The New Screen Images
And Their Impact on the Field of Planning

Sigmund Asmervik
Foundation for Scientific and Industrial Research
Norwegian Institute of Technology

Working Paper No. 465

April 1988

Institute of Urban and Regional Development
University of California at Berkeley

The New Screen Images and Their Impact on the Field of Planning

INTRODUCTION

We are witnessing tremendous new changes and transitions caused by the new information technology. These changes permeate every aspect of our lives, from the personal to the global. On a global scale, currency transactions across national borders give us an idea of the dimensions. In 1986, international foreign exchange reached the incomprehensible number of $87 trillion. This figure is 23 times the U.S. GNP. But what is most striking is that traditional trade accounts for just 18 percent of the $87 trillion. The rest is accounted for by transactions -- just information -- flowing across national borders. The increase of these information transactions has been enormous in the last few years. Before 1970, they made up between $1 trillion to $3 trillion per year. The increase from 1985 to 1986 was $22 trillion. The numbers in 1984 were just half of the 1985 transactions.

In this light, we can better understand that the sudden fall of the stock market on Black Monday, October 19, 1987 had to do with the mind-boggling dimensions of information technology. It is more than just a slogan to say that we are moving from print to electronic media, from page to screen.

In spite of the increasing use of paper in the computer age, less than one out of five words were delivered by print in the U.S. as far back as 1977. The old slogan, "Publish or Perish," is rapidly changing to "Demo

or Die." The literacy question is being discussed in a new arena. Most people can read, but they don't read much; this situation is partly born of information overload, a natural product of the increasing use of television and the different forms of video during the last three decades. Tomorrow's literacy may be defined not as the ability to read, but the ability to consciously and critically choose what to watch and how to watch it, whether over TV, video, or computer monitors.

The last five years have been the most turbulent years in the history of media in the U.S., according to "Field Guide to the Electronic Environment." The 1986 issue states that as many as 26 new kinds of public electronic media are on the market.

Planning, as a profession and a field of teaching and research, is and will be increasingly affected by these new tools. In this short paper, I will not trace the impact of all the new technologies on the field of planning. I will comment on five technologies which I find relevant to the field of planning in different ways: CAD, image processing, video, CD-ROM, and interactive videodiscs.

THE NEW KNOWLEDGE

- *From aggregation to selection,*
- *From broadcast to broadcatch.*

A few decades ago it was a compliment to be called a "walking encyclopedia." Knowledge was a cumulative aggregation of different data. This has changed dramatically in just a few years. There is an urgent need to redefine knowledge to be able to live in a society plagued by information overload. Instead of different forms of aggregate knowledge, we need methods and theories for selection and simplification. It is not

by chance that a great part of new mathematics deals with the problem of oversimplification.

Consumers are taking over the 'information marketplace', and this is a very important shift in the way information is produced and used. Instead of products being sent by a producer, a product is being sought by a user. We are changing from broadcast to broadcatch. Newspapers are produced today using about 10 percent of the information available online and people on average read only about 10 percent of that. With direct access to an electronic newspaper, the reader will have the total 100 percent of information at his disposal.

The skills we need to develop (besides skills for the activities of daily living) can be summed up in two main categories:

- Skills that enable us to live with change, which are much more important than in the past;
- Skills to understand structures and processes rather than single objects and isolated phenomena.

Selection of knowledge will be more important than storage. In a society overloaded with information, we can get information in three major ways: (1) by grazing, (2) by browsing, and (3) by hunting. An example of grazing for information is when we just flip randomly through channels on our television sets. We browse for information when we scan newspapers and magazines. When hunting information, we choose consciously by looking for and isolating specific information. The computer is a brilliant tool for information hunting.

The new sort of information I am talking about has to do with hunting information, little to do with browsing for information, and nothing at all to do with just grazing.

VISUAL IMAGES

- *From text to pictures,*
- *From confidence to illusion.*

Nothing seems more obvious than what you see is what you get. But for a long time, the function of the human eye was not understood. It was not until the first half of the seventeenth century that Kepler was able to theorize the geometry and perception of the human eye.

New technology developed in the last few decades still confuses us about the reality and illusion of what our eyes see. For example, when I visited the new media lab at MIT this fall, I was confronted with the world's first projected hologram, a GM Camaro car parked in midair. Trying to grasp it with my hand, there was nothing to catch. The information was in my head, and not in the air!

