Soft Copy (1974–1994)

David Reinfurt

Self-Portrait

A double self-portrait offers some clues to Muriel Cooper's thinking around human-computer interface design. This composite picture registers at least three different photographic times and as many imaging feedback loops. It's a layered image on its surface, and baroque in its construction; the picture was assembled over 10 years, beginning around 1974. Around that time, Cooper wrote a bio which laid out her interests: "… beginnings and process. More with change and technology and their meanings to human communication than with rigorous graphic design theory and style."[1]

Cooper was not a traditional graphic designer. She was certainly not a computer programmer. But she was persistently interested in graphics, new technologies, and their interfaces. In the summer of 1967, she attended a computer-aided design and programming class in the Department of Mechanical Engineering at MIT taught by Nicholas Negroponte. Negroponte had joined the faculty in the School of Architecture and Planning, establishing the Architecture Machine Group in 1968. By 1972, Cooper was beginning to explore how computers might apply to graphic design, and Negroponte arranged for the installation of one computer at the MIT Press under the short-lived umbrella of a graphic research unit.

While Media Director at the Press around 1973, Cooper was introduced to Ron MacNeil. Cooper and MacNeil co-founded the Visible Language Workshop (VLW) within the MIT Department of Architecture in 1974 and worked together for twenty years. In 1971 MacNeil had also enrolled in Negroponte's programming class and by 1978 he apprenticed himself to the Architecture Machine Group, spending six months and leaving with a cast-off teletype interface board and a 16-line machine language program.

Although Cooper was not technically conversant with the computers, she did immediately recognize their potential:

> I was convinced that the line between reproduction tools and design would blur when information became electronic and that the lines between designer and artist, author and designer, professional and amateur would also dissolve.[2]

Beginning with her exposure to the Architecture Machine Group, continuing with brief computer experiments at the MIT Press, and eventually through direct engagement with the electronics and software that MacNeil brought into the VLW, Cooper sporadically attempted to teach herself to program. She never learned but remained fascinated by the relationship between technology and graphic production; computers offered a bright new horizon for direct, immediate control plus the promise of real-time feedback. In the slideshow introduction to an MIT Summer Session at the Visible Language Workshop in July 1981, Cooper described

Muriel Cooper, self-portrait with Polaroid SX-70, video imaged and printed at the Visible Language Workshop, c. 1984 >p. 145

Computer self-portrait, Muriel Cooper (right) with Donis A. Dondis, produced in Nicholas Negroponte's design and programming class, MIT Department of Mechanical Engineering, 1967 > p. 51

that idea of instant visualization, of effecting the production tool, or the reproduction tool, being able to respond back to the tool very fast, "oh it's too red", "oh it's too green", all that sort of comes from the frustrations of having dealt professionally … the new tools are going to, if they are in some way controlled or understood by the users, become as interactive as these cruder things that we have described … the idea of typesetters on your desk gives you a kind of control you haven't had since you were a medieval monk.[3]

The source images for Cooper's double self-portrait are from around 1974, still frames excerpted from a video recording. Ron MacNeil suggests these were captured by a Portapak battery-powered black-and-white video camera system, a new technology at the time. Portable 16 mm and 8 mm film cameras were widely available for recording moving images on the go, but the film medium and its processing limited what could be shot and where. There was a necessary delay between exposing an image and viewing it. Film is light-based and chemical, but video is electronic and magnetic and so removed this time gap – images could be captured and played back on a monitor immediately.

The photographic camera that Cooper points back at the video camera is a Polaroid SX-70 compact instant camera, identified by its flash bar and all-black body. Based just around the corner on Main Street in Cambridge, Polaroid routinely provided development versions of its advanced imaging technologies to the VLW for experimentation. The SX-70 was quickly adopted in the workshop as an immediate, responsive image-making tool.

The SX-70 produced instant photographic prints, although this technology was nothing new. Since its first consumer camera, the Land Camera Model 95 launched in 1947, Polaroid had manufactured film that produced photographs within minutes of exposure without any additional darkroom processing. The SX-70 significantly improved the film technology by packaging paper and chemicals as a single unit, preloaded into a replaceable cartridge. After taking a picture, the image emerged directly from the SX-70 with no further manipulation. Unlike earlier films, the new film left no chemical residue and produced no additional waste, and SX-70 pictures could be made in rapid succession. (At the product launch, Polaroid president Edwin Land unfolded an SX-70 from his suit pocket and shot five photographs in 10 seconds.)

Like the Portapak video camera, the SX-70 was designed to be portable, with a compact, collapsible form. It could be tucked into a bag or coat pocket so that the camera traveled with its user. Also like the Portapak, the SX-70 provided immediate feedback in the form of a printed image, visible moments after it was exposed. This concise imaging loop opened up a wide range of novel uses for the camera. Cooper's designer at the MIT Press and student in the Visible Language Workshop, Wendy Richmond, recalls: "We documented every step of the way. We learned this from Muriel, who always had a Polaroid or 35 mm camera hanging from her neck. We were more interested in the process than the final product."[4]

The chronology of these two still frames is clearly marked. The top frame catches a moment of photographic exposure; Cooper's right eye is closed in framing and concentration while the flash from her Polaroid SX-70 fires. Although instant Polaroid was used extensively in the VLW, relatively few photographs include Cooper. More often than not, as here, she was behind the camera.

While the first frame is the instant of image making, the bottom frame records the moment of image printing. These two points in time as recorded on videotape are not far apart, but here the gap is essential. Between the first and second frames, an instant photograph emerges from the camera. The image captured in its chemical sandwich will develop in the next sixty seconds. Meanwhile, Cooper stares directly back at the Portapak video camera, one eye given to her SX-70. She is a cyborg – her left eye replaced and upgraded by the Polaroid lens. The undeveloped photograph coming out of her camera is a record of what she sees, and soon it will reveal the Portapak, its operator, and the surrounding context. For now, that picture remains blank.

Around 10 years elapsed between the making of these two video images and the assembly of the composite print. The finished double print was produced on a large-format printer in the Visible Language Workshop. This "printer" was more of a camera, and used large-format (24-inch-wide) instant photographic paper provided by Polaroid. One such apparatus was a 20-by-24-inch experimental Polaroid camera that printed an electronic image directly to instant photographic paper. MacNeil described the hybrid machine: “You would send a color signal to this amazingly sharp flat screen full tone scope and it would do the rotating filter-wheel dance to get all the colors.”[5]

In this inside-out camera, the screen displays an electronic image that provides the light source used to expose a sheet of photographic paper. An early version of the printer exposed red, green, and blue channels of the image in sequence to build up a composite color image. The large, high-resolution digital print was ready in a matter of minutes, and “digital Polaroid” became a primary output tool at the VLW. Workshop coordinator Rob Haimes worked with this technology at the VLW and later attempted to adapt this technology on a wider scale with Agfa Corporation. Competing inkjet printers proved more commercially viable, and this idiosyncratic digital printer remains principally an experiment.

By 1980, MacNeil was fully engaged in another ambitious hard copy output system, the Airbrush Plotter. Funded by grants from the Outdoor Advertising Association, this multiyear project supported much of the other work in the VLW, was cobbled together using rejected computer chips from Fairchild and National Semiconductor. The Airbrush Plotter combined digital image capture, image-processing software, and large-format digital output. Capture was handled by a line-scanning chip bolted to the film plane of a Nikon camera and moved via a stepping motor. A hacked one-color print head produced the output using airbrush inks.

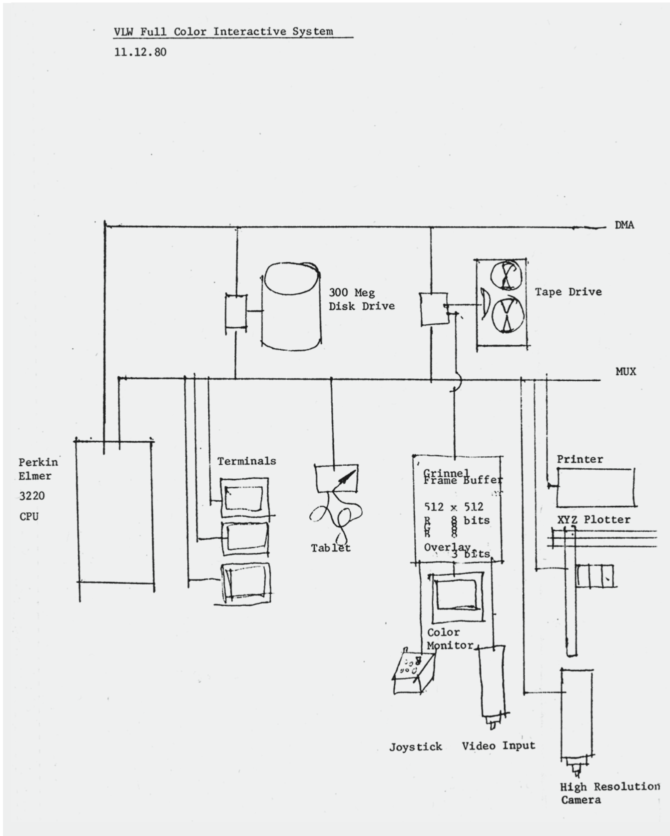
In addition to the large-scale inkjet printer that was at the center of this project, MacNeil, Rob Faught, and other VLW students over several years also developed a proto-Photoshop image-editing suite called SYS. MacNeil recalls the pieces of SYS as including “a 32 bit Super Mini (128K of core memory, but cost of $125K), a 300MB hard drive as big as a refrigerator on its back, a full color frame buffer with real time frame grabber, and a virtual disk image management system that let us zoom in and out.” The architectural scale of Airbrush Plotter images required a very high-resolution electronic work area, and SYS addressed a frame buffer capable of 2,000 by 7,000 pixels. SYS became a central image-processing tool in the VLW, and workshop coordinator Lee Silverman suggests that the video source images in the Cooper self-portrait were likely captured and processed by SYS.[6]

