Chapter 5

Impact of Technology on the Creative Environment

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Chapter 5

Impact of Technology on the Creative Environment

FINDINGS

The development and widespread use of the new information and communication technologies are changing the creative environment in a number of ways, many of which will have significant implications for the intellectual property system. These technologies, for example, are redefining who creators are and what motivates them, the kinds of tools and materials they use, and how they gain access to these tools, the skills and knowledge they need to pursue their work, and their roles and relationships to others in their environment.

In this new environment, the incentives and rewards provided by the intellectual property system may no longer achieve their intended policy goals, In many cases, they inadequately reflect the motivations, needs, and perceptions of the members of the creative environment, or the kinds of activities that they pursue. Moreover, they may miscalculate the economics of creating, producing, and distributing intellectual properties, Under these circumstances, new kinds of inducements may be required.

One of the most significant differences in today's creative environment is the growth in the number of participants and the transformation of traditional roles and relationships. New participants have entered the scene as new technological opportunities have emerged. Not parties to previous intellectual property agreements, many of the new players and even some of the older ones who now operate in new modes, have new and divergent attitudes about who should have access to works and materials, and about what kinds of activities and pursuits should be rewarded. Under these circumstances, controversies are likely to develop among players about the distribution of rewards. Furthermore, in the future, there may be less consensus about the basic aims of the intellectual property system.

The new technologies will greatly enhance the creative environment, providing new and powerful tools that can expand the boundaries of creativity, changing the ways in which creators and inventors carry out their work, and opening the way for more people to participate in the creative process and to share the products of scholarly and scientific research. At the same time, these technological capabilities also pose new problems for the intellectual property system. Allowing users to access and manipulate creative works with unprecedented ease and speed, they make it more difficult for creators and inventors to identify or trace incidents of copyright infringement or plagiarism.

INTRODUCTION

The American system of intellectual property rights was established to foster creativity and learning by providing economic incentives to individual creators, [1] It was assumed that such incentives, in the form of exclusive rights, would stimulate the development and dissemination of ideas, discoveries and inventions, information, and knowledge. As a result, artists, writers, and scholars would have at their disposal the resources necessary to support their creative work. Most of what they needed was available through printed materials,

[1] Throughout this chapter the term creators is used in a generic sense to include all those people who are involved in artistic or intellectual activities.

Today, however, we have moved far beyond the print culture into an era where the new information and communication technologies are rapidly altering the environment for creativity. This raises the question of whether incentives of intellectual property rights, established in an era when the printing press dominated communication technology, remain adequate in an age of information and electronics.

This chapter analyzes the relationship between incentives and the creative environment by examining: 1) how technology relates to the creative environment, and 2) how today's new technologies are affecting that environment. Where possible it will distinguish between the environments in which artists, scholars and scientists, and information entrepreneurs operate to determine whether technology is affecting these areas in different ways in order to identify where creators might require different kinds of incentives and rewards.

THE CREATIVE ENVIRONMENT

Artists, writers, composers, and inventors do not work in a vacuum. Nor, as the social historian Elizabeth Eisenstein has pointed, "do major innovations, discoveries, and artistic works spring to life abruptly and full blown, like Minerva from Jove's brow."[2] Rather, an invention, discovery, or creative act is more like a complex social process than an isolated incidents The environment in which these processes occur is the "creative environment."

The creative environment consists of several elements:

- the creators themselves—the scholars, poets, writers, artists, inventors, and others who produce intellectual works;
- the tools and materials that creators need to perform their tasks;
- the foundation of artistic and intellectual material on which to build, which might be as fundamental as an epic poem or as sophisticated as an on-line, bibliographic database;
- a set of skills and procedures for carrying our their work;
- a formal or informal system of education and training;
- a network of relationships with others, each constituting a set of roles; and
- a community of shared and supportive values and a system of incentives and rewards.

Together, these elements constitute a system in which each part affects all others. The creative environment can also be influenced by external factors, such as economic developments, politics, or social change. Technology is one external factor that is likely to have a particular significant impact because just to be able employ it generally requires the restructuring of the environment in which it is to be used.[4]

As the following discussion shows, the influence of technology on the creative environment is likely to take several forms. It will affect who the creators are and what motivates them, what kinds of tools and materials creators use and how they get access to them; the skills they need to carry our their work; and their roles and relationships to others in their environment.

[2]Elizabeth L. Eisenstein, *The Printing Press as an Agent of Change: Communications and Cultural Transformations in Early Modern Europe*, vol. I (Cambridge, England: Cambridge University Press, 1979), p. 31. For two other discussions of the interrelated activities and processes leading to invention and creativity, see also, Arnold Pacey, The *Maze of Igenuity, Ideas and Idealism in the Development of Technology* (Cambridge, MA: MIT Press, 1980); and Daniel J. Boorstin, *The Discovers: A History of Man Search to Know His World and Himself* (New York: Vintage Books, 1985).

[3]Eisenstein, op. cit., p. 31.

[4]Langdon Winner, *Autonomous Technology: Technics Out of Control as a Theme in Political Thought* (Cambridge, MA: MIT Press, 1977), p. 100. See also Jacques Ellul, *The Technological Society* (New York: Vintage Books, Alfred A. Knopf, 1964).