Vision is still in many ways a mystery. In spite of this, or maybe because of it, we can detect a tendency to move from text to visual images in the use of the latest information technology. This trend is worded in ways such as: "Towards the end of the century as much as half of the GNP will be connected to handling visual information," or "In the year 2000 the bulk of the available information will consist of digital images."

To display information pictorially is complex for the designer but often beneficial to the user, who may find it helpful to have concepts and relationships displayed in a nonverbal way. It is interesting to note that those in such abstract and alphanumerical fields as mathematics and statistics are among the most frequent users of the new media to visualize their problems.

There are some profound and interesting differences between the traditional written language and visual images. Written language, as compared to pictures, is slow and linear. Conclusions are reached by going step-by-step through different sequences. Visual images, on the other hand, give an instant message. You can choose which part you will look at first, and you get the main message directly without going through step-by-step linear sequences.

One of the main reasons, if not the most important, for increased interest in the visual image on digital and analog screens is that messages can be sent at higher speeds. But there are also other important reasons. The picture can explain the whole -- the structure and the main message of a phenomenon -- better than texts.

Another important application for visual images is in showing a time series of a phenomena (e.g., yearly, daily), and cycles, which can often explain a problem in a striking way. From there, motion pictures are just around the corner. Motion pictures are a type of time series.

In certain fields, theories and methods for using graphs, diagrams, and symbols to explain different phenomena have been developed. One such field is cartography, where theories of graphic semiology have been developed, particularly in Europe, where a tradition was established by Jacques Bertin in France in the 1960s. New challenges ahead are to develop these theories and methods for computer and video screens.

Along with the new technology and its applications to the field of planning comes the necessity, for both the professional and the layperson, to learn how to interpret the pictures, maps, drawings, models, and videos used to simulate a proposed future. In Sweden, some important work in this vein was started in the late 1960s by Acking and Kuller at the

University of Lund. Their theories were strongly influenced by environmental psychologists and addressed different semantic models, attempting to describe in a scientific way the subjective reactions of the general public to different built environments.

Researchers at the Environmental Simulation Laboratory at the University of California at Berkeley have made important contributions to research on these problems. Peter Bosselmann and his colleagues have made a distinction between the terms conceptual simulation and perceptual simulation. They also separate static and dynamic simulation.

Static conceptual information includes maps and two-dimensional plans; dynamic conceptual simulation includes computer modeling of different problems such as ecological processes, population trends, etc. Static perceptual simulations include sketches and photographs; dynamic conceptual simulations include filmed modelscope tours of scale models of places. The laboratory has been especially active in this last category. They asked the very important question, "How good are the simulations?" After testing the alternatives on a real drive, a filmed tour, and a filmed modelscope tour, the answer they came up with is that the filmed modelscope tour is good enough to be used to present planning proposals. But the electronic media have also introduced new dimensions of illusion. Remember the example with the projected hologram? A photo is no longer what it once was. It can no longer be used, for example, as court evidence. It is not only the history of the Soviet Union that can be changed by removing persons from "authentic" historical photographs (I am thinking of the way Trotsky was retouched from pictures). The new video and image process techniques make it possible to change a visual image on the screen almost instantly. This is an invaluable tool for many reasons

when creating high-quality pictures. But it also emphasizes the necessity of ethics in the field.

Although we can now see actual photographs of the surface of the moon and the cells of our bodies, visual images seem to go beyond the representation of concrete images. In some ways, yesterday's reality has become tomorrow's illusion.

TRENDS IN INFORMATION TECHNOLOGY

- *From hardware to software,*
- *From analog to digital,*
- *The marriage of the computer and the video.*

For at least two decades most of the development in information technology took place in the field of hardware. Cheaper, faster, and more powerful machines were presented each year. For some reason, hardware development seems to have slowed. It is hard to imagine a machine faster and more powerful than the Cray Super, and the development of personal computers seems also to have reached a plateau. For example, the newly released models from Apple and IBM are converging. Macintosh features are drawn from IBM and IBM draws from Macintosh. The new MacII is astonishingly similar to IBM's new PS-2.

The first digitalized images were revealed and transmitted as early as 1924, but it is in the last decade that we have experienced the real digital revolution. Digitalized media are a totally plastic, noise-free message carriers of sound and image. Their limitation is that they cannot produce motion pictures, which is the main reason that the video, based on analog signal and used for motion pictures, has survived.