The final composite double image was produced alongside slow-scan television transmission experiments from around 1980–1983 at the Center for Advanced Visual Studies (CAVS), and to a lesser degree, in the Visible Language Workshop at the same time. Slow-scan television (SSTV) was a means of sending and receiving images over an analog telephone line. The slow-scan unit digitally stored a frame of video which was encoded, scanned line by line into frequency-modulated audio waves, and transmitted as a standard audio signal over a telephone line to a remote receiver. There, a slow-scan unit received the audio signal and its waves were translated back into pixel values and reassembled one row at a time on the remote video display. Image transmission was reduced to the relatively slow speed of 8 seconds per frame to fit the limited bandwidth of existing telecommunication networks, and this gave the technology its name.

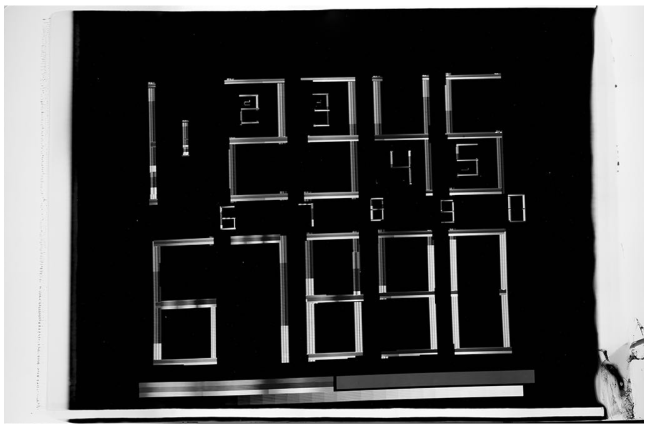
Slow-scan technology had been around since the late 1950s and was used to send images back from the first U.S. and Soviet space missions. At MIT, artists including Aldo Tambellini and Bernd Kracke in the Center for Advanced Visual Studies, Peter Droege from the Architecture Machine Group, and Lee Silverman from the VLW were actively experimenting with its potential.

One such experiment was organized on February 16, 1980. “Artists’ Use of Telecommunications” was a three-hour multilocation electronic conference organized by the San Francisco Museum of Modern Art. At MIT, the event involved artists, architects, and engineers from CAVS, the Architecture Machine Group, and the Visible Language Workshop. Other participants were geographically dispersed, with nodes in Tokyo, Vienna, Vancouver, New York, and Toronto, all transmitting images and text to one another. Transmitted images were transcribed to a digital videodisc at the Architecture Machine Group.

Documentation of the event captures exuberant multimedia chaos. Remotely sent images appear, almost magically, line by line on a video monitor from the top of the screen, accompanied by the wild squeal of its encoded audio data. Each image slowly erases the previously transmitted image over the course of its eight-second transmission. Assembled participants witness the received images while actively preparing for the next to be sent. At one point, Marvin Minsky of



Schematic diagram of electronic image manipulation and output system at the Visible Language Workshop, 1980 > p. 141



Large-format Polaroid digital print, slow-scan transmission, c. 1982 > p. 165

the MIT Artificial Intelligence Laboratory records a contest between a live turtle and its artificially intelligent robot equivalent.

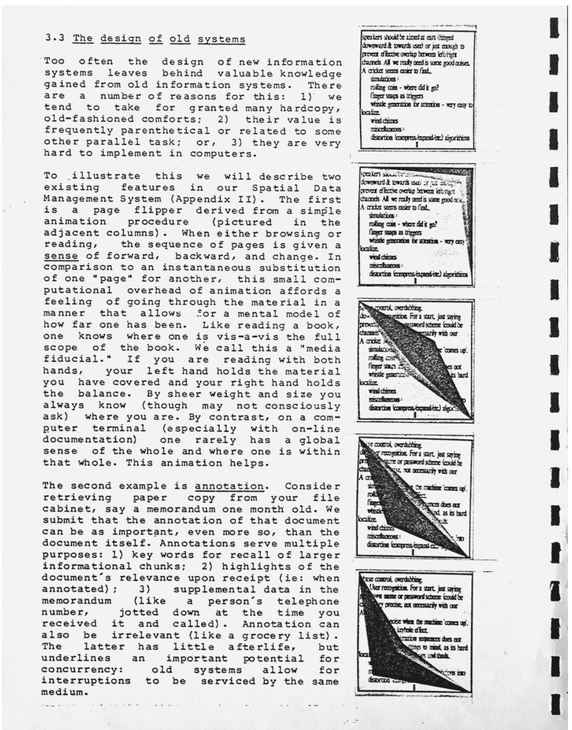
Another slow-scan event, "Interfaces," was organized between CAVS and the American Center in Paris. An image of recently inaugurated U.S. President Ronald Reagan was split into a grid of smaller images, then slow-scan-transmitted from Cambridge to Paris. In Paris, the receiving video monitor was photographed with a Polaroid instant camera and the images were reassembled to produce a 10-by-12-foot mural. A similar image of French President Valéry Giscard d'Estaing was sent in the opposite direction.

Slow-scan transmission events were also organized directly with and in the Visible Language Workshop. TransMIT was a day of slow-scan transmissions and talks on the possibilities and consequences of electronic image circulation, held on January 19, 1983. Cooper delivered the opening remarks, which were followed by talks including "Graphic Information Systems" by Patrick Purcell of the Architecture Machine Group, "Not Art, Teleculture" by Robert Horvitz, editor of *Coevolution Quarterly*, and a transmission performance event, "I Am a Machine," staged together with the School of the Art Institute of Chicago.

About 10 years after the initial video was shot, the footage of Cooper and her SX-70 was frame-captured, transmitted, and displayed, stacked on two identical monitors which were captured in turn by a large-format Polaroid camera. The resulting double self-portrait is a remarkably resonant image. Cooper is caught somewhere in between the original image, its transmission, and the transmission's reproduction. Silverman recalls that Cooper was only superficially engaged in the slow-scan transmissions at the VLW. And yet, as with many other new graphic technologies, she immediately recognized slow scan's potential, and this picture concisely encapsulates its possibilities. Ron MacNeil neatly summarized what was eventually at stake in this image:

> In time, images stay on the screen. And now they travel through networks. I think what Muriel finally discovered was the act of communication design in the process of radical change away from creating single artifacts to creating design processes that need to have a life of their own over these networks.[7]

A tangle of technologies worked together to produce this double self-portrait. If an interface can be described as a shared boundary across which two separate components of a system exchange information, then this photograph might be considered one, and also a prototype for Cooper's thinking about interfaces. The final image collapses its original videotaping, Cooper's Polaroid photographing, frame digitizing, audio conversion, transmission, reception, decoding, documentation, and large-format reproduction all in one shared surface. The composite manifests, even conjures, an interface; it is the space where these imaging techniques connect and exchange information. It was a first step for Cooper, and, typically, the resulting image is less important for her than its process. This picture was around 10 years in the making – a long way from the real-time interface she was looking for.



3.3 The design of old systems

Too often the design of new information systems leaves behind valuable knowledge gained from old information systems. There are a number of reasons for this: 1) we tend to take for granted many hardcopy, old-fashioned comforts; 2) their value is frequently parenthetical or related to some other parallel task; or, 3) they are very hard to implement in computers.

To illustrate this we will describe two existing features in our Spatial Data Management System (Appendix II). The first is a page flipper derived from a simple animation procedure (pictured in the adjacent columns). When either browsing or reading, the sequence of pages is given a sense of forward, backward, and change. In comparison to an instantaneous substitution of one "page" for another, this small computational overhead of animation affords a feeling of going through the material in a manner that allows for a mental model of how far one has been. Like reading a book, one knows where one is vis-a-vis the full scope of the book. We call this a "media fiducial." If you are reading with both hands, your left hand holds the material you have covered and your right hand holds the balance. By sheer weight and size you always know (though may not consciously ask) where you are. By contrast, on a computer terminal (especially with on-line documentation) one rarely has a global sense of the whole and where one is within that whole. This animation helps.

The second example is annotation. Consider retrieving paper copy from your file cabinet, say a memorandum one month old. We submit that the annotation of that document can be as important, even more so, than the document itself. Annotations serve multiple purposes: 1) key words for recall of larger informational chunks; 2) highlights of the document's relevance upon receipt (ie: when annotated); 3) supplemental data in the memorandum (like a person's telephone number, jotted down at the time you received it and called). Annotation can also be irrelevant (like a grocery list). The latter has little afterlife, but underlines an important potential for concurrency: old systems allow for interruptions to be serviced by the same medium.