IMPACT OF TECHNOLOGY ON CREATORS

Societies are shaped and characterized by the technology that predominates in them. one can speak, for example, of Stone Age man or of the basket weavers. Today, computer technology is becoming pervasive. While virtually everyone encounters this technology daily in one form or another, its power and scope ensure that it will have an especially pronounced effect on those involved in creative, scientific, and scholarly pursuits. In particular, it will affect how artists, inventors, and scholars see themselves–their self-image, and what motivates them.

Self-Image and Motivations

The historical case of the printing press illustrates how technology can affect creators' self-images and motivation. In fact, the concept of individual authorship, which definitively changed authors' self images, emerged from this new technology.[5] Before the printing press manuscripts were treated more or less as sacred texts whose authorship was as irrelevant as it was difficult to ascertain. Daniel Boorstin captures how difficult it was to trace authorship before the establishment of a printed, title page:[6]

> There were special problems of nomenclature when books were commonly composed as well as transcribed by men in holy orders. In each religious house it was customary for generation after generation of monks to use the same names. When a man took his vows, he abandoned the name by which he had been known in the secular world, and he took a name of one of the monastic brothers who had recently died. As a result, every Franciscan house would always have its Bonaventura, but the identity of 'Bonaventura' at any time could only be defined by considerable research.
>
> All this, as we have seen, gave a tantalizing ambiguity to the name by which a medieval manuscript book might be known. A manuscript volume of sermons identified as Sermones Bonaventurae might be so called for any one of a dozen reasons . . . . Was the original author the famous .Saint Bonaventura of Fidanza? Or was there another author called Bonaventura? Or was it copies by someone of that name? Or by someone in a monastery of that name? Or preached by some Bonaventura, even though not composed by him. Or had the volume once been owned by a Friar Bonaventura, or by a monastery called Bonaventury? Or was this a collection of sermons by different preachers, of which the first was a Bonaventura? or were these simply in honor of Saint Bonaventura?

The printing press not only gave rise to the concept of the individual author, it also affected how creative people were motitated. With the enhanced economic value of printed books fostered by the new technology, creators encountered conflict concerning whether they were—or should be— 'serving the muses or mechanic printers, [or were] engaged in a 'divine art' or a 'mercenary metier. ' "[7] Just as the printing press affected the self-image and motivations of 17th and 18th century creators, so too are the new information technologies already changing contemporary creators' attitudes and perceptions about themselves and their work.

In many fields, the convergence of audio, video, and computer technologies now allows the creator to express his/her art in multiple modes and media, changing the way he/she defines his role. Basing her art on a variety of technologies, the entertainer, Laurie Anderson, for example, defines herself at one and the same time as a musician, a composer, a video maker, a writer, an inventor, and a pop stars The same technologies turn audio engineers into stage

[5] As Einsenstein has pointed out

> From the first, authorship was closely linked to the new technology. As Febvre and Martin suggest, it is a 'neologism' to use the term 'man of letters' before the advent of printing. Partly because copyists had, after all, never paid those whose works they copied, partly because new books were a small portion of the early book trade, and partly because divisions of literary labor remained blurred, the author retained a quasi-ameteur status until the eighteenth century

Eisenstein, op cit., pp 15;1- 154

[6] Boorstin, op. cit., p 530

Eisenstein, op. cit., p. 53.

[7] J. Hoberman, "The New Avant-Garde From Anderson to Byrne," *Dial Magaine*, July 1985, pp. 5-6.

performers, sound-mixers into composers and performers on records,' and computer scientists into film artists. Many artists are also software designers, many composers are technicians, and many biologists are information scientists. As technology becomes more integral to the arts, artists have to become technicians before they can create.

Beyond changing perceptions of their roles, the new technologies may actually affect how creators think, how they become aware of who they are and what they do, and how they define their relationship to the rest of the world. After analyzing people's experiences with the computer, Sherry Turkle observes:[10]

> The computer becomes part of everyday life. It is a constructive as well as a projective medium. When you create in a programmed world, you work in it, you experiment in it, you live in it. The computer's chameleon like quality, the fact that when you program it, it becomes your creature, makes it an ideal medium for the construction of a wide variety of private worlds and, through them, for self-exploration. Computers are more than screens onto which personality is projected. They have already become a part of how a new generation is growing up.

By firing creators' imaginations, the new technologies are also widening the scope of creative activity itself and opening new opportunities. The interactive fiction writer, Ann Byrd-Platt, for example, was discouraged from becoming a novelist, believing she could not distinguish herself from "the hundreds and hundreds of writers just like her."[11] She found that an understanding of computers and technology gave her new areas in which to exercise her creativity. In writing interactive fiction—an art form impossible without computers—she succeeded in finding a niche for herself and her creativity.

Technology, may also change how society perceives creators and their work. For example, while most people have always recognized that the stage director imparts a unique contribution to the performance of a play or musical, the director was unable to claim 'authorship' of his work, because his contribution could not be written down or expressed unambiguously. Today, however, video-recording technology, can 'fix' the unique way in which actors, props, motion, and scenery are arrayed in each director's interpretation of a work. By thus establishing his authorship, the stage director has greater credence in his claim to copyright.[12]

Technology has also affected the motivations of artists and scientists. Changes in attitude seem to be most pronounced in those areas where the new technologies have helped to enhance the market value of creative and scientific works. Again, as in the age of the printing press, many creators are wrestling with choices about whether to focus on intrinsic or monetary rewards.