The competition in the media market has been as intense as a crime thriller in the last few years. Stewart Brand's recently published book, The Media Lab: Inventing the Future at MIT, exemplifies the competition for the home video market between videodiscs and videocassettes. According to Brand, VCR (videocassette recorders) surpassed the videodisc players for superior marketing and superior technology. Promoters of the videodisc catered to a more educated and sophisticated public, and refused to deal with pornography, whereas VCR promoters built an industry on it. Pornography accounted for half the sales of prerecorded videos during the first years. Later on, it settled at about 15 percent while the rest of the business took off, according to Brand. The technological differences between the two media were reportedly more pronounced. The discs produced a higher-quality image, but could not be recorded on. Magnetic tape, on the other hand, was an invitation to do it yourself. This explains why the video became the medium for the proletariat in just a few years.

Future predictions look to the new dense media with optical storage capacity, such as CD-ROM and videodiscs, as the next revolution in storage and publishing. The development of screen design and user interfaces seem to be two of the main research areas for the near future. Both areas are relevant to architecture and planning.

However, it is within the field of software that brave new creations are expected. Integration and cooperation will be important key words. Nicholas Negroponte, the Greek-born architect and director at MIT's new media lab has long envisioned a fascinating integration of the three media giants: the broadcasting and motion picture industry, the print and publishing industry, and the computer industry. His prophecies seem to have reached fruition. The last few years have seen interesting hybrids

of these industries. "A marriage between the computer and the video" is a phrase describes the power of the interactive videodisc. The annual Nebraska Videodisc Symposium in October 1987 echoed these prophecies: computers and television are dissolving. They will both disappear, to be replaced by all sorts of combinations and integrations between different technologies.

THE PLANNING PROCESS

- *From product to process,*
- *From document to interactive use of electronic media.*

The planning process can be divided into four main phases:

- Phase II -- Proposal phase, with the development and testing of different alternatives being typical for this phase.
- Phase III -- Decision-making phase, when politicians and the public are brought into the process and the material presented must be made understandable to the general public.
- Phase IV -- Publication and information phase, by when the material should be easy to understand and readily accessible.

In the planning process, we have three main groups of users: planners, who needs data and calculations for their work; other professionals with whom planners need to exchange information; and the public, to whom the information should be accessible and clear.

Materials presented in the planning process should be as short as possible, be true and reliable, and focus on main points and explain consequences.

Contradictions can easily appear. It is difficult to achieve clarity, brevity, and truth simultaneously. The paradox inherent in the above principles is described below.

The most definite and judicial way to present a plan is often the most difficult to understand for the layperson. And the clearest presentation is using three-dimensional pictures, photos, and video which are also the easiest to unfairly manipulate. Thus, ethical considerations enter the presentation process, and the new technologies demand high ethical standards of professionals. Houses can be made to look shorter using special camera angles; models of proposals can be improved by showing them in nice weather, with lots of smiling people. Conversely, a solution can be made to look bad by illustrating it with no trees but lots of cars.

We will now take a closer look at some of the new media and how they can be used in the different phases of the planning process.

CAD, COMPUTER-AIDED DESIGN

- A term that encompasses everything from Cray to Mac, from drawing to three-dimensional modeling and animation.

The term CAD was introduced in the 1960s and is often combined with the acronym CAM, computer-aided production. CAD/CAM sounds good phonetically, which is one reason it has stood its ground against many other terms introduced in the last ten to 15 years. In practice, CAD/CAM refers to the combined use of the computer and a workstation, and the use of a plotter/printer in our work as architects and planners.

One of the classic books on the subject is William J. Mitchell's Computer-Aided Architectural Design (1977). Mitchell summarizes the main tasks for the computer in architecture and planning as follows:

- o Store and retrieve data;
- o Automatically generate solutions to well-defined problems; and
- o Test potential solutions to a stated hypothesis.

In representing reality with visual images, he divides these into three categories: analog representations, iconic representations, and symbolic representations.

An example of analog representation is the way the famous Spanish architect Antonio Gaudi employed a flexible, suspended wire frame covered with cloth and hung with weights. As the wire and weights were manipulated, the wire frame took on different forms, and gave an analog image of the different solutions.

The iconic image is an image that looks like the object itself, as in perspective drawing or a three-dimensional model. Symbolic images represent different solutions by using symbols as letters and numbers.

One main use of the computer by planners is in site studies, based on points, lines, surfaces, and volumes. More complicated studies which include dynamic models and time series are powerful tools as well.