"Books without Pages" (storyboard for a page-flipping interface), proposal to the National Science Foundation by Nicholas Negroponte, Richard Bolt, and Muriel Cooper, 1978 > p. 156

Books without Pages

In 1978, Cooper with Negroponte and Richard Bolt prepared a proposal to the National Science Foundation to explore the transition of published information onto electronic screens. The proposal, titled "Books without Pages," begins: "This proposal is about SOFT COPY."[8] "Soft copy" was a neologism, best understood in opposition to its opposite, "hard copy." Soft copy is fluid, dynamic, mutable, carried in a digital medium and appearing on electronic screens. Hard copy is fixed, registered, permanent, found in books and printed matter.[9] These two forms are opposed, but the authors suggest that each is mediated by the interface through which it's delivered. They proposed to study the interface of a book, and from this departure point they would consider how its format might transition from paper to a digital medium, from hard to soft copy. The proposal's abstract continues:

> It is both forward and backward looking upon information systems as qualitative, human resources. On the one hand we propose to evaluate specific visions of the future. On the other hand, we posed questions of hindsight to assure that some of the old fashioned qualities of communication are not lost.

"Books without Pages" emphasized the distinct and complementary backgrounds of its authors. Negroponte, Cooper, and Bolt are described, respectively, as "a researcher in computer / TV media, an expert in graphic design, and a psychologist with a computer background." The varied perspectives of the participating researchers were essential, as interface design would require a broad perspective. Understanding social and cultural convention together with individual user considerations was essential in order to offer any specific technical or design recommendations. The work was divided into four areas of concentration: text as a graphic event, media-inherent bases of orientation, videodisc technology, and sound synchronized with text.

Much of the proposal builds directly on ideas Negroponte had developed in the Architecture Machine Group, but it also reads in line with Cooper's emerging thinking about digital interfaces. In print, Cooper designed for an active reader. A digital medium held even more promise for its reader to guide and effect the process: "Books without Pages is about interaction and dynamism. … The reader becomes an active agent in the information system with data in the round, itself a world's fair of sound and light."

The proposal details differences between hard and soft copy. In a section titled "On not throwing away the message with the medium," a letter received through the U.S. Postal Service is considered. This letter arrives with marks which indicate its journey, and the color of the envelope, handwritten address, even the stamp all pack extraliteral communication into the object. These cues partly account for the persistent preference for using a physical object for communication. The experience is richer, more dimensional. Soft copy fails to account for any of these physical communication properties; but it has other expressive dimensions, and these offer the possibility of compensating for the missing tactile qualities. Sound, graphics, and animation are all possible in an electronic book. Most importantly, however, soft copy is mutable.

A book's interface is entirely learned. The page-turning, left-to-right, front-to-back conventions of a codex book were established and implemented by repetition. Page numbers, sizes, chapters, paragraphs, paragraph breaks, and so on, all the way down to the forms of the letters on the page, all evolved slowly as standard typographic furniture. These were invented, not discovered, and reading a book requires decoding these design cues.

With the move to a digital format, all of these conventions were up for grabs. "Books without Pages" made this clear, asking: "What is a Book without Pages? Why is it still called a book?" Conventions of the book weren't simply tossed out by Cooper, Negroponte, and Bolt. They were reconsidered, and many were kept and adapted. For example, having discrete pages was identified as a useful orientation device. The authors suggested replacing the endless scroll of soft copy with a page-based interface, complete with a page-flipping animation. Using this real-world analogy, a user might gain a sense of her place within the body of the text that would be missing in a digital text. The authors expanded on the idea:

> By "sense of place" is meant orientation stemming from the tangible specifics of the context in reading/viewing activity: e.g., where one is in the text; how far one has come, how far one has yet to go; formatting suggestive of what is to come ("frame"-like function); ever-present tables of contents, with tangible, interactive "pointers," progress indicators, and so forth.

Section 5.1 in the proposal, "Understanding text as a graphical event," describes how a dynamic, electronic typography might work. It starts by examining how form modulates meaning in an analog medium by examining a used-car advertisement: "'CAR WARS' said a poster, with text reading into a one-point perspective, followed by the name and address of a used car lot offering galactic loans and astronomical discounts." At first this appears to be a trivial example, a cheap visual pun pushed into the service of selling used automobiles. But Cooper, Negroponte, and Bolt suggest that dimensional typography like this might have greater capacity for carrying meaning in a digital medium. Three-dimensional information environments allow for multiple connections between texts that would be more difficult to render within the two static axes of a printed page.

Cooper, Negroponte, and Bolt addressed existing computer interfaces as well. Scrolling text had appeared in the earliest computer interfaces. When a text was too long to fit on a screen, one line after another appeared, flashing on at the bottom of the display as the rest of the text moved up. This was a relatively intuitive interface, and one that mapped onto a physical object seen through a window too small to enclose it. But the authors suggested that this scroll animation was not as effective as it could be. When lines appeared on the bottom of the screen, they appeared at once, flashing and causing the previous line to jump one line up. Text was not legible during the move.

The authors suggested easing this transition with a simple bitwise animation that draws the text on screen scanline by scanline. Instead of each full line flashing on in succession, this technique would continuously redraw the screen and insert intermediate steps in the perceived animation. The scroll would appear smoother, the text would be presented continuously, and a reader would be able to continue reading as more information was dynamically added. The technique, named “Hollywood scroll” by one manufacturer, became the standard for presenting long texts and is now omnipresent in browser, desktop, and mobile interfaces.

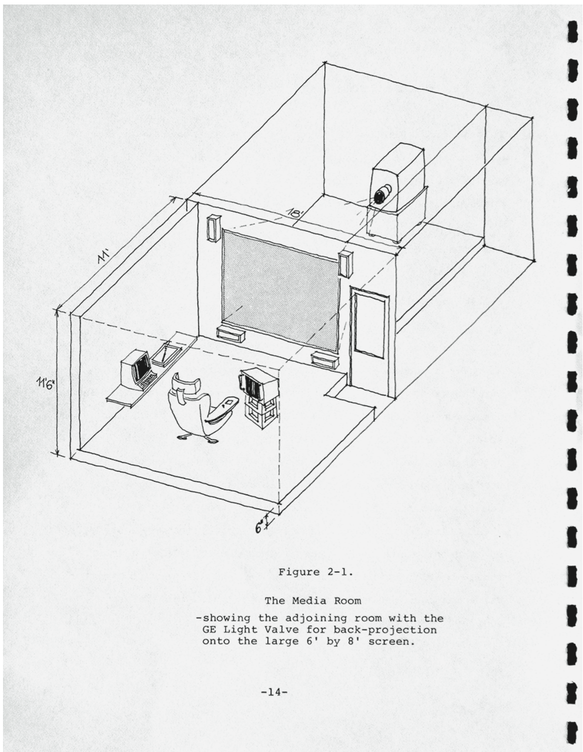
Negroponte, listed as the principal investigator in the proposal, summarized what was at stake with such designs:

> future systems will not be characterized by their memory size or processing speed. Instead, the human interface will become the major measure, calibrated in very subjective units, so sensory and personalized that it will be evaluated by feelings and perceptions. Is it easy to use? Does it feel good? Is it pleasurable?

In the end, the proposal wasn’t funded by the National Science Foundation. Cooper found other outlets for the ideas, and the name was repurposed by Negroponte for work funded separately by the Office of Naval Research and the Defense Advanced Research Projects Agency.

Bolt and Negroponte had previously worked together on the Spatial Data Management System (SDMS), a multimodal computer interface for accessing digital information. Bolt was the lead scientist on this project, sponsored through the Defense Advanced Research Projects Agency and run under the umbrella of Negroponte’s Architecture Machine Group. SDMS is repeatedly referenced in the 1978 National Science Foundation proposal and forms the conceptual basis for many of its ideas.

Spatial data management asserted that computer interfaces relied too heavily on symbolic, linguistic links. Data were stored in hierarchical relations of nested directories and files, organized by type and recalled by a filename. To locate a specific document, the user would have to recall its name. Analog filing systems, such as an actual desktop, work differently. The user might remember that a certain document is in the third pile from the left, or is collected with others from about the same time in a folder on the floor, or even is the one with a red cover. These spatial organizational cues had not yet been applied substantially to the organization of files within a computer interface. In spatial data management, every file had a location, an address, rather than simply a name. Each file exists somewhere, and the graphic interface allows quicker, visual access to its contents.



“Books without Pages” (diagram of The Media Room), proposal to the National Science Foundation by Nicholas Negroponte, Richard Bolt, and Muriel Cooper, 1978 > p. 162

The data in SDMS were stored on videodisc. This optical storage format facilitated random access to the digital contents as well as responsive control of playback speed. Videodisc was a central medium for work in the Architecture Machine Group, where previous experiments had exploited the specific capacities of the medium. “Books without Pages” describes one such disc which, instead of including continuous video data, was comprised of 54,000 distinct still images culled from the slide collection of MIT’s Rotch Architecture and Planning Library. The videodisc could be quickly scrubbed forward or backward to locate a particular slide, displayed as a still frame. The collection could be browsed by chapter headings.