Traditionally, artists have been inspired to create and scientists driven to invent and discover for reasons that can be clearly set apart from monetary rewards. The graphic artist Milton Glaser succinctly characterized these kinds of motivations when he said:

> I would suspect that a good many people would say that the basic reason they do their work is that it pleases them, because they love it, because they are obsessed by it, and because they don't feel that they have any choice.[13]

Underlying motivations and the sense of purpose for creators remains strong. Explains Theodore Bikel:

> The arts are about risk taking. More often than not [they are] about endangerment. You endanger your soul each time you put some

'.See for example Ken Emerson, "David Byrne: Thinking Man's Rock Star," *The New York Times Magazine*, May 5, 1985, pp.54-57. In creating "Once in a Lifetime" teams of technical and artistic individuals create together, working out their sense of structure, relying on intuition, improvisation, and technology. Thus the creator may be both musician and engineer.

[10]Sherry Turkel, *The Second Self: Computers and the Human Spirit* (New York: Simon & Schuster, 1984), p. 15.

'Ann Byrd- Platt, OTA Workshop on the Impact of Technology on the Creative Environment, Apr. 24, 1985.

'James Hammerstein, OTA Workshop on the Impact of Technology on the Creative Environment, Apr. 24, 1985.

'Milton Glaser, OTA Workshop on the Impact of Technology on the Creative Environment, Apr. 24, 1985.

pen to paper each time you try to interpret somebody else's words. We are about poetry-. We are about the gossamer fabric of hopes, of dreams. We finally in the last analysis hope that what we do create will furnish the nation laughter, the nation's tears, certainly the nation's memory of what today. was like and what yesterday was like. [14]

Scientists, too, have been fueled chiefly by nonmonetary concerns. One major force driving them to pursue their work has been the desire to be the first to solve a problem, to be the discoverer, or the inventor. It was, in fact, the originality of a finding that served as "testimony that one had successfully lived up to the most exacting requirements of one's role as a scientist."[15] This desire to be first gave rise to numerous battles over originality in the scientific community during the 18th and 19th centuries. [16]

Equally important has been the scientist's desire to contribute to the advancement of knowledge in his field. Traditionally, once a scientist made an original contribution, he did not try to maintain the right of exclusive access to it. Rather, scientists' discoveries and inventions became part of the public domain available for all to use and build on.[17]

Benjamin Franklin exemplified this ethic. Explaining why he had turned down an offer from the Governor of Pennsylvania to patent the Franklin stove. he wrote to a friend:

> I declined from a Principle which has weighed with me on such occasions, vis. That as we enjoy great Advantages from the Invention of others, we should be glad of an opportunity to serve others by an invention of ours, and this we should do freely and generously.

Nor did scientists traditionally seek to market their discoveries. Louis Pasteur's attitude was typical. Although he himself estimated that the use of his method would save 100 million francs per year, he was not interested in profiting financially from his discoveries. As he explained to Napoleon III:

> In France scientists would consider they lowered themselves by doing so.[19]

While many of these traditional motives are still in force, recent technological developments have noticeably affected how scientists and creators feel about their work, the reasons they pursue it, and the rewards they expect to gain from it. In particular, the enhanced commercial value attributed to many information products and services has brought about both conflict and change.

Changing motivations are probably the greatest in fields of science where the commercialization of research results has proved highly profitable. Industry representatives are now actively courting the traditional scholar-scientist. As one professor of biological science at Harvard University described it,

> At this point, it's mind boggling. I'm courted every day. Yesterday, some guy offered me literally millions of dollars to go direct a research outfit on the west coast . . . He said any price.'"

Such offers have placed many scholars in conflict about their roles. While some respond favorably to these developments–even to the point of creating their own firms to exploit their discoveries for profits—others have opposed them as unsuitable for academic science. Trying to sort out what is appropriate behavior for academics and academia, a number of major universities have themselves begun working together to develop policy guidelines for university-industry relationships. [z]]

'Theodore Bikel, OTA Workshop on the Impact of Technology on the Creative Environment, Apr. 24, 1985.

Robert K. Merton, *The Sociology of Science: Theoretical and Empirical Investigations* [Chicago, IL: The University of Chicago Press, 1973)

' Ibid,

I bid.

"As quoted in Bruce Willis Bugbee, *Genesis of American Patent and Copyright Law* (Washington, DC: Public Affairs Press, 1976), p. 72.

'As quoted in J.D. Bernal, *Science and Industry in the Nineteenth Century* (London: Routeledge and Kegan Paul, 1953), p. 86.

' 'As quoted in Henry Etzkowitz, ''kjntrepreneurial Scientists and Entrepreneurial Universities in American Academic Science," *Minerva*. vol. XXI, Nos. 2/3, summer/autumn 1985, p. 199.

