EXHIBIT 9

Designing Workscape™: An Interdisciplinary Experience

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ABSTRACT
Workscape is a clean-slate design for an office document management product. It was developed through a unique collaboration among the staffs of Digital and MAYA. From earliest concepts to current refinements and productization, Workscape has benefited from interdisciplinary design methods involving specialists from the fields of human factors, computer science, and visual design. Extensive use of mockups, in a variety of media, proved particularly effective in bridging differences of terminology and methodology between these three disciplines.

KEYWORDS: Design, documents, interdisciplinary

INTRODUCTION

Early in 1990, Digital Equipment Corporation commissioned MAYA Design Group to produce a clean-slate design for an office document management product, to specifically address the issue of breaking down the barriers between paper, email, databases and other forms of electronic information storage. Three years later, the project is of interest both for its results (see the CHI'94 Demonstration: *Workscape: A Scriptable Document Management Environment* by Lucas and Schneider) and for the unique collaboration among the staffs of Digital and MAYA that led to those results.

This paper is mostly about that collaboration and about the origins and development of the Workscape concept, and less about its technical details. It tells the story of how the concept flowed together out of three disciplinary streams - human factors, computer science, and visual design - and how the work of each of those streams informed and influenced the others. The methods employed at the beginning of the project have proved useful throughout its progress. In the current stage of engineering refinement, the disciplines continue to interact on details of appearance, usability and performance.

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Before the project was formally under way, there was a desire, initially expressed by Jim Morris, to focus a deeply felt, but vaguely articulated need for some fresh thinking about office work. First, it had begun to look, and still looks, like paper in the office won't go away and, really, we don't want it to go away. It's an ideal display medium in many situations. Furthermore, paper is just one of a list of other useful media, each with its own validity: mail, fax, voice mail, computer based forms, spreadsheets, etc. The list is still growing. One problem is that a lot of time and effort goes into translating or interpreting between these media and this takes a lot of stuff: workstations, telephones, file cabinets, in boxes, piles of work, fax machines with curly paper. Just look at the typical busy and productive office scene; you get the picture.

A unified set of requirements gradually emerged out of the different disciplinary perspectives of MAYA's principals (Ballay: Visual design; Peter Lucas: cognitive psychology; Morris: computer science). Working with documents effectively in a realistic setting requires a more seamless way of managing all of these separate, legitimate media, and moving around within them and between them; this desire was a major factor in shaping the project. Another was the recognition that we seem more willing to put effort into hunting information when we need it than into putting it away neatly in the first place. Finally, we wanted to make use of the common experience that when we successfully describe or find a document, it often depends on some attribute other than it's title or keywords; maybe its thickness, or how it was bound and the color of the binding, or where we last saw it in the room.

Lacking a formal description for this new, whole concept, we began to give it names; names which in their own way described our needs and desires: Jim first suggested the *Elephant* (the creature that never forgets where I put things); then the *Information Compactor* (a lot of information does turn out to be trash, but we want to retrieve a few pieces; if we only could know which ones).

An important part of the story is that we discovered others, inside Digital, who shared these desires and cared enough about them to want to make something useful happen. In particular they wanted something useful that would run on commonly available workstations of the near term future.

At this point, the name *Hyperfax* emerged as a claim that, just as fax had bridged the electronic-to-paper gap for media like mail, Hyperfax would bridge similar gaps among a spectrum of media. As things turned out, fax technology itself has a useful but not principal role in the product. But the word stuck as a working name, and the Hyperfax project became the beginning of a long, intensive, and fruitful design collaboration between MAYA and Digital.

PROTOTYPES

From the beginning, it was clear that this project required the input and collaboration of a variety of disciplines. It seemed an ideal match to MAYA's interdisciplinary organization and design goals. As anyone who has tried it can tell you, interdisciplinary work is difficult; we believe it is inherently difficult. To be trained and educated in any discipline involves spending several years in classrooms and laboratories with people who are telling you what's important from their point of view. So when professionals are brought together from different disciplines there is an immediate and automatic divergence about what's important.