Multimodal inputs, of both voice command and touch, guaranteed redundancy, aiming to approximate human interaction. Thirty years before the first iPhone or iPad, the authors of “Books without Pages” wrote: “When the reader indicates that he wants to turn the page, he indicates by a simple finger-gesture captured on a small touch-sensitive pad located on the arm of the chair in which he is sitting.”

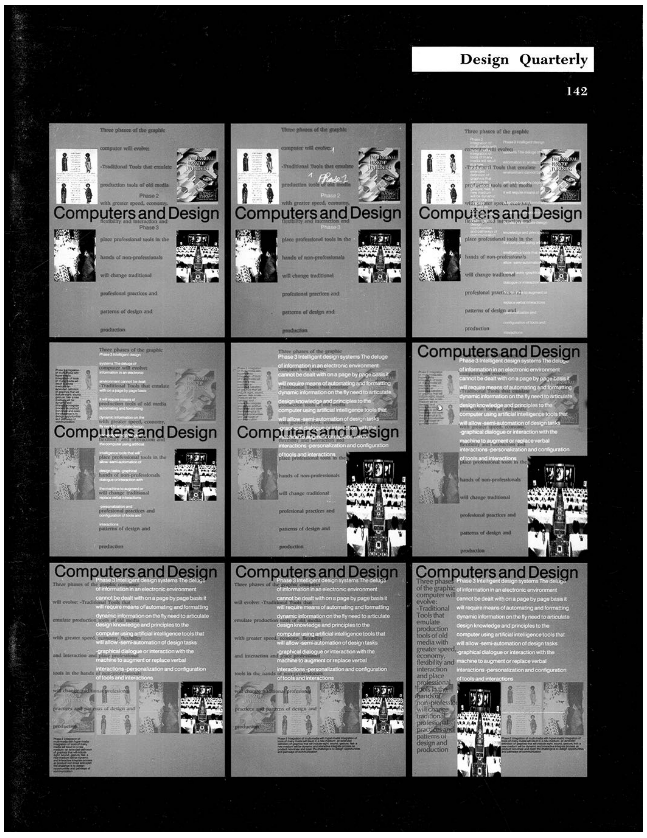
SDMS was staged in the Media Room, a space within the School of Architecture which included a wall-sized projection screen and a multimedia interface including touchscreen, trackpad, and joystick centered around an Eames lounge chair. Computers were removed from this user space, sequestered to a machine room located behind the projection screen. The result was a seamless, immersive user environment.

SDMS preceded “Books without Pages,” and many of its ideas were embedded in the latter. In spatial data management, location was employed as a metaphor. A model could be imagined, an intuitive multivalenced relation between distinct pieces of data which creates an immersive, enveloping information space. The user navigates by reading from one file to the next. These ideas followed Cooper from this unrealized proposal.

Computers and Design

In 1989 Muriel Cooper guest-edited *Design Quarterly* no. 142, a special issue on “Computers and Design.” As the magazine’s managing editor Mildred Friedman describes in her introduction, it continued directly from the issue on “Design and the Computer” (1966), guest-edited by Peter Seitz. Where that issue had looked forward, speculating on how design would approach the new electronic tools becoming available, “Computers and Design” looked first in the other direction, uncovering precedents for the application of computer logic to graphic design and connecting these to current work in the MIT Media Lab and Visible Language Workshop. Cooper’s own engagement with the changing tools of graphic design put her in a useful position to connect the dots, as Friedman describes:

> The contributions to design theory and practice of Muriel Cooper – who in mid-career as a highly regarded designer of books and other graphic materials threw it all over to take on the issue of new graphic languages that bridge art and technology – are both rare and remarkable. Her example is a challenge to the self-satisfied streak in us all.[10]



***Design Quarterly*, no. 142, “Computers and Design” (cover), 1989**
> p. 175

As guest editor, Cooper split the issue into three sections. “The New Graphic Languages” is a retrospective audit of designers and artists working before computers in ways that anticipated software. The second section introduces the Media Lab, and the third describes current work of the Visible Language Workshop.

At the start of “The New Graphic Languages,” Cooper places the computer within a historical trajectory and identifies a new, synthetic design discipline that will evolve as a consequence:

> Today’s personal computer is a functional tool that mimics old tools. But the next generation of graphic computers will permit the merging of previously separate professional tools; at the same time, powerful networking, increased bandwidth and processing capabilities will make the transition from print to electronic communication the basis of a vast industry. The primary interaction of electronic communication environments will be visual. Traditional graphic design skills will continue to be important for display and presentation, but a new interdisciplinary profession, whose practitioners will be adept in the integration of static and dynamic words and images, will be required to organize and filter information growing at an exponential rate.[11]

She suggests that new design practices often emerge in parallel with the appearance of new media. As print media expanded, graphic design emerged. With the explosion of electronic media such as broadcast television and videotape, new design fields emerged around motion graphics and animation. Emergent media had their own constraints: the paper formats and inks of a printed page; the 4:3 aspect ratio and low resolution of television; the mass economics of broadcasting and publishing. Each imposed practical bounds on what could be communicated and how. As Cooper describes, “reality was filtered and organized through the limitations of the media.”[12] But digital media are something else – there is no natural frontier to the amount of information they can carry. Previous media marked their own boundaries, which in turn were used to organize their contents. With digital media, the amount of information is practically infinite, and so the job of filtering and organizing is increasingly urgent. Cooper describes a near future where the flow of information will be too fast for any designer to format it. Design will become a task of creating templates and processes rather than bespoke pieces of communication.

Following Marshall McLuhan, Cooper acknowledges that each new medium first embeds and then evolves conventions from the medium it replaces. The digital medium of the computer is no exception. Electronic graphic design softwares for typesetting and image editing were first created to accelerate print production, but soon enough the computer itself became a communication vehicle: "programmers began to experiment with personal graphic ideas. It was only a matter of time until these tools migrated into the creative domain." But Cooper suggests that software can only make this move from graphic design tool to medium if its user interfaces are responsive and intuitive. "At this stage the term user-friendly was unheard of."[13]

The defining quality Cooper identifies for a digital medium is its unique ability to integrate other media. The computer can merge video, sound, static text, animated text, and interactivity. Unlike traditional media which rely on linear formats and closure, digital media are open-ended, dynamic, and nonlinear. Bringing together various media in this new form also requires a new type of designer.

There are precedents, and Cooper compiles a list. The first was László Moholy-Nagy and his diagrammatic score for a proposed film, *Dynamic of the Metropolis*. This graphic used typography to communicate both the temporal structure as well as the feeling of the proposed film sequence: "In fact, the score itself becomes a piece of meta-art. It is not hard to imagine Moholy using a computer."[14]

Next was Gyorgy Kepes, her colleague at MIT, who published a series of books that eloquently argued for the interconnectedness of art, technology, and design and a refreshed graphic language to reflect changing relationships. Charles and Ray Eames follow, identified for their interdisciplinary thinking and practice that bridged product design, film, and exhibitions. Cooper describes a teaching demonstration the Eameses assembled together with designer George Nelson in 1953 called "Sample Lesson for a Hypothetical Course." The multimedia performance, staged at the University of Georgia and at UCLA, included projected still images, graphics, film, sound, and even the smells of baking bread, all integrated into a classroom lecture in a university hall.

Cooper also describes Swiss graphic designer Karl Gerstner's book *Designing Programmes* from 1964, which "explores the structure of design as programmed systems and resultant processes rather than as unique product." Although out of print by this time, the book, she writes, is "just beginning to be seen not only as an homage to the grid but as a way of thinking that permeates all forms of human and natural design, one that is particularly appropriate to future computer design and art."[15]

Cooper understood interface design as a question of media integration, closely related to theater and performance, and fundamentally concerned with creating a plan for synchronizing various information streams. She recognized that this new design problem also required a new vocabulary. Early attempts at graphic computer interface design evolved from work at the Xerox Palo Alto Research Center and relied on a string of metaphors including overlapping windows, files, and folders. The familiarity of such real-world analogies was only transitional for Cooper. She saw something else coming:

> A multi-media work environment will not only provide the user free browsing through media but the opportunity to interact with three-dimensional information in real time. Animated and simultaneous multi-media events in linear time, which are mapped dynamically in space, present a challenging design problem.[16]

Interfaces had yet to explore this problem adequately, clinging to models that employ a physical environment to provide a familiar transition to the flat, mysterious digital world. She compares the desktop computer interface to a printed Advent calendar where windows in the calendar are marked with dates and appear seamlessly. When opened, these windows offer portals into other (imaginary) spaces. In the same way, a folder on the desktop or a window in a software application appears as a portal to another space. Existing interfaces provide an easy transition as a mirror of the world, but software doesn't need to be so literal. Cooper's most precise insight follows:

> But in fact, it is not the real world, and at some point on the learning curve moving iconic metaphors around is as tedious as rummaging through filing cabinets. At that point the

user understands that the computer is a medium different from the physical world, one that offers the power of abstraction.[17]

The next two sections of “Computers and Design” describe the work of the Media Laboratory and of the Visible Language Workshop, Cooper’s research group within it. “The Media Laboratory is a pioneering interdisciplinary center that is a response to the information revolution, much as the Bauhaus was a response to the industrial revolution.”[18] The Media Lab was established to eliminate the isolation of separate approaches by mixing the most forward-thinking research together with technical advances in imaging, software, interactivity, computation, and human cognition. It evolved directly from Negroponte’s Architecture Machine Group and collected the Logo Group, the Artificial Intelligence Laboratory, Electronic Music, and Cooper’s Visible Language Workshop within a brand-new building designed by I. M. Pei in a prominent campus location. The Media Lab worked across disciplines, and this followed Cooper’s belief that computer interface design problems center on the integration of different media and could not be solved without the broad approach that varied perspectives offer.