'''Academe and Industry Debate Partnership, " *Science*. vol. 219, No. 4481, January 1983, pp. 150-151, See also U.S. Congress, Office of Technology Assessment, *Information Technology Research and Development: Critical Trends and issues*, OTA-CIT-268 (Washington, DC: U.S. Govemrnent Printing Office, February 1985), Creators in the arts and entertainment face similar choices. With the development of a mass media marketplace, these fields have become big businesses where intellectual works are often treated purely as economic commodities. The development and proliferation of new channels of distribution has promoted fierce competition for entertainent products, which has greatly increased its commerical value.[22] Under these circumstances, authors, artists, musicians and other creators may be faced with difficult choices about whether to develop their art in response to the market or to their own internal forces. 23 As Milton Glaser described this dilemma:

> If you begin with the idea that the movie business is a business that has an artistic element to it, , . . [then you need to recognize that] the control of the movie business essentially is in the hand of the people who think of it as a business, invest the money, and are in it to make money and do.[24]

The choice a creator makes depends on his fundamental motives and on his relationship to others within the creative environment. For software developer David McCune, for example, there really is no choice. As he says:

> I'm going to program computers no matter what. 1'm concerned that I make enough money to pay the rent and buy myself a computer, basically. Other than that I don't really care much.[25]

Some artists are supported by government grants or endowments from private foundations. Few are successful enough to attain both the desired economic independence and artistic freedom. Most, however, choose to work within the existing system and, when they can, to finds ways to express their creativity. In effect, they work in both worlds, the world of art and the world of business.

[22]Tom Whiteside, "onward and Upward With the Arts," Cable I, II, and III [three-part article series], *The New Yorker*. May 1985.

' 'Just such a phenomenon occurred, as has already been noted, with the growth of the book market after the development and widespread deployment of the printing press. Such an occurrence happened again in late 19th century America, when the book market was expanded to meet the needs of an increasingly literate population. To profit from this literate, although generally less educated audience, it was common for publishers, for example, to press authors to lower their artistic standard for the sake of increasing sales, See for example, Lewis A. Coser, Charles Kadushin, and Walter Powell, *Books: The Culture and Commerce of Publishing* (New York: Basic Books, Inc, 1982), pp. 226-227.

[24]Milton Glaser, OTA Workshop on the Impact of Technology on the Creative Environment, Apr. 24, 1985.

[25]David McCune, OTA Workshop on the Impact of Technology on the Creative Environment, Apr. 24, 1985.

TOOLS FOR CREATIVITY

Machine tools enhanced man's ability to perform physical tasks. Similarly, the new information technology will enhance his ability to carry out intellectual pursuits. [26]

Because these technologies are primarily intellectual tools, they are likely to be used extensively in science, scholarship, and the creative and performing arts. In these areas, technologies may:

1. expand the boundaries of the fields as we know them,
2. change the ways in which creators and inventors carry our their work, and
3. allow more people to participate in the creative process and to share the products of scholarly and scientific research.

Expanding Boundaries

History offers many instances in which new technological tools have advanced the boundaries of science and scholarship, also expanded the domains of art and entertainment. The invention of the clock and the lens, for example, greatly facilitated the development of the

[26]For a discussion of how information and communication technology can extend man's creative process of knowing, see Marshall McLuhan, *Understanding Media: The Extensions of Man* (New York: Signet, 1964). For a more recent and speculative discussion about the impact of the computer on the mind, see Robert Jastrow, *The Enchanted Loom: Mind in the Universe* (New York: Simon & Schuster, 1981).

sciences of mechanics and astronomy.[27] Similarly, technologies expanded the domains of art and communication. With the substitution of oil paint for egg tempera, the course of painting was dramatically changed, giving rise to the Renaissance style of art. " The development of the camera, too, brought entirely new forms of art and entertainment. As the art critic John Berger notes in his analysis of the impact of the camera on our perception of the visual arts:

> The art oft he past no longer exists as it once did. Its authority is lost. In its place there is a language of images. What matters now is who uses this language and for what purposes ."'

Like their earlier counterparts, the new communication technologies are exerting a wide-ranging influence on the arts and sciences and on the development of other information products and services. They offer new tools. By taking advantage of computers' high-speed data-processing abilities, computer graphics can represent many types of information and art, from mathematical formulae to cartoons. Computers facilitate the manipulation and rearrangement of anything that can be expressed in computer-readable form—images, data files, text. The new techniques for inexpensive reproduction–xerography, audio and video duplication, computer copying–also allow creators and other users to gain access more easily to a much broader range of intellectual properties than ever before,

These technologies have varying effects on the actual substance of creation. For some people, new technological capabilities enhance the creative process by making it faster, cheaper, or easier to produce a work. For others, they actually change the boundaries of their art.

A growing number of authors, for example, write on word processors because the new devices make it easier to edit, store, and transmit their documents. For these authors, word processing has not produced a new form of literary expression; it has simply facilitated the mechanics of creating literary works. Similarly, film makers use sophisticated and intelligent tools to capture or create images and sounds with greater ease and dazzling speed.

Beyond facilitating the creative process, some technological advances have actually opened new channels for the expression of creativity, thereby expanding the very nature of science and art, Using these new computerized channels to generate graphics and synthesize music, artists, film makers, and composers are creating new kinds of images. These new pictures and sounds are born of equations, algorithims, and mathematical models. Using computer programs and mathematical values to represent color, shape curvatures, shading, and even randomness, teams of engineers, artists, and film makers "produce extraordinarily complex and lifelike graphic simulations that rival and sometimes exceed those born of traditional animation."[30] Whether used to "draw" a seaside landscape (see box 5-l), to generate special effects, or make motion pictures, the power for creation lies in the software and the imagination of the team. For creators at Lucasfilms, today's tools represent only the beginning of what will later be possible: In the future, "the computer will allow Hollywood to tell stories that could not have been told any other way.''"