Responding to this condition, we became impressed by a piece of conventional wisdom we learned from others who had tried integrating disciplines, "Get Physical Fast". The production of prototypes, especially tangible mockups, even if they were crude, went a long way toward bridging disciplinary differences in priorities and terminology. The design, the object of discussion, becomes the "thing" out here where we can point to it and touch it, rather than the personal, internal concept, guarded by a phalanx of disciplinary biases.

Our first mockup was a wooden block model [Figure 1] that attempted to convey the idea of linking many media in a variety of combinations of hardware modules.

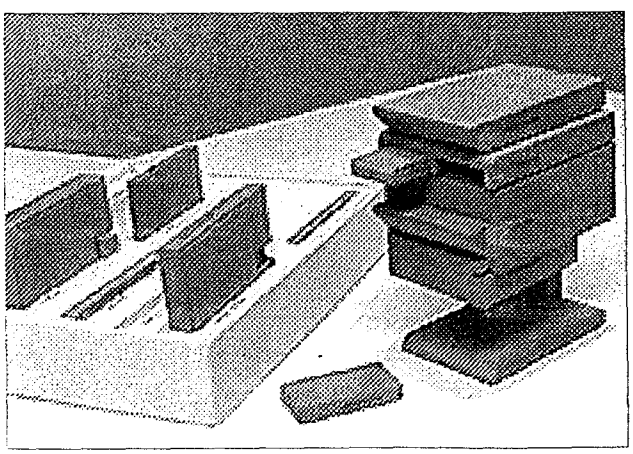

Figure 1. An early physical/conceptual model of Workscape when it was still called Hyperfax. A few wooden blocks and a little paint expressed it's richness of configurability.

As it turns out, the linking is mostly accomplished in software, but the model helped clarify the concept. At that point, we didn't really know the direction the project would take, but MAYA was prepared, intellectually and in its mix of resident skills, to proceed in a hardware or software direction. Software has dominated so far, but recently hardware issues, especially hardware/human issues, have begun to assert themselves again.

We also reconfirmed that the use of mockups is universal as a means of enhancing creativity, at least among the disciplines represented at MAYA. Only the media and some of the terminology change. Recognizing this, and making it explicit among ourselves, gave us a way to start working on Hyperfax. Stated perhaps a bit simplistically, we all began working on mockups of the parts of Hyperfax we understood best, the graphic interface, the interactions, the data structures, whatever. The process began in parallel and became interdisciplinary as we discovered the points of interdependency in our models.

HUMAN FACTORS

Our first push into the human factors of Hyperfax was an extensive series of field studies at places where people did complex office tasks requiring a variety of media. We interviewed 22 people at seven sites and recorded the physical and organizational details of their workplaces. Some sites were intensively computerized, others were largely paper based. Technology wasn't at issue. We were more interested in finding out about people and the work they do. What are the tasks they think they're doing? With whom do they interact, under what circumstances, and in what medium? How does their work environment reflect and support their task and their human self-image?

One of the most striking things we found was the large amount of environmental information which was lying about the workplace [Figure 2] and how intimately it was connected to people's performances. Cues in the environment -- some obvious like a Post-it note, others less obvious like a document's location in the room -- told the person about the state of the document. We coined the phrase "where it is is what it is." to describe this pervasive phenomenon.

We saw environmental information used to initiate, control, and monitor work flow. In some cases it was the moving of a document from one pile to another, from this desk to that table; in other cases it was the positioning of information, or its icon, at a particular place on a screen to designate its status.

At the level of individual documents, there was a pervasive use of binding to facilitate work. "Binding" is a term we adopted to describe the kinds of relationships that were developed among documents. Some bindings were hierarchical, such as forms kept in a labeled folder. Other bindings varied with regard to their permanence. Some were permanent, as in a bound report; or tentative, as with a staple or paper clip; or ephemeral, as with a pile of papers.

The pile, of course, turns out to be the most common, adaptable and useful binding of all.