Computer graphics is a vast area with multiple uses. The fantasy and creativity of the planner are often more limiting than the technology. The latest programs which combine video images with computers make it possible to manipulate digitalized images in many ways. Animation, modeling, and real time presentations are new, fascinating, and powerful tools to simulate future images.

Looking at the four phases of the planning process, we can see how CAD applies to different parts of the process:

- Phase I -- Data collection. Here, the computer is a very helpful tool. The ability to store and retrieve data has obvious utility. Online updated databases give the relevant information.
- Phase II -- Planning proposals. Here, also, CAD is of great help. With a computer and a relevant program, several different alternatives can be produced and tested in a short time.
- Phase III -- Decision-making. Here the CAD systems are less useful, but interesting capabilities are produced when the computer is combined with other media such as video.
- Phase IV -- Information. The CAD system has little or nothing to do with this phase.

IMAGE PROCESSING

- *Making the invisible visible.*

It took a long time to comprehend how the human eye perceives and processes what it sees. After understanding these aspects, it was obvious that our primary sense has a very limited range. Illusions are taken for reality; we continually misjudge sizes, distances, and directions. The new information technology used the computer's eyes to take us to outer space and deep into our own biomedical mysteries. During the last two decades, technology has made the invisible visible.

Image or picture processing is mainly used in three areas: biomedical image processing, remote sensing, and industrial automation. Remote sensing is the area that relates to planning. When used with satellites,

remote sensing provides continuously updated and detailed information of the different parts of the world, a capabiliy that we could not have dreamed of a few years ago. Think of how the Chernobyl catastrophe was described by satellite pictures. In this arena, GIS, geographical information systems, is a field with great potential.

Remote sensing and image processing relate to the four phases of the planning process in these ways:

- Phase I -- Data collection. This is the phase when remote sensing and image processing are most useful.
- Phase II -- Planning proposals. Image processing can be important when testing the consequences of different proposals.
- Phase III -- Decision-making There is little use of remotely sensed pictures, although perhaps it can be used to convince viewersof important connections between different proposals.
- Phase IV -- Information. There is use if there are some good quality, impressive shots.

VIDEO

- The visual medium of the masses.

The VCR and inexpensive videocameras made the videotape an inexpensive media for mass consumption. Because you could record and produce yourself, it was a fascinating do-it-yourself tool kit. Although the picture quality of the VHS is not impressive, it is a medium easily used without special education or training and it had a tremendous success on the home market in the late 1970s and early 1980s. More than 40 percent of the U.S. population now have VCRs.

Video is often compared to film and while the two media have many similarities, the differences outweigh the similarities. Film has its obvious advantage over video in picture quality and is easier to edit. But it is a relatively expensive medium, both in equipment and production. It is fairly complicated to operate and you need trained professionals. The production time is often somewhat long.

Video, on the other hand, is inexpensive (referring to the VHS standard). You can shoot and play on the same day, and most people who can operate a camera can produce a home videotape. But editing is much more complicated than for film.

For video production, as for all other production, one must evaluate the consumers carefully in choosing standard and quality. I break it down into three levels:

- Level A -- For internal use in a family, organization, or company. For this purpose, the VHS is very good and the amateur production can be very inexpensive.
- Level B -- For internal use, for example, between actors in a planning process, politicians, and other professionals involved in the planning process.
- Level C -- Level C represents a great leap. At this level, the productions are made for the general public and have to compete with other public media products, such as commercials on TV, newspapers, and radio. This means that you need first-class professionals and better equipment than the VHS.

The use of videotape cassettes in the planning process can be defined as follows:

- Phase I -- Data collection. In this phase, inexpensive VHS equipment can be very useful to describe the existing conditions in an area, such as traffic density, interesting landscapes, interviews with the population, etc.
- Phase II -- Planning proposals. In this phase, the video is of less use.
- Phase III -- Decision-making. In the decision-making phase, short videotape productions can be very helpful to illustrate special parts of a proposal. The strongest feature of video, the motion picture, can here be used to show traffic, live interviews, recreational activities, etc.
- Phase IV -- Information. To inform the public, videotape cassette is a good medium. While it should be produced by professionals, the standard could very well be VHS. This provides the opportunity to play the tapes at home and in schools and other institutions.