Like their counterparts in the arts, scientists use increasingly powerful computers to carry out more and more complex calculations, and to represent and to simulate experiments, processes, and phenomena. The use of supercomputers and color imaging techniques for numerical computation in fields such as physics enables scientists to solve increasingly com-

[27]John P. McKelvey, "Science and Technology: The Driven and the Driver, " *Technology Review,* January 1985, p. 42. As McKelvey points out, the casual relationship works both ways, with pure science often given rise to new technologies.

[28]Milton Glaser, OTA Workshop on the Impact of Technology on the Creative Environment, Apr. 24. 1985.

[29]John Berger, British Broadcasting Corp., *Ways of Seeing* (London: Penguin Books, 1972), p. 21, as cited in Edward W. Plowman and L. Clark Hamilton, *Copyright: Intellectual Property in the Information Age* (London: Routledge & Kegan Paul, 1980).

[30]Stuart Gannes, "Lights, Cameras Computers. " *DISCOVER*, August 1984, pp. 76-79,

[31]Ed Catmull, Head of the Computer Development Group, Lucasfilms, as quoted by Stuart Gannes, "Lights, Cameras . . . Computers," *DISCOVER,* August 1984, p. 79.

Box 5-1.-Using Computer Generated Imagery to "Draw" a Seaside Landscape

Photo credit: Lucasfilm, Ltd., © 1985

This composite image, titled "Road to Point Reyes" was produced by a team of creators working in the Computer Graphics Project at Lucasfilm. Under the direction of Robert Cook, the landscape was defined using patches, polygons, fractals, particle systems and a variety of procedural models. Each of the elements of the landscape were rendered separately and later composite. Rob Cook designed the picture and did the texturing and shading, including the road, hills, fence, rainbow, shadows, and reflections. Loren Carpenter used fractals for the mountains, rock, and lake, and a special atmosphere program for the sky and haze. Tom Porter provided the procedurally drawn texture for the hills and wrote the software by combining the elements. Bill Reeves defined the grass by means of a moving particle system he developed. He also wrote the modeling software. David Salesin put the ripples in the puddles. Alvy Ray Smith rendered the flowering forsythia plants using a procedural model. The visible surface software was written by Loren Carpenter. Robert Cook wrote the antialiasing software, a program to prevent unauthorized access.

The picture was rendered using an Ikonas graphics processor and frame buffers, and was scanned on FIRE 240, courtesy of MacDonald Dettwiler & Associates Ltd. The resolution is 4K x 4K, 24 bits/pixel.

plex problems—problems with so many variables that the true visualization requires a numerical solution. For example, modeling gas flowing in black holes, where the actual manifestations of the gas dynamics around them are too small to be observed, requires numerical experiments of a new order of magnitude. Explains Larry Smarr:

A typical experiment makes use of at least 10,000 time steps. Thus, the finite-difference solution is a set of five variables on a space time lattice of 250 million points, that is, the solution of 1.25 billion numbers of nonlinear partial differential equations.[32]

[32] Larry L. Smarr, "An Approach to Complexity: Numerical Computations, " *Science, vol.* 228, No. 4698, Apr. 26, 1985, pp. 403-405.

Participants at OTA workshops convened for this study,"[33] described the multiple ways in which the new technologies are expanding the boundaries of science, music, art, dance, photography, film, and television:

> In musical composition and performance, new sounds and arrangements result from computer synthesizers, digital sound analyzers, and electronic editors. Although musical notation can begin on paper, it may also be "drawn" electronically. The technology not only provides tools to generate sounds, but also the means to store and manipulate them as well. Thus composition and performance can result from revision, expansion, or recombination of unending variety of chords, melodies, rhythms, or pitch.
>
> A dance sequence blends the performance of a live dancer with that of computer-generated images and information. Intricate and complex sequences of movement and dance are developed by the choreographer and performed by the computer. While early computer representations of dance were rudimentary representations, computer images are now essential elements of the performance itself. In some instances, the computer-generated dance sets out new steps, followed in turn by the live dancer. For some choreographers and dancers, the boundaries between technology and dance cross in the generation of new art forms. (See box 5-2.)
>
> The new technologies not only affect performance in dance directly, as adjunct art forms; they also provide new ways to permanently record dance. In turn, once stored, these computer records not only become choreographical records, when broken down into their elements, they can also become sources for new steps and sequences.
>
> Technological changes in cameras, film, lighting equipment, laser separators, print publishing, and computer processing of electronic images are all affecting photography.
>
> Computing power display technologies enhance capacity that they expand science into new horizons. (See box 5-3.) This expanded capacity allows for new ways of visualizing and analyzing physical phenomena such as the behavior of a molecule or the evolution of a galaxy.

The power of the new technologies is not limited to science and the arts, it cuts across virtually all information-related fields. New information technologies have expanded the variety, scope, and sophistication of information products and services. Described by some observers as being in the very process of "self-creation,"[34] the information industry—from database businesses, software and hardware providers, publishers, cable television, information analysis centers and clearinghouses—continues to grow. In the U.S. software industry alone, there are an estimated 1,200 companies and thousands of individual free-lancers creating and producing software and providing services worth $40 billion annually.

