the earlier technology was used—they lack the community of education that provided support to novices learning printing and graphic arts, to teach them complex design issues, professional ethics, and other skills not present within the limited space of the interface.

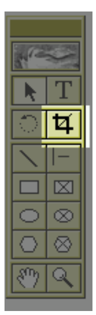

Figure 8: Crop tool (highlighted) in Adobe PageMaker toolbar

In the end, the computer is not capable of supporting the amount of information necessary to contemporary work, either at the macro- or the micro-level. As a networked device, the interface offers a portal for users to connect up to other users in a virtual collaborative space for learning and work. As a locally contextualized object, the interface becomes enmeshed with a functional information context, one that denies exclusively online or offline information.

The space here departs from current notions about virtual reality. If this is a city, it is one designed less from the relatively comfortable, just-like-the-real-world (but-shiner) virtual architecture of William Mitchell's *City of Bits* and more like the postmodern architecture of Bernard Tschumi's Glass Video Gallery—both depth and surface (Figure 9). Nor does it seem like the nostalgic information ecologies of Nardi and O'Day, who highlight some significant potential social issues in their discussions of networked collaborative spaces but who also tend to use "real" worlds as their models.

Figure 9: Tschumi's Glass Video Gallery

4. CONCLUSIONS

The increasingly complex space for computer-based work and learning promises to reshape how we design and use documentation. For example, our current approaches to understanding usability tend to prioritize usability-lab based observation. Although certainly these methods will continue to be important ways to test how users interact with discrete objects—interfaces and manuals—they fail to engage with crucial broader work processes. Contextual inquiry and participatory design provide much richer avenues for understanding how people actually work—and designing support systems that adequately support that work.

In addition, information now must include the ability to flow from one location to another. I mean this not merely in the sense that we should be able to cut and paste from one window to another or email a file to a colleague—although those will certainly continue to be important aspects. I also mean that users need the ability to represent complex information spaces and to directly manipulate that information in a variety of ways. A program such as ProTools, for example, provides numerous ways to manipulate, filter, move, and rearrange information in ways that word-processing and website design programs cannot approach. Indeed, ProTools itself is not capable of supporting information flow at a very complex level—most users will connect the computer system up to other communication devices such as keyboards, notebooks, whiteboards, and more. Information spreads out to PDAs, digital cameras, SmartBoards, and more. We need the ability not merely to work within information spaces, but to move that information around in eddies and pools. We have yet to develop interfaces that adequately support this work.

5. ACKNOWLEDGMENTS

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