The Media Lab was comprised of thirteen research groups at that time: Human Interface; Epistemology and Learning; Computers and Entertainment; Electronic Music, Performance and Technology (The Cube); Computer Animation and Graphics; Electronic Publishing; the Visible Language Workshop; Film/Video; Spatial Imaging; Vision Sciences; Speech Recognition; Advanced Television; and Telecommunications. Significant cultural and language differences existed among the disciplines. Communicating and negotiating criteria within the Lab was a model of what happens beyond its walls when disciplines intersect. Typically, Cooper considered this an opportunity rather than a handicap:

The Media Lab’s greatest strength may prove to be the collision of the disparate disciplines and values represented there. The valuation models of a scientific community do not easily mesh with those of the art community although they avowedly seek the same grail. In much the same way, the meaning of the Bauhaus was in the conflict between painters like Klee and Feininger, and technocrats like Moholy-Nagy.[19]

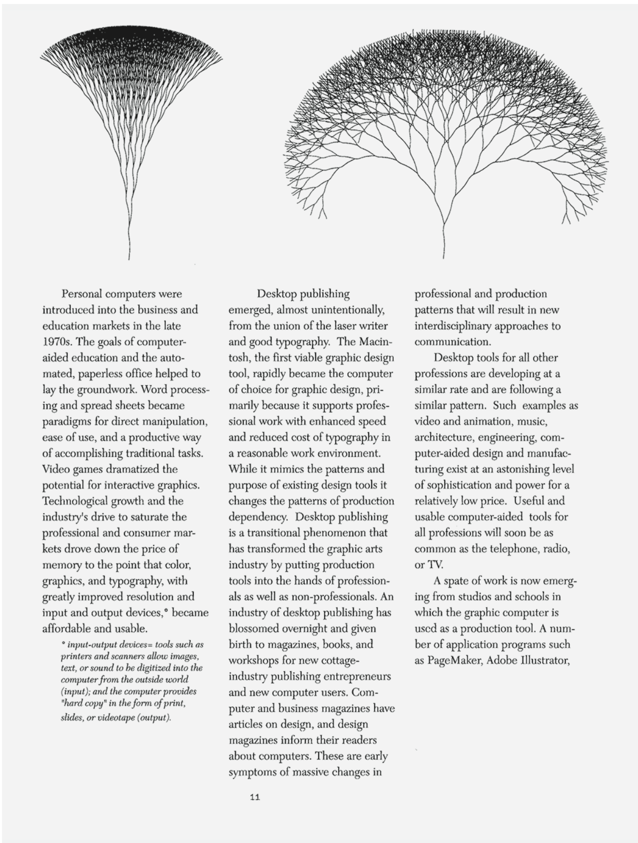
The final section of the issue, on the Visible Language Workshop, is something between a mission statement and a working manifesto.

In an electronic environment, the volume of real-time information will outstrip our ability to process it. The use of graphics as a filter for this complex information, as a means of making it both meaningful and expressive, is the critical research challenge of the Workshop.[20]

Cooper restates the problem in terms of media integration, using the multiple sensory dimensions available in a dynamic medium in order to organize this massive digital flow. She inventories techniques that the VLW was actively exploring, including translucent, anti-aliased, and layered text; very high-resolution displays; simultaneous video, text, and sound; and dynamic interfaces capable of processing information in real time. “Designers will simply be unable to produce the number of individual solutions required for the vast number of variables implicit in real-time interaction. Design will of necessity become the art of designing processes.”[21]

The cover of the *Design Quarterly* special issue neatly illustrates these themes. It presents a three-by-three grid of thumbnail renditions of the cover as it dynamically shifts through a temporal sequence. Software to produce these images was written by Suguru Ishizaki, but the image was choreographed by Cooper. It is more a provocation than a working prototype, but as with much of her strongest work, this imagined interface suggests a path forward. It is rhetorically succinct and telegraphs many of the themes that she developed at length in the issue. The cover image is captioned on the back:

Four images and three text segments are used to explore ways simultaneously to represent multi-tiered information using changes of size, placement, color, and translucency. Each frame will change as the “reader” browses in real time with text and image cues dependent on the linkages that have been designed for browsing. On one level this series is analogous to a book printed on translucent paper, but it takes advantage of the potential for change inherent in the computer.[22]



Personal computers were introduced into the business and education markets in the late 1970s. The goals of computer-aided education and the automated, paperless office helped to lay the groundwork. Word processing and spread sheets became paradigms for direct manipulation, ease of use, and a productive way of accomplishing traditional tasks. Video games dramatized the potential for interactive graphics. Technological growth and the industry's drive to saturate the professional and consumer markets drove down the price of memory to the point that color, graphics, and typography, with greatly improved resolution and input and output devices,* became affordable and usable.

** input-output devices= tools such as printers and scanners allow images, text, or sound to be digitized into the computer from the outside world (input); and the computer provides "hard copy" in the form of print, slides, or videotape (output).*

Desktop publishing emerged, almost unintentionally, from the union of the laser writer and good typography. The Macintosh, the first viable graphic design tool, rapidly became the computer of choice for graphic design, primarily because it supports professional work with enhanced speed and reduced cost of typography in a reasonable work environment. While it mimics the patterns and purpose of existing design tools it changes the patterns of production dependency. Desktop publishing is a transitional phenomenon that has transformed the graphic arts industry by putting production tools into the hands of professionals as well as non-professionals. An industry of desktop publishing has blossomed overnight and given birth to magazines, books, and workshops for new cottage-industry publishing entrepreneurs and new computer users. Computer and business magazines have articles on design, and design magazines inform their readers about computers. These are early symptoms of massive changes in professional and production patterns that will result in new interdisciplinary approaches to communication.

Desktop tools for all other professions are developing at a similar rate and are following a similar pattern. Such examples as video and animation, music, architecture, engineering, computer-aided design and manufacturing exist at an astonishing level of sophistication and power for a relatively low price. Useful and usable computer-aided tools for all professions will soon be as common as the telephone, radio, or TV.

A spate of work is now emerging from studios and schools in which the graphic computer is used as a production tool. A number of application programs such as PageMaker, Adobe Illustrator,

11

Design Quarterly, no. 142, “Computers and Design” (interior layout with computer graphics by Hugh Dubberly), 1989

Muriel Cooper at three-screen workstation, 1989 > p. 176

Intelligent Graphics

Design Quarterly's cover image was created in 1988. One year before, artificial intelligence researcher Henry Lieberman joined the Visible Language Workshop. Intelligent graphics that responded to the user, similar to what's imagined on the *Design Quarterly* cover, soon emerged as a research locus in the Workshop.

Lieberman came from the MIT Artificial Intelligence Laboratory where he worked on computer graphics with Seymour Papert's Logo Group. Logo was an experimental software that leveraged machine intelligence to teach children about problem solving and, by proxy, computer programming. The software allowed a child to direct a surrogate "turtle" on screen, creating drawings by telling the turtle where it should move. In this way, the child would have to work backward from the intended drawing to produce its recipe as a logical sequence of steps. In an article published in 1996, Lieberman recalls: "I was struck by how engaging the computer graphics domain was for the kids and by the power of combining both visual and abstract problem solving."[23] Lieberman and Cooper came together around the idea that computer interfaces might do more than simply present information or facilitate data manipulation. A more responsive, intuitive interface combined with machine intelligence could produce software that worked symbiotically as a designer's assistant.

Ron MacNeil was consistently exploring this research territory at the VLW. His TYRO was an intelligent design assistant which visualized a particular graphic layout as a function of the total set of constraints on its arrangement. The program visualized the design problem as a "spiderweb" network of connected parts expressed by their hierarchical relationships. The software would generate multiple design alternatives based on these assumptions. Introducing TYRO in Kobe, Japan, MacNeil began with a sequence of alternate versions of a slide generated by the program, apologizing tongue-in-cheek that he could not make up his mind which to show.

VLW student projects by Dorothy J. Shamonsky ("Scripting Graphics with Graphics: Icons as a Visual Editing Tool," 1977), Russell Greenlee ("Using Abstract Descriptions and Visual Properties to Generate Page Layouts," 1981), and Timothy Shea ("Use of Computer-Based Rule Systems in Graphic Design," 1984) built a vocabulary of approaches for applying software intelligence to graphic design.[24]

Another area of intelligent graphics research centered on automatic layout. Cooper had recognized that information flow was accelerating to such a degree that the role of the designer would necessarily evolve. Lieberman, paraphrasing Cooper, recalls: "Digital data simply comes too fast, and is too dynamic to have every visual presentation designed by hand."[25] Automatic layout software, assisted by templates and drawing on an expert knowledge base of design rules, was a promising avenue. A project started in 1986 explored this territory. Working with IBM, VLW researchers began to explore how digital tools could supplement the mechanical process of graphic design. Cooper collaborated with art director Joan Musgrave, whose work involved designing and producing serial corporate publications for IBM.