CD-ROM (COMPACT DISC/READ ONLY MEMORY)

- *The new papyrus.*

Some of the most exciting developments in the media industry at the moment are the development of different types of compact storage that is read optically by a laser beam. The break-through in CD audio a couple of years ago inspired many companies to go into this fascinating technology. Digital storage of information in this medium paves the way for a real revolution in storage and publishing. No wonder people are talking about how these technologies will replace print and books as papyrus replaced clay.

The technical data behind these products resembles the introduction of the microchip to the computer. The storage capacity of a CD-ROM disc, at the size of a CD audio is about 540 megabytes or 540 million bytes. That's about 1,200 standard floppy disks! All this for a cost of $10, with random access within one second. Translated into another medium, the book: the first popular CD-ROM produced in 1986 contains Grolier's Academic American Encyclopedia, 20 volumes and a considerable index. It takes up just one-fifth of a CD-ROM and costs approximately $200. CD-ROM has, of course, drawbacks. You can not write on it as you can on a magnetic disk. And it has very reduced possibilities for presenting moving pictures compared to the videodisc.

CD-ROM has varied uses in planning:

- Phase I -- Data collection. CD-ROM is useful to some degree in collecting data from permanent registers and statistics from maps. CD-ROM is a very good medium for different sorts of maps.
- Phase II -- Planning proposals. There is very little use of CD-ROM in this phase.
- Phase III -- Decision-making. This is not a field for CD-ROM.
- Phase IV -- Information. CD-ROM has a great future as mass information and publishing medium, although much depends on developing hardware to combine with the now well-established CD audio player.

INTERACTIVE VIDEODISC

- An interesting marriage between the digital computer and the analog video.

Interactive video has two main points of interest: It combines technologies based on both digital and analog signals. It is an interactive medium. The user selects information instead of just grazing.

The principles for the videodisc were invented in 1925 by John L. Baird. Almost 40 years later in 1962 a playable disc that was optically recorded and read was produced. Up through the early 1970s there was great optimism about the videodisc. But as with much of the new technology, it went through different phases of development. The period of uncritical optimism is often followed by perhaps an excessive pessimism. That happened in the late 1970s when the disc had lost the home market to the videocassette tape. During the last two and three years there has been a new surge of optimism around the interactive videodisc. The time is ripe for a more pragmatic and realistic benefit evaluation.

Like CD-ROM, the videodisc is an optical storage medium, with low-cost, large storage capacity (54,000 separate images, or for video, about 30 minutes play time on one side). But the videodisc is not a recording medium. It is printed once and forever like an LP record. The videodisc differs from CD-ROM in that it uses analog video signals, which means that it is capable of playing motion pictures. And it can have two audio tracks. Because it is interactive, with an access time of 1-2 seconds, it is an exciting medium for many purposes. Some of the interactive videodisc capabilities include freezing any one of 54,000 still frames; playing frames step by step; playing in slow motion; and playing with fast motion and scan, to mention the most common applications.

In interactive video, we talk about levels of interaction:

- Level 0, or basic level refers to playing just one way, with no use of computers or other technology.
- Level 1 -- Here, interaction is limited to simple commands through the control panel on the player or the keypad.
- Level 2 -- Interaction is made possible through the use of industrial or educational videodisc systems containing programmable microprocessors.
- Level 3 -- Interaction offers still greater program potential and capabilities. At this level, disc players are interfaced with a computer, often a microcomputer, which allows a wide range of programming possibilities and work with one or two screens.

The four main areas for the interactive videodisc are home entertainment, marketing and sales, training and education, and information and storage. The two last areas relate most directly to the field of planning. Referring to the four phases discussed earlier:

- Phase I -- Data collection. Data can be collected by interactive video from stored information in different fields and media such as photos of historical buildings and books.
- Phase II -- Planning proposals. Interactive video has relatively little use in this phase.
- Phase III -- Decision-making. A video of a whole town or community could be stored on a disc (54,000 stills) and called up during a discussion of the location of a new building. Images could be stored of both summer and winter.
- Phase IV -- Information. A whole set of county or town plans could be printed on one disc, from which people could get information by using the media interactively.

CONCLUSIONS

The different and new screen media have their own characteristics and can be used in different phases of the planning process. Some, like CAD and remote sensing, are most relevant to the two first phases. Others, like CD-ROM and interactive video, are best suited to the last phase, whereas inexpensive videotape can be used in all phases.

Diagram 1 shows how the different new media can be used in the different phases.