The new technologies can both enhance existing information products and services and generate new ones. Figure 5- I lays out the multidimensional and multifaceted technological capabilities that play a role in developing information products and services to meet a wide range of information-related functions. At the same time, the technologies enhance the value of information products and services by making them more accurate, timely, and accessible.

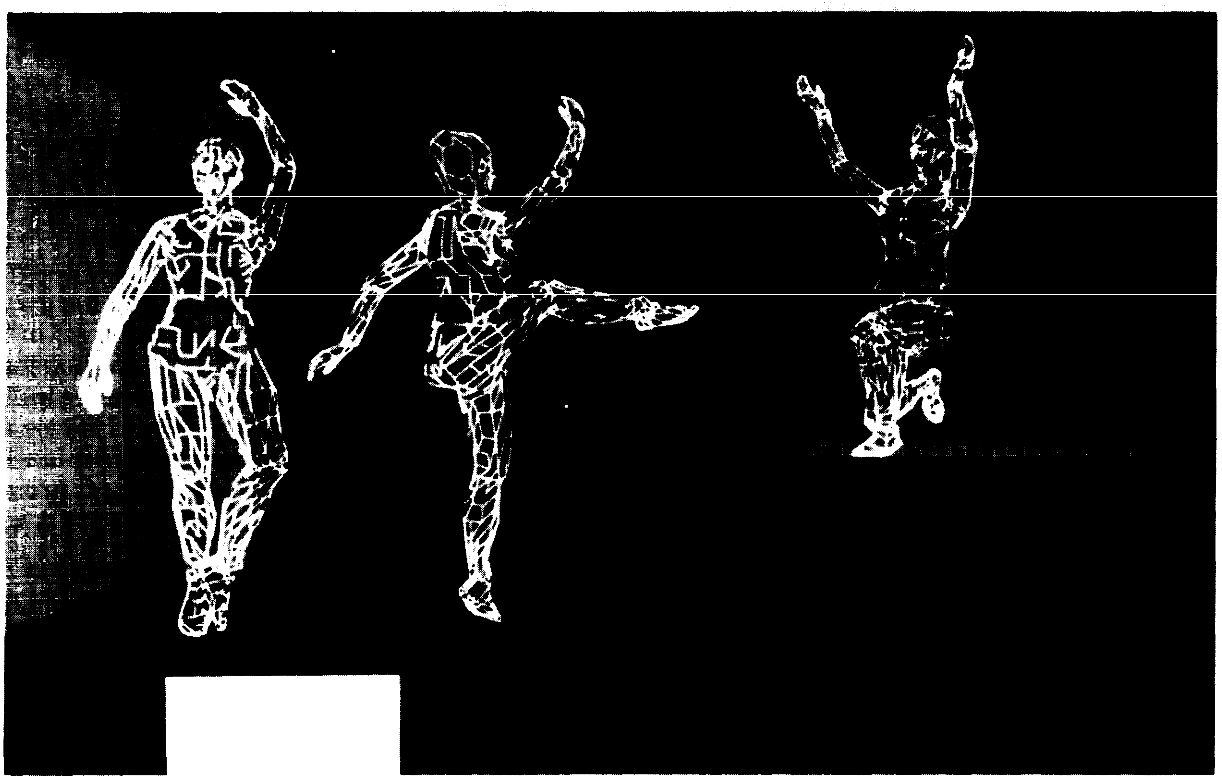
New Ways of Proceeding

The development and use of new tools also influences the way people perform creative activities. Historically we can see, for example, that the technology of mass printing and publishing changed the process of conducting scientific research and scholarship by imposing precision and standards for publication. Books were reviewed, examined, and marked up in ways they had never been before. For the first time, images could be printed with text. A system for organizing books was developed; titles were systematically arranged with bibliographies compiled, making it eas-

[33] OTA Workshops: Technologies for Information (Treat) on, Dec 6, 1984; Display, Printing, and Reprography}, Mar 13, 1985; Impact of Technology on the Creative Environment, Apr 24, 1985).

[34] Charles W. Moritz, President and Chief operating office, Dun & Bradstreet Corp., Keynote Address, 15th Annual Convention and Exhibition, The Information Industry Association, Nov. 7, 1983. New York City.

Box 5-2.-Dance and Computer **Technology**



"And who can tell the dancer from the dance?"

–William Bulter Yeats

Computer graphic images depicting dancers and dance sequences were created at the New York Institute of Technology's Computer Graphics Laboratory by Robert McDermott, Rebecca Allen, Paul Heckbert, Lance Williams, and Jim St. Lawrence. The computer-generated figures are "rotoscoped" to mimic the steps of a videotaped human dancer's performance. They can then be combined with live action film or video as in Twyla Tharpe's "Catherine Wheel," a co-production between Dance in America and the British Broadcasting Corp.

ier to use the growing volume of written works. These changes, in turn, facilitated the development of the scientific method.[35]

Printing and the widespread distribution of books also fostered new relationships among scientists, artists, intellectuals, and their geographically distant counterparts. As Eisenstein has pointed out:

> The fact that identical images, maps, and diagrams could be viewed simultaneously by scattered readers constituted a kind of communications revolution itself.[36]

Just as technology affects the tools used by creators and enhances and expands the creative process, so too it will lead to new ways of operating. With computers' increased capacity to store, retrieve, and manipulate information and images, the process of creativity and research is becoming more interactive. Two phenomena illustrate this: electronic snipping and pasting and computer networking.