Work began by documenting typical graphic design processes at IBM, chronicling the day-to-day work of Musgrave and her staff. Graphic design was principally a mechanical, repetitive process, and the tools, steps, and approaches were inventoried and recorded in a database. Digital alternatives were created, software tools and techniques to match, replace, or augment the analog design tasks. As Musgrave described:

> A new way of working was explored. The model of collaboration was for me to sit next to a programmer and create a design that would then be visualized on a computer screen. The collaborations were in real time, thus immediate results could be seen as we worked. Although I was familiar with giving direction to illustrators who in a week or two would return artwork on paper, this new interactive way of working was visually quite exciting when "instant" results were seen.[26]

Cooper and VLW researchers put these ideas into practice on a cover design for *Perspectives in Computing*, an IBM systems journal published from 1980 to 1988. Illustrations and photographs were commissioned to accompany each article, cropped, scanned, and placed into a digital image library. A grid was established for the cover, and the illustrations would be placed within its square boxes. The masthead typography was scanned and all of the elements brought together in an application at the VLW. This layout software, written by VLW student Russell Greenlee, grew out of work funded by Hell GmbH and Hewlett-Packard for which IBM provided a case study. The interface presented a thumbnail collection of low-resolution illustration tiles on the right. These proxies could be recropped, color-adjusted, and scaled using VLW paint software. From the collection of images, the software drew on the database assembled through observation of design practices at IBM. The rules in the database were stated in the IF-THEN logic of a computer program. For example:

Selection: IF overall color dominance is not similar and has the desired relation of contrast, THEN keep the selected image, ELSE reject the image that has least popularity OR change the color of the image.

Or:

Style relation: IF the images are of a similar style and there exist more styles to choose from, THEN select an image from a style not already selected.

Full cover alternatives were programmatically constructed according to these rules, the software radically accelerating the design process. Previously, after initial pencil sketches, one or two cut-and-paste mockup alternatives might reasonably be prepared. The computer produced as many mockups as requested, and the design problem quickly became a question of too many alternatives. Still, a rules-based approach to computer-assisted graphic design was promising. Grids for flexible but structured page layout are a tenet of modernist graphic design, and the programmatic thinking of software was a natural complement.

Other projects with IBM included using VLW animation software to produce computer images for publication covers. Animated software models could be manipulated in real time, and cover design candidates were excerpted from the moving image: “By stopping the action and using a still in the animation progression, a dynamic approach to looking at options was possible.”

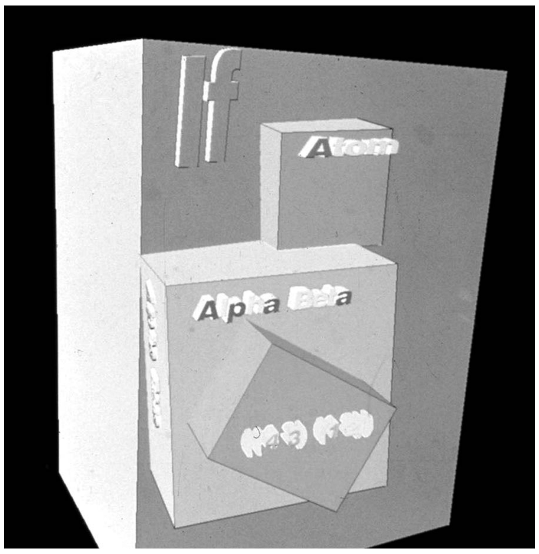
As with earlier interfaces, the value Cooper saw in intelligent graphics was the possibility for the computer to become a medium flexible enough to match a designer’s intuition, fast enough to provide immediate visual display, and responsive enough to engender a feedback loop between the graphic designer and her tool.

Visual programming was another area explored. Cooper recognized that harnessing a computer’s power relied on knowing how to program it, and she imagined that more visual, intuitive, responsive interfaces to computer languages would open the door for a different kind of programmer. At the VLW, artificial intelligence programs were applied to visual design problems, but this was also done in reverse: visual design principles were applied to constructing artificial intelligence programs. It was this approach that she hoped to facilitate by bringing a more immediate, visual approach to computer programming.

No matter how new and high-end the machine, computers were never responsive enough for Cooper. The logic of computer programs made intuitive sense, and she was persistently interested in learning to code. She was equally frustrated by never learning it, as her programming knowledge remained more conceptual than practical: “Because she was such a visual thinker, she was flabbergasted to the point of being offended that programming wasn’t as visual as it had the potential to be.”[27]

Around 1991, Lieberman led a project that constructed three-dimensional visual models of a program’s structure built as the program runs. These graphics, somewhere between a cereal box and a building, communicated the logical program and provided a visual surrogate to the literal code that directed its flow.

Intelligent graphics research at the VLW was also gathered under the heading “Learning by Example.” Pursued through a number of student and staff projects from around 1986 through 1994, the methodology built on the expert rules employed by IBM. But, instead of merely feeding design knowledge into a database, graphic design that learned by example recorded both previous solutions to a specific layout problem as well as further attempts. The design software became smarter and more personalized the more it was used.



3D program representation, Henry Lieberman, c. 1991
> p. 180

Cooper was convinced that graphic design was best taught by providing concrete examples rather than laying out a series of rules. Examples are multidimensional, and, while these may be applied toward one specific design problem, aspects of other problems are always embedded in them. Providing multiple examples was essential for a student to unpack the underlying principles for herself.

Likewise, learning by example required quantity. It thrived when it was used extensively, and the repetitive tasks of graphic design provided a good case. In a feedback loop with its user, a learning-by-example program could further program itself. Lieberman made several softwares to model this, including a page layout software, Mondrian, and a programming software, Tinker. Tinker offered a graphic interface to programming logic, and could be used by a seminovice to produce new software. One example showed Tinker programming a Pong game by example, as the user modeled configurations of the game to the software, and demonstrated how its rules were applied by showing examples of their use.

Graduate student Suguru Ishizaki worked on programming-by-example projects at the VLW. Among other work, Ishizaki developed an electronic map system that learned to update the migration patterns of certain animals based on past behaviors. He also applied the approach directly to graphic design software, building a recording engine that ran underneath existing page layout software to collect a designer's decisions. Typeface choices, color selections, arrangement, and scaling of objects were assembled to develop a particular user profile. The software would develop over time by becoming more responsive to its user. In his dissertation, "Typographic Performance: Continuous Design Solutions as Emergent Behavior of Active Agents,"[28] Ishizaki identified an approach that he called "Improvisational Design," which imagined that a document might dynamically, fluidly change as a user reads it and might evolve as she changes her intentions over time. The thinking was indebted to Cooper's drive toward more responsive interfaces which, through immediate feedback, would facilitate deeper, more exhaustive design thinking. This type of interface was really more of a software space, a total environment – smooth, immersive, and most importantly, working dynamically in real time.

Information Landscapes

Information Landscapes (still from introduction animation), Muriel Cooper, David Small, Suguru Ishizaki, and Lisa Strausfeld, 1994, > p. 183

By 1993, Ishizaki and David Small were working on a prototyping software to facilitate sketches for such a spatial interface. Small was an MIT undergraduate when he first got involved with the Visible Language Workshop in 1986. He continued as a graduate student, receiving an MS in Media Arts and Sciences from the Media Lab in 1990. Small was a Research Specialist by this time and Ishizaki was working toward his PhD, completed in 1996. Small finished his own PhD in 1999, with a dissertation titled "Rethinking the Book."

Small worked closely with Cooper, and his work provides a consistent line through 10 years at the VLW. His master's thesis on "expressive typography" explored how type might develop within software. This graduate work built from previous VLW projects around "soft" typography for improving screen legibility, but also took the possibilities of a purely dynamic typography seriously: "Perhaps the most exciting property of the computer is the ability to create images that evolve and change over time."[29]

At MIT, Small had access to increasingly fast computers, including a newly developed supercomputer. He described its potential for design:

> The use of the Connection Machine, a massively parallel supercomputer, provides us with a radically different way of thinking about the nature of graphics. It is possible to think of the screen, not merely as a canvas on which images can be pasted, but as an active, computationally rich medium.[30]

This thinking echoes what Cooper had been working consistently toward and had crisply articulated in "Computers and Design." Graphic software would evolve from production tool to communication medium only when its interfaces were sufficiently responsive. At that point, the tool would dissolve into the medium, and users would become readers.

Ishizaki insisted on this distinction in the opening pages of his dissertation, footnoting his first use of "reader":

A reader is a person (or a group of people) who is actively involved in the reading of information presented by the design system. The term "reader" is preferred to the term "user" or "recipient" because of its emphasis on the sense of active communication.[31]

Another strand of VLW research at this time used three-dimensional renderings to articulate complex information architectures. A project for NYNEX used a spatialized representation of connected nodes for a networked video conferencing tool. Relationships between individual communication points could be visualized by physical location, by status, and by recent activity, each of which adjusted the three-dimensional representation. Another interface for air traffic controllers displayed complex and overlapping flight paths using a constellation of adjustable views. Each of these was produced in the conventional manner as a static three-dimensional computer model, surveyed by a camera that moves through the scene and then rendered as static animations.