DIAGRAM 1

	Phase I	Phase II	Phase III	Phase IV
CAD	Primarily for Phase I & II			
REMOTE SENSING	Most relevant to Phase I			
VIDEO	Relevant to all phases			
CD-ROM	Can be of use for Phase I			Most relevant to Phase IV
INTERACTIVE VIDEODISC	Can be of use for Phase I			Most relevant to Phase IV

One of the most important questions in the whole planning paradigm is this: are different technologies giving us pictures of the past, or are

they simulating images of the future? You can describe and explain the past, but you can only suggest and simulate the future.

The way these new media show us images of the past and the future, and the extent to which we can have confidence in the pictures shown, are giving direction and content to the coming paradigm of planning. As the diagrams show, remote sensing, CD-ROM, and video are all basically media of the past; only CAD, computer graphics, modeling, and animation are media for the future. Diagram 2 shows how the different technologies respond to the past and future.

DIAGRAM 2

	Past	Future
CAD		Primarily for simulating the future.
REMOTE SENSING	Images of the past.	
VIDEO	Primarily documentation of the past.	
CD-ROM	A medium for storage of the past.	
INTERACTIVE VIDEODISC	A medium showing the past.	

I have just commented on five areas of the new screen images. As mentioned in the beginning, there are many more, mostly combinations of the five discussed. The five areas dealt with represent a wide spectrum and cover in different ways all phases of the planning process.

While the screen images are fascinating, paradoxically, they are frightening in some ways. On the one hand, they help you to see what you could not see before and they help you to calculate what you earlier could not. But on the other hand, they tease you; you can never be sure reality is represented or a variation of reality. The photo that seems to represent a concrete image can turn out to be an illusion. Thus, paradoxically, more control and more databases can create instability and uncertainty. This brings us back to the Black Monday on the stock market of October 19, where incomprehensible amounts of money were moved as information between the main concentrations of capital around the world. Where you earlier did not see, you now see; and areas that, before, were visible and under control, are now elusive -- and sometimes, obviously out of control.

REFERENCES

Block, J. et al. Understanding Three Dimensions. Englewood Cliffs, NJ: Prentice Hall, Inc. 1987.

Bosselmann, P. Perceptual Simulations of Environments, Working Paper 444, Institute of Urban and Regional Development, Berkeley, CA, 1985.

Brand, S. The Media Lab. New York, NY: Viking Press, 1987.

Bruce, V., et al. Visual Perception, Physiology, and Ecology. London; Hillsdale, NJ: Lawrence Erlbaum Ass., Ltd., 1985.

Greenberg, D. P. "Computer Graphics in Architecture," Scientific American, May 1974, pp. 98-106.

Hsing, R. Visual Communication and Image Processing. Proceedings of SPIE, Volume 707, Cambridge, MA, 1986.

Isailovic, J. Videodisc and Optical Memory Systems. NJ: Prentice-Hall, 1985.

Jeong, T.H. Practical Holography II. Proceedings of SPIE, Volume 747, Los Angeles, CA, 1987.

Klinger, A., et al. Data Structures, Computer Graphics, and Pattern Recognition, New York, Academic Press, 1977.

Lambert, S., et al. CD-ROM, The New Papyrus. Redmond, Microsoft Press, 1986.

Levine, M.D. Vision in Man and Machine. New York: McGraw-Hill, Inc., 1985.

Margolin, V., et al. The Promise and the Product. New York: McMillan, 1979.

Mitchell, W. J. Computer-Aided Architectural Design. New York: Petrocelli/Charter, 1977.

Negroponte, N. The Architecture Machine. Cambridge, MA: MIT Press, 1970.

Negroponte, N. Soft Architecture Machines. Cambridge, MA: MIT Press, 1975.

Parsloe, E. Interactive Video. Sigma Technical Press, Cheshire, UK, 1983.

Pipes, A. Computer-Aided Architectural Design Futures. London: Butterworths, 1986.

Setty, K. S. L. Visual Simulation and Image Realism II. Proceedings of SPIE, Volume 303, San Diego, 1981.

Sugarman, A. D. et. al. High Tech Real Estate. Homewood, IL: Dow Jones-Irwin, 1985.

Surmanek, J. Media Planning. Lincolnwood, IL: NTC Business Books, 1986.

Tescher, A. G. Applications of Digital Image Processing VIII. Proceedings of the International Society for Optical Engineering, Volume 575, San Diego, CA, 1985.

Tufte, E. R. The Visual Display of Quantitative Information. Cheshire, CT: Graphic Press, 1983.