[35]Eisenstein, op. cit., pp. 80-111.

"Ibid., p. 56.

Box 5-3.-Using Computer Graphics as a Tool To Explore New Surface Structures

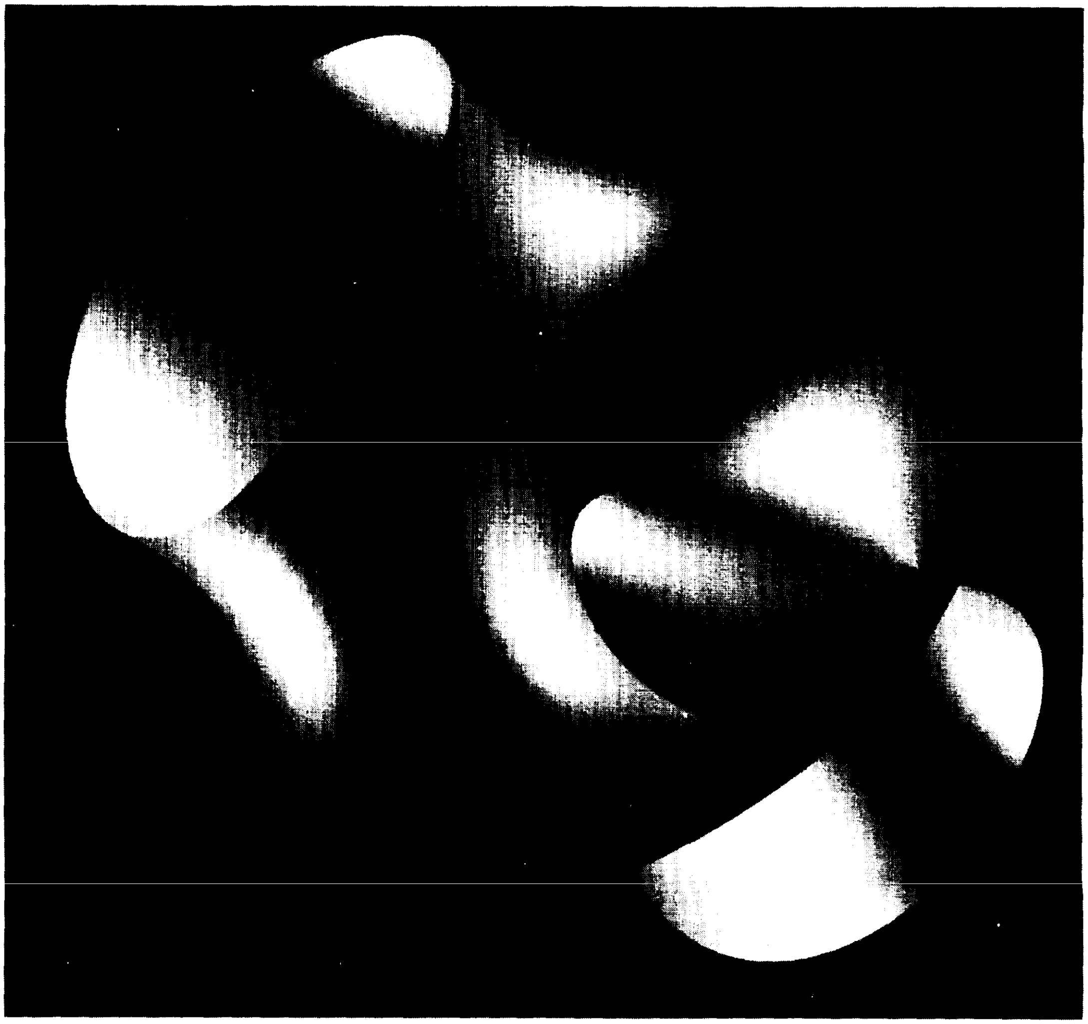


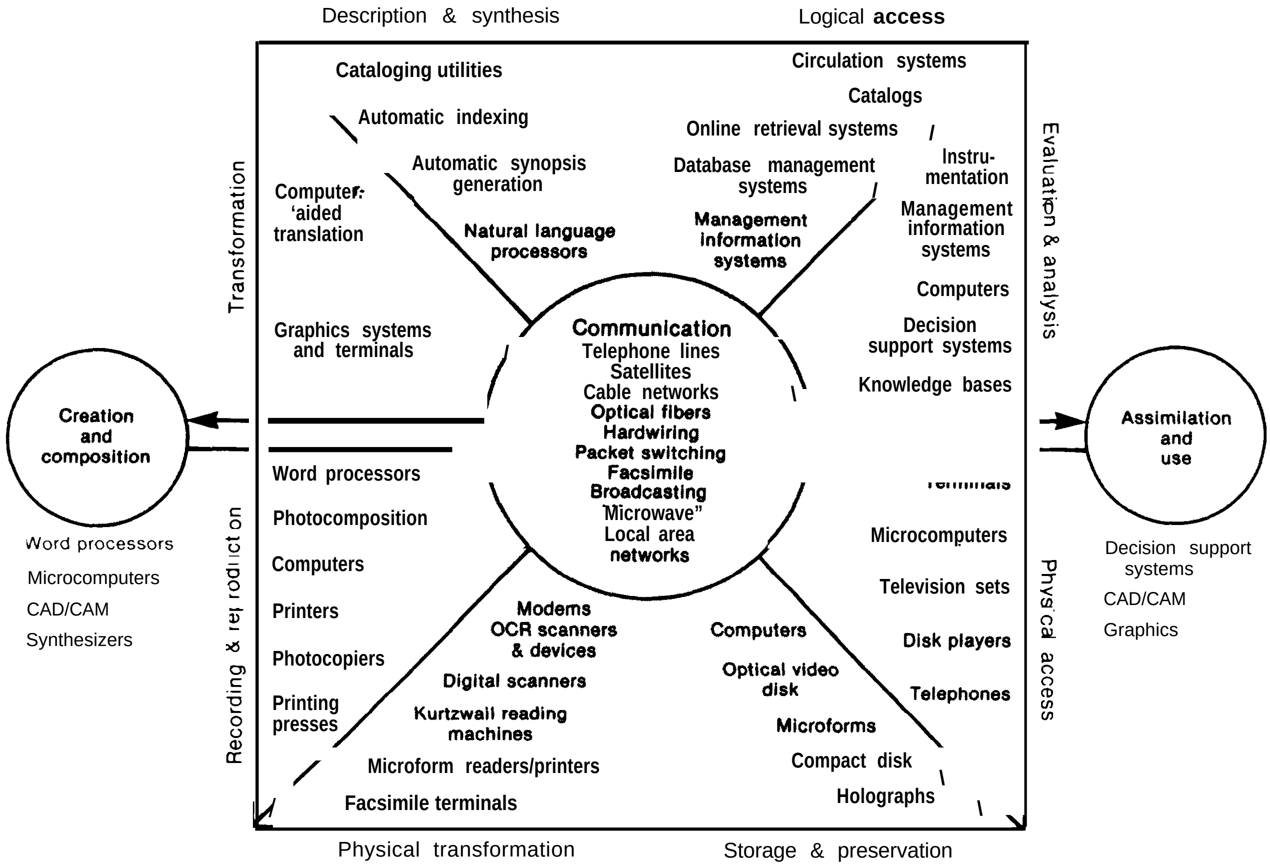
Photo credit: D. Hoffman and J.T. Hoffman. © 1985

Minimal surfaces are mathematical idealizations of membranes which are stretched in such a way as to attempt to make their surface area as small as possible. They occur as soap films, as interfaces in liquid crystals, and have been used theoretically in physics and general relativity.

In 1984, David Hoffman, a mathematician at the University of Massachusetts at Amherst and William H. Meeks III, then at Rice University, were able to prove the existence of a new minimal surface, the first of its type to be discovered in 200 years. By using numerical methods to approximate a possible example, and then computer graphics developed by James T. Hoffman to view portions of it, they were able to discern that the surface was highly symmetric. According to David Hoffman, “This provided qualitative information and insight which led to a new general theory and the construction of infinitely many examples.” Moreover, he notes, “The ability to process and condense large amount of information by means of computer graphics is well known in other fields, but has only recently been used in mathematics.”

Pictured below, is a computer-generated view of the new minimal surface.

Figure 5-1.—Applications of Information Technologies to the Creation and Processing of Information



SOURCE King Research, Inc., July 1985

Electronic Snipping and Pasting

Even when done with scissors and paste, snipping and pasting consists of a process of storing, retrieving, and manipulating information. The computer, with its unique capacity to perform these tasks, is the ultimate editing tool. With this technology readily available, the creator is now as prone to re-create as to create in the first place.