These projects were included among VLW works in progress at the fourth Technology, Entertainment, and Design (TED) conference in Kobe, Japan, in 1993. TED was a new idea at that time, a conference bringing together leading figures in these three increasingly related industries to present their work. Like Negroponte, TED's founder, Richard Saul Wurman, also trained as an architect. (Characteristically, Cooper called Negroponte and Wurman by abbreviated nicknames, Nicky and Ricky.)

Other VLW projects demonstrated infinite zoom, real-time information display, layers, filtering, and gestural control. All of the VLW work was presented under the rubric "information that arrives too quickly to design." In these projects, templates, animation, and machine intelligence replaced the conventional role of the graphic designer to render this high-bandwidth information flow legible.

On the return flight from Kobe in spring of 1993, Small, Ishizaki, and Cooper conceived the idea of collapsing these various research strands into one real-time information space.[32] That fall, a Silicon Graphics Onyx workstation with Reality II Engine display arrived at the Visible Language Workshop on short-term loan. This cutting-edge, quarter-million-dollar computer workstation could finally render dynamic, three-dimensional typography in real time, which would make the interface imagined on that flight possible. Small and Ishizaki got to work immediately on a submission for the Computer-Human Interaction (CHI) conference to be held in Cambridge in April 1994.

The software was assembled over one month of intense work, with Small and Ishizaki programming on the loaned computer in shifts, working asynchronously and discussing in between. The software used to produce their CHI submission was named simply Typographic Space. It allowed for the quick investigation of issues involved in populating a three-dimensional typographic environment which could be dynamically navigated by a user. The animation and composition engine which made this possible was built on work by VLW student Bob Sabiston.

Typographic Space was experimental software, without specific tasks or a real user interface. It was a tool used to realize interface sketches. The first spaces used geographic information systems to render physical maps overlaid by additional information. The maps grounded the scene in a familiar spatial metaphor, on which was layered abstract, typographic information. The three-dimensional interfaces soon moved to more assertively abstract "spaces," typically a constellation of colored type, with architectural-hierarchical relationships, rendered in an ink-black environment. Translucency, dynamic color, and blur were all employed as graphic filters capable of translating the rush of electronic information into meaningful, coherent chunks. The user was offered a first-person perspective, flying through this information space, reading by navigating its structure.

Even on the new SGI machine, programming an immersive, navigable field of information was a technical challenge. Small developed an efficient approach to rendering typographic glyphs in 3D space, based on previous VLW font work. Anti-aliased font rendering, which paradoxically renders type more legible on screen by blurring its edges, was a signature achievement of the Architecture Machine Group. In 1981, Ron MacNeil had built on this work and digitized a "very funky typewriter font" while developing SYS. Type-digitizing experiments continued in the VLW, including the "2-bit font" and "Brute-force Bodoni."

By this time, typographic rendering at the VLW was considerably more sophisticated but also more computationally intense. Small responded with an ingenious solution. Individual letters were rendered as texture maps (one-color images) applied to regular polygons. This was computationally less demanding, so that instead of calculating *x*, *y*, and *z* positions for every point along the complicated Bezier curves of a specific letterform, the software used the approximations of regular geometric primitives. To the user, the effect was the same. But this method, combined with Silicon Graphics' Performer code library, allowed for rendering a very large quantity of letters in one three-dimensional scene, fast enough for the user to navigate with no delay. (This font-rendering scheme was later repurposed in Processing, a Java-based software sketching tool developed at the Media Lab. Processing's font format employs remnants of Small's code and signals its debt through an idiosyncratic file extension, .vlw.)

Typographic Space implemented a simple flight simulator interface. This provided an off-the-shelf visual metaphor for navigating three dimensions. Nothing in the model changed, but instead a camera provided a surrogate for the user's view as it moved around the unbounded space. The mouse controlled viewing distance, and a collection of keys adjusted rotation and translation. Small describes the result as "smooth, simple, and as fast as your thoughts ... where information 'hangs' like constellations and the reader 'flies' from place to place, exploring yet maintaining context while moving so that the journey itself can become as meaningful as the destination."[33]

Typographic Space was submitted as a videotape of software experiments together with a short paper.[34] Around the time of the CHI submission, Cooper gave this space a more imaginative name: Information Landscapes. It was a term that slotted into a contemporary lexicon populated by many "information"-prefixed neologisms, including information anxiety, overload, superhighway. Cooper's name provided a frame for others to understand the possibilities inherent in its prototype form. Typically, although she was not engaged in the technical, procedural details of the software, she grasped its ramifications.

"Information Landscape" suggested an electronic environment that extends from the user's screen in all directions. This was not a new idea in interface design – even a Unix command line interface hints at the larger space beyond, accessed by a linguistic-symbolic command. But, in an "Information Landscape," this was made both explicit and literal. The user's graphic interface became a virtual window, a windshield, to peer into and navigate through the information landscape within.

Existing interfaces relied on the distinction between user input and display. From Xerox PARC's Alto and Star to Apple's Lisa, from Macintosh to Microsoft Windows, prevailing models employed a WIMP (windows, icons, menus, pointing device) paradigm and a mouse to control onscreen proxy objects. These were often hinged to a metaphor. Direct manipulation of the virtual object (a trashcan, paintbrush, file folder, document) via the mouse's cursor issued a command to the underlying operating system. For example, dragging a file to the trashcan deletes it from the hard disk, opening a folder allows the user to see its contents, dragging a window expands the view into its contents. An Information Landscape dispenses with these proxies in favor of a more immediate relationship to its data. There are no onscreen buttons, no objects, menus, or control panels. Instead, a concrete three-dimensional "landscape" of its data is presented for the user to navigate directly.

Cooper, Small, and Ishizaki realized that the legibility of the underlying data was critical. Cooper asked:

> How do you retain the integrity of the information, and at the same time, retain the context and clues that allow you to traverse complex information? You are, in a sense, in an architectural construct, but you don't have the constraints of having to believe a physical building. So you can both use the abstract conceptual issues, as well as the physical cues that people are accustomed to.[35]

The structure of the information landscape would have to mirror the structure of the material it presents. This is a typical graphic design problem, but here an extra dimension complicates it. Drawing on city planning, Small quotes Kevin Lynch from *The Image of the City* in his dissertation:

By this [legibility] we mean the ease with which its parts can be recognized and can be organized into a coherent pattern. Just as this printed page, if it is legible, can be visually grasped as a related pattern of recognizable symbols, so a legible city would be one whose districts or landmarks or pathways are easily identifiable and are easily grouped into an over-all pattern.[36]

By calling this a "landscape," Cooper placed its information in a context that is connected and meaningful. Traversing a landscape reveals the relationships between its constituent elements. Moving from one place to another is continuous, and the overall environment reveals itself as a function of the user's exploration. Small encapsulates this idea:

We must also consider that any journey through space is also one through time. No movement is ever truly instantaneous and the way in which we move and how the journey unfolds through time can be of great help in revealing the underlying structure of a landscape.[37]

But this structure could, and would naturally, change, as it was composed of electronic data with continuously shifting relationships. The tradeoff for an information landscape was clear: the more static the model, the more understandable. The more dynamic, the greater the possibility to reveal some of the relations between its data. The models could change, but not too much. Cooper, Negroponte, and Bolt had identified this issue years before in "Books without Pages":

Not only can dynamic text depart from the statically usual, but it can modulate in real-time before the reader, even as a function of where he is looking. Consider a text line where any word may dynamically change in size, shape, color, luminosity. This additional dimension, call it "Z," can be an intrinsically "non-spatial" dimension (color, luminosity), or can be along spatial dimensions into or across the page, exhibiting actual movement.