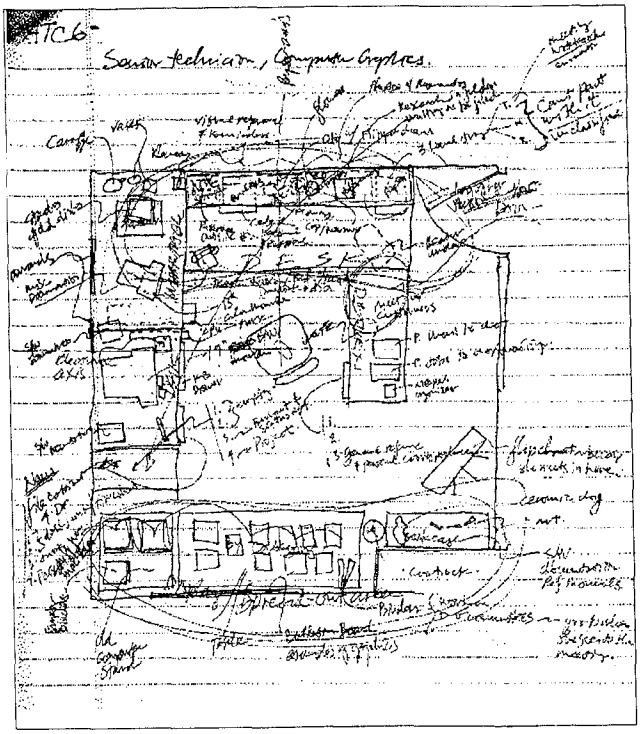

Figure 2. A field note diagram of a document intensive office. Repeating patterns in these diagrams led to some of the spatial document management concepts of Workscape.

The result of these observations was an "interaction mockup" incorporating the concepts of environmental information. It was built on a base concept of concentric work zones and incorporated spatial information management and notions of binding, and particularly the use of piles as a document management technique.

COMPUTER SCIENCE

It became clear very early that the typical two-dimensional display of documents on a screen wouldn't provide the rich working environment we desired. Our goal was to be able to display, and have easy access to many documents, probably hundreds at a time; not the one to twenty that are typically found on a computer screen. It has become a common contemporary goal underlying the work of other researchers. For comparison, see in particular the "Information Visualizer" by Card, Robertson and Mackinlay (1991)[1].

Encouraged in part by the sense of spatiality emerging from our own field studies, we began looking for ways to make meaningful use of the z-dimension. It held promise as a technique to display, disambiguate and navigate large numbers of documents along some range of salient dimensions, for example: date, subject matter, or "importance".

We produced a series of tentative software mockups with varying techniques for dynamically ordering the search space. All of the techniques used the illusion of depth, modifying it and restructuring it as needs changed, to find documents, arrange them in the screen workspace, select them, edit them, bind them, etc. In particular, we experimented with depth and other spatial organization cues as an aid in tasks which involved a large number of documents.

What emerged was a Hypercard mockup called "200 Points of Light" for its display of 200 rectangular, sometimes very small, objects arranged in three dimensions. The mockup satisfied us that a three-dimensional space where documents could be arranged in x, y, and z, but had no z-thickness, was sufficient to permit spatial document management and yet had the potential to provide usable performance on less than high-end workstations.

VISUAL DESIGN

As it was becoming clear that a convincing depth illusion would be a key feature of Hyperfax, the visual design people at MAYA began developing model screens and appearance guidelines for screen displays. The central goal was a manageable illusion of three dimensional space; one which had the visual richness to be convincing and usable for displaying and working with virtual documents in virtual space. From my bias, I believe that the long history of representational painting might have some light to shed on the pathways to this goal.

Wanting to go beyond an investigation of the well known, individual depth cues, we undertook a little sub-project, called "Project Giotto" [Figure 3], which was a more holistic study of the development of illusory space in Italian painting during the Renaissance. We were only slightly surprised to find that there are revealing parallels to the short, recent history of graphical user interfaces. In addition to the gradual introduction of depth cues during the 14th and 15th centuries, we found instances of tiled windows, borderless windows, and eventually simultaneous multiple views; a sort of multiwindow approach where the boundaries of the windows are only suggested, not defined. Overarching these is a movement from a codified, symbolic rendering of space, to realistic and hyper-realistic space, to the representation of conceptual space. This movement closely parallels what we see happening in the images of communication technology (e.g., in videos and advertising) and in graphical user interfaces.

A partial trace of our visual design effort [Figure 4] shows how the Hyperfax concept accrued out of parallel focused developments. To understand the significance of these images, think of them as frames from a movie of a concept coming into focus along parallel dimensions: richness of visual representation, user manipulability, and engineering efficiency.

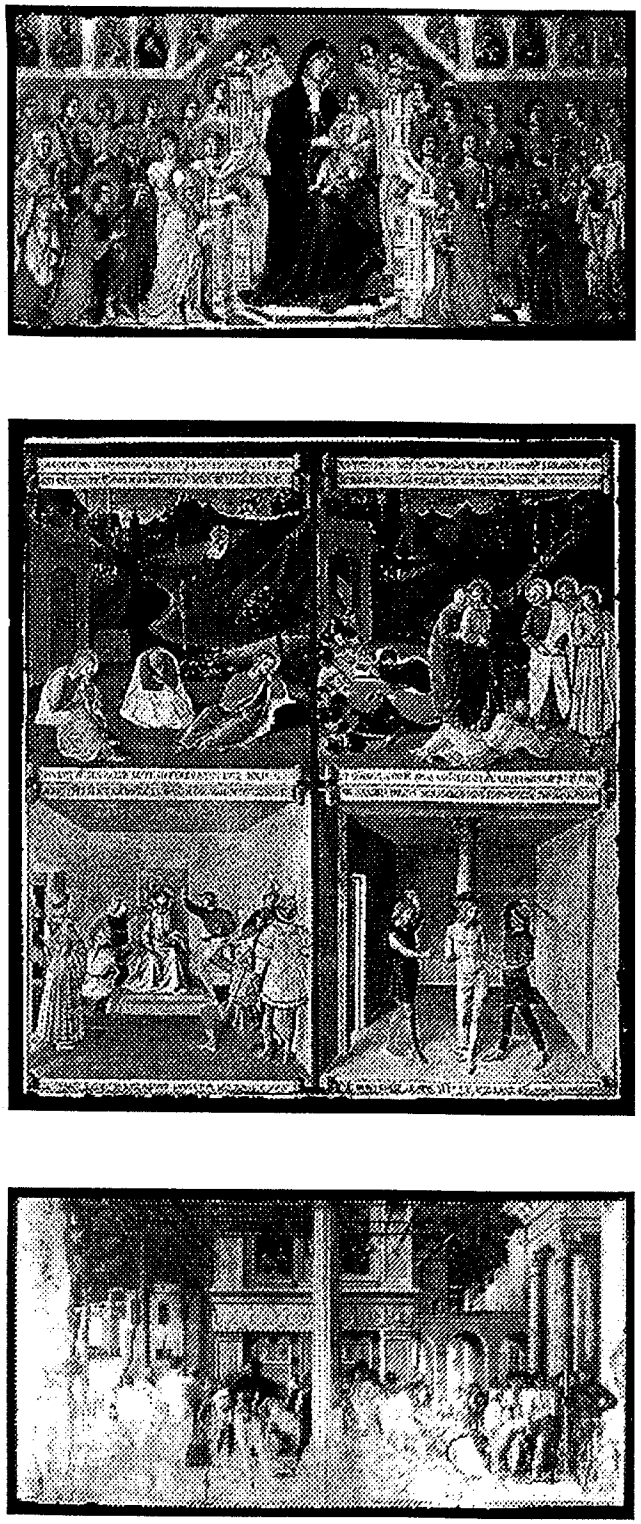

Figure 3. Some of the Italian Renaissance paintings from Project Giotto: *top* - size and positional hierarchy in a two-dimensional display; *middle* - tiled three-dimensional windows with header bars; *bottom* - full three dimensional display with perspective and reference grids.