They continue:

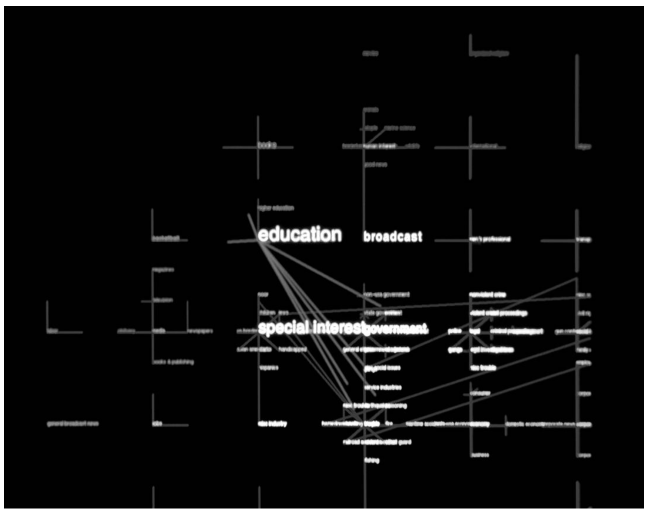
Why should text move or change? We see at least five reasons: to convey information that itself is changing, to pace the observer, to save "real-estate," to amplify, and to be attention getting. Each reason can be addressed in terms of kinds of change, which include (but are not limited to): 2-D/3-D translation and rotation; color changes; shape transformations; transparency; and transfigurations between icons and symbols.[38]

Following Cooper's and Lieberman's leads, Ishizaki was also investigating how artificial intelligence might make the new interfaces more user-friendly and more meaningful. Software understands the data model that manifests an information landscape and therefore could manipulate its display as it is being used. He imagined small chunks of data interacting with other small chunks of data, rearranging their relations in an infinite design process which he described as closer to dance than to graphic design. He proposed what he calls "A Model of Dynamic Design," in which

the visual designer can think during the course of designing ... creating visual design solutions that are as active and dynamic as a dance performance. A design solution, such as a display of on-line news, is considered a performance consisting of a number of active design agents, or performers, each of which is responsible for presenting a particular aspect of information, such as a headline or a news story.[39]

In "Dynamic News Display," a software project included on the CHI videotape, Ishizaki demonstrated this idea. An analog watch face floating on top of a world map provided the central interface to a news delivery system. Stories were anchored to their geographic reference and appeared on screen as they happened, tethered to the sped-up clock display. The interface used blur to push less immediate information to the background, dynamic linespacing to indicate nested relationships, and shifting color to indicate temporal shifts. Animation between these filtering strategies helped the user navigate the shifting terrain. This interface was also an information landscape.

Another information landscape was imagined by VLW student Lisa Strausfeld. Having previously studied architecture, Strausfeld addressed the spatial aspect of data directly, producing three-dimensional blocks of information that communicated different data relationships depending on the user's point of view. In her thesis "Embodying Virtual Space to Enhance the Understanding of Information," Strausfeld describes one such setup:



Information Landscapes (still from Galaxy of News), Muriel Cooper, David Small, Suguru Ishizaki, Earl Rennison, and Lisa Strausfeld, 1994
> p. 185

Imagine yourself without size or weight. You are in a zero-gravity space and you see an object in the distance. As you fly towards it, you are able to recognize the object as your financial portfolio. From this distance, the form of the object conveys that your portfolio is doing well. You move closer. As you near the object, you pass through an atmosphere of information about your net assets and overall return statistics. You continue moving closer. Suddenly you stop and look around. Your financial portfolio is no longer an object, but a space that you now inhabit. Information surrounds you.[40]

Muriel Cooper, presentation at TED conference, video, 1994
> p. 181

In an information landscape, the feedback loop between a graphic instruction and its realization had finally caught up to where Cooper always wanted it to be. The gap between a user's decisions and their consequences was more or less removed, and the tightness of this loop offered the possibility of continuous feedback and adjustment. Perhaps the most radical consequence of this work was its collapse of the user interface with its display. These two pieces become one in an information landscape – a user is completely immersed in the data she is manipulating. The user marks a path through the landscape, and reveals its structure en route as a function of her constant readjustment within it. It is an almost total synthesis of tool and medium.

Cooper presented Information Landscapes at the fifth Technology, Entertainment, and Design conference held in February 1994 in Monterey, California. At the start of her talk, Cooper, joining Wurman on stage for a conversation, sits down, sips a glass of water, and promptly removes her shoes. The presentation that follows is notably improvised, but also immediate and affecting.

Information Landcapes provided a sparkling new look into the networked data space that increasingly surrounded contemporary life. This world was barely glimpsed in 1994 through text-only Internet Relay Chat rooms, Usenet groups, mailing lists, and the thin graphic windows of Netscape Navigator 1.0 browsers. The new software offered a profoundly richer vision.

In an Information Landscape, interface was not a boundary or a thin layer for exchanging information between two working parts of a system, but rather a deep, immersive space. There were no buttons, no surrogates, no menus. Direct manipulation, a tenet of successful interface design, was even more direct. Information Landscapes offered a real-time, dynamic, and ultimately invisible bridge between the representation of information and its manipulation, realizing the responsive, real-time interface Cooper was always after.

Following TED in February and the CHI conference in Cambridge in April 1994, Cooper actively traveled and demonstrated the new work. She visited corporate sponsors and technology companies and spoke to design audiences in a flurry of activity around the work. Returning to Cambridge (Massachusetts) from Cambridge (England), where she had presented Information Landscapes to an audience of influential designers at the Alliance Graphique Internationale, she hosted a Department of Defense dinner at the Cyclorama building in Boston. That evening Cooper collapsed unexpectedly. She died May 26, 1994 of an apparent heart attack at the age of 68.

Wurman dedicated his book *Information Architects* to Cooper, and her "real-time display of heavenly navigation." Negroponte eulogized her, acknowledging her new work as consistent with her searching approach. Information Landscapes was the latest and most profound step in a career of restless exploration: "She has broken the flatland of overlapping opaque rectangles with the idea of a galactic universe."[41] But Cooper was already there, years before the computers fast enough to realize her vision arrived. She succinctly identified what remains at stake:

You're not just talking about how the information appears on the screen, you're talking about how it's designed into the architecture of the machine, and of the language. You have different capabilities, different constraints and variables than you have in any other medium, and nobody even knows what they are yet.[42]

Notes

1. Muriel R. Cooper Collection, Morton R. Godine Library, Archive, Massachusetts College of Art and Design, box 12-240.

2. Steven Heller, "Muriel Cooper" (interview), in *Graphic Design in America: A Visual Language History* (Minneapolis: Walker Art Center, 1989).

3. Muriel Cooper, "Graphics and New Technology," slide talk at MIT's Visible Language Workshop, 1981; available as an audio file at http://messagesandmeans.tumblr.com/post/77128529451/graphics-and-new-technology-slide-talk-by

4. Wendy Richmond, "Muriel Cooper's Legacy," *Wired* 2.10 (1994).

5. Ron MacNeil, email to author, 2012.

6. Lee Silverman, email to author, 2015.

7. Tom Wong, "Muriel Cooper Memorial Exhibition," exhibition pamphlet, 1994.

8. Richard Bolt, Muriel Cooper, and Nicholas Negroponte, "Books without Pages," proposal to the National Science Foundation, 1978, Muriel R. Cooper Collection, box 12-284. The following quotations are also taken from this source.

9. Ellen Lupton, "Fluid Mechanics: Typographic Design Now," in Donald Albrecht, Steven Holt, and Ellen Lupton, *Design Culture Now: National Design Triennial* (New York: Princeton Architectural Press and Cooper-Hewitt, National Design Museum, 2000).

10. Muriel Cooper, ed., "Computers and Design," *Design Quarterly*, no. 142, (1989), 3.

11. Ibid., 4.

12. Ibid., 4, 7.

13. Ibid., 10.

14. Ibid., 14.

15. Ibid.

16. Ibid., 17.

17. Ibid.

18. Ibid., 18.

19. Ibid., 20.

20. Ibid., 22.

21. Ibid., 26.

22. Ibid., back cover.

23. Henry Lieberman, "Intelligent Graphics," *Communications of the ACM* 39, no. 8 (1996).

24. Available as PDF from http://dspace.mit.edu.

25. Lieberman, "Intelligent Graphics."

26. J. F. Musgrave and M. R. Cooper, "Experiments in Digital Graphic Design," *IBM Systems Journal* 35, nos. 3–4 (1996).

27. Henry Lieberman, email to author, March 25, 2015.

28. Suguru Ishizaki, "Typographic Performance: Continuous Design Solutions as Emergent Behavior of Active Agents," PhD diss., Program in Media Arts and Sciences, School of Architecture and Planning, MIT, 1996, 18.

29. David Small, "Expressive Typography: High Quality Dynamic and Responsive Typography in the Electronic Environment," master's thesis, Program in Media Arts and Sciences, School of Architecture and Planning, MIT, 1990, 7.

30. Ibid, 8.

31. Ishizaki, "Typographic Performance," 15.

32. Janet Abrams, "Muriel Cooper's Visible Wisdom," *I.D. Magazine* (September-October 1994), 54.

33. David Small, "Rethinking the Book," PhD diss., Program in Media Arts and Sciences, School of Architecture and Planning, MIT, 1999, 29, available at http://acg.media.mit.edu/projects/thesis/DSThesis.pdf.

34. David Small, Suguru Ishizaki, and Muriel Cooper, "Typographic Space," in *Conference Companion, CHI '94* (New York: Association for Computing Machinery, 1994).

35. Muriel Cooper, from video documentation of TED 5 conference, Monterey, California, 1994.

36. Small, "Rethinking the Book."

37. Ibid.

38. Bolt, Cooper, and Negroponte, "Books without Pages."

39. Ishizaki, "Typographic Performance."

40. Lisa Strausfeld, "Embodying Virtual Space to Enhance the Understanding of Information," master's thesis, Program in Media Arts and Sciences, School of Architecture and Planning, MIT, 1995.

41. Nicholas Negroponte, "Design Statement on Behalf of Muriel Cooper," presentation at the Chrysler Design Awards (1994).

42. Elizabeth Glenewinkel, "Muriel Cooper's Legacy to Design," master's thesis, Master's in Design Methods, Institute of Design, Illinois Institute of Technology, 1996.