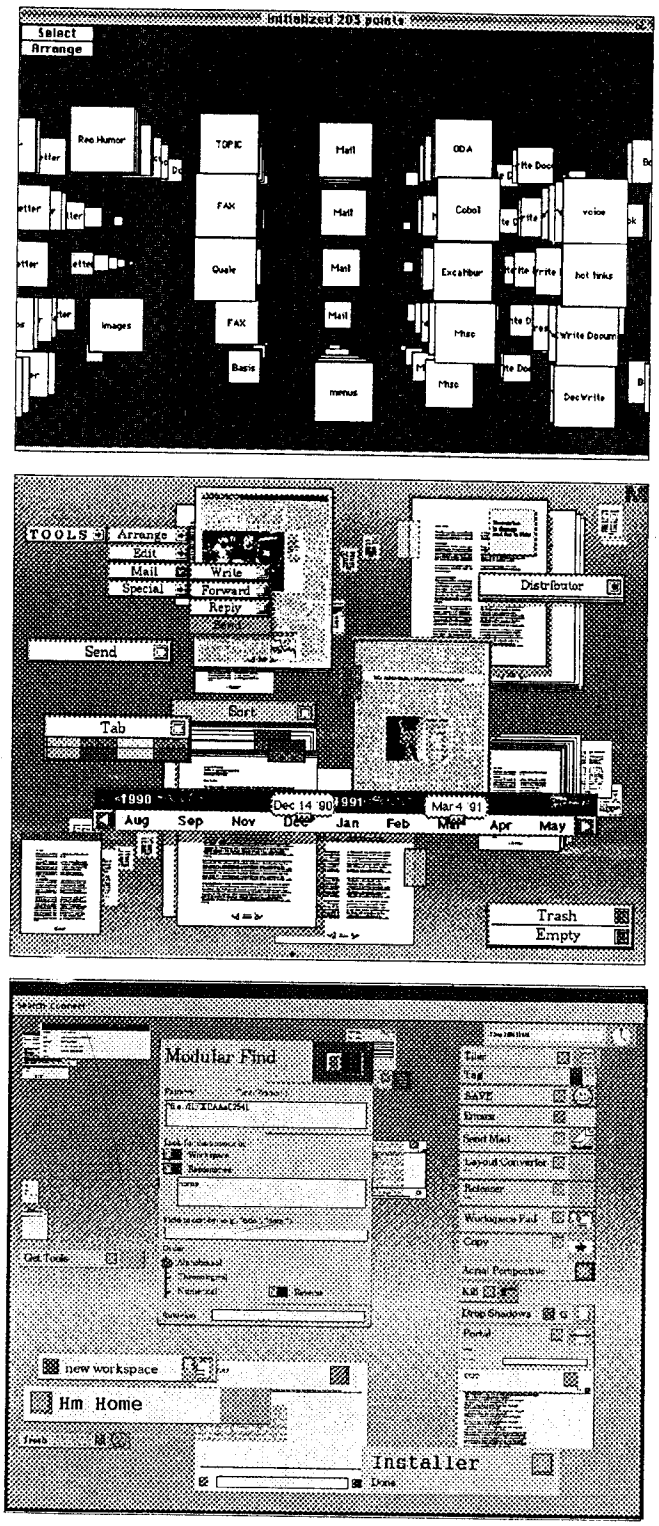

Figure 4. Three stages from a larger series of screen mockups for Workscape, arranged chronologically: *top* - an early Hyperfax display rendered in Hypercard; *middle* - a frame from a Macromind Director graphic mockup anticipating an advanced version of Workscape; *bottom* - a recent screen image taken from a running version of Workscape.

CONVERGENCE

What perhaps doesn't show as well are the many unpredictable instances in which progress in one discipline triggered developments in another; for example, how observations of people using real piles of paper lead to the coded screen behavior of virtual piles of documents. It seems to have less to do with the traditionally rational processes that we find in most design methodology literature, and more to do with the intractive, social and opportunistic qualities of designing, like those described by Chris Jones in his later work, *Essays in Design*2. One of us, Carolanne Fisher, is currently working on a kind of pile behavior I call "ad hoc piles". With ad hoc piles, one document can acquire a tentative, light weight association with others just by being "put with" them. This extension of our basic piling paradigm, in which one needs to make a pile using a "piler" tool, is a direct outgrowth of unplanned observations of people shuffling real papers on real desks.

Briefly stated, the big wins emerging from this collaborative process were, first, a novel yet sensible way to deal with hundreds of documents at once. They are all always open, always displayed, and displayed in a continuous three-dimensional document space So there's a basic modelessness about the medium. Second, with all documents being created essentially equal, Hyperfax could employ a single, consistent set of interactions with all documents, whether they are electronic text, or a scanned image, or a tool document which works in the document space to process or arrange other documents. Finally, all this is made possible by high quality graphics which take into consideration the technical nuances of rendering the document space within which Hyperfax works, it's not just styling. The win is that it's possible to read the salient recognition characteristics of a document such as page layout, the presence of a picture, or the color of the document, even when it's displayed far away, at a very small size.

At this stage, about a year and a half ago, this constellation of concepts came together into a working prototype. It is now running at Digital and MAYA on generic Motif platforms without any special 3-D capabilities, and is being used daily for a range of document management tasks. It was time for a new name, a more descriptive name, an official Digital name: Hyperfax is now "Workscape".

Meanwhile, as Digital concentrates on productization to their engineering standards MAYA is working to incrementally flesh out the Workscape concept. It's important to recognize that the MAYA/Digital collaborative work style has not been a special condition put in place just for the early conceptual stage of the project. We continue in this way to work on the refinements of Workscape and we continue to experience one disciplinary focus becoming the impetus for innovation in another. A few more recent examples to make the point:

In Workscape we would like to have, simultaneously, computational efficiency and the perceptual enhancement of realistic cast shadows. Trying to meet these conflicting desires has led to efficient means of approximating shadows in a way that they are indistinguishable from ray-traced shadows in an actual working situation, which has many documents displayed at once in a Workscape screen environment.

The virtual tools that we are designing for Workscape have shape properties related to their function and behavior in virtual space; not unlike the way that the shape of a real tool in real space -- hammer head, claw, handle -- relates to its function. The shaping of these tools was made possible by a software development which provides customized "border shape" properties for screen objects which are, fundamentally, just rectangles.

User studies identified a difficulty wherein one documents could hide behind other documents in space. We were unintentionally creating an infant's spatial reality in which, as Piaget demonstrated, that which can't be seen doesn't exist. This led to a reconceptualization of the kinetics of moving documents and how they behave when tight space results in partial occlusions or when they pass behind one another.

And so it goes. Most recently we are being attracted back into reconsidering some of the user level hardware which supports Workscape by providing more natural navigation of illusory space. With a little bit of luck, we'll have something to say about that next year.

So, what did we learn *about* working this way, *by* working this way? It's a simple but, I think, very important message:

- Interdisciplinary work is hard; we all have to get past little things like differences in our terminology and bigger differences like deeply ingrained work styles and methods of describing goodness.
- There's good news, too; a stimulating creative atmosphere can be achieved, but it takes some explicit work on learning about one-another's work styles and standards of judgment. We actually put aside in-house seminar time for this.
- It really works for us to physically work side by side, graphic designer next to cognitive psychologist next to software engineer. Its a way of avoiding departmentalization, and there seems to actually be something enjoyable about the experience of creating in this kind of pluralistic professional environment.
- We have a greater respect for the power of mockups, in anyone's language, to provide a tangible bridge across language differences. We can't always agree on what we just heard someone else say. But we can usually agree on this mockup, this thing that we can see and touch, and play with.

ACKNOWLEDGMENTS

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REFERENCES

1. Card, Stuart K., Robertson, George G., and Mackinlay, Jock D. The Information Visualizer, An Information Workspace. In *Proceedings of CHI'91 Human Factors in Computing Systems* (April 27 - May 2, New Orleans, LA) ACM/SIGCHI, N.Y., 1991, pp181-188.

2. Jones, J. Christopher, Essays in Design. John Wiley & Sons Ltd., Chichester, G. B., 1984