Computer and video technologies are having such an effect on film editing. With tools such as EditDroid, developed by Lucasfilms, the arduous task of editing thousands of feet of film is simplified by electronic snipping and pasting.[37] By computerizing the editing process, a film artist can rearrange footage in the same way a writer rearranges words on his word processor: inserting and deleting images frame by frame; taking whole sequences from one place and shifting them to another; and scrolling through sequences again and again. All this is done in a matter of seconds.[38] As in creating texts or developing on-line databases and information services, films can also be edited, merged, and reformed. In the same fashion, old films, stored tape footage, and other archival material can all serve as the basis for new derivative products and creative works.

Electronic snipping and pasting has also altered the world of the still image photographer. Using laser and computer technologies to scan original photographs and convert them into

[37] Experts point out that film editing is a major component in the making of a film. It can take as long as the shooting itself. A typical finished feature film consits of 10,000 feet of film, on six reels, the result of as many as 2,000 splices from the original footage. See Gannes, op. cit.

[38] Ibid,

digital data, one can manipulate the 'no-longer photographic' image in very sophisticated ways.[39] Color, texture, figures, and so on can be varied slightly or totally. (See box 5-4, "Now you see them, now you don't. The same technologies can also transmit photographs electronically to printers in remote locations.

These capabilities can alter both the way a photographer works and his control over his work. Before digitized photography, for example, the photographer could control his images by controlling the film negatives. Today, however, the commerical photographer must negotiate in advance, in exact detail, how the image will be used, for what length of time, and under what circumstances. Explains Bill Weems: "The human relationships of the whole industry have changed dramatically now. . . . You have a whole new world to deal with here. Images are not only stored and retrieved, but are digitized and re-created."[40] To work out these relationships, additional time must be spent dealing with administrative and transaction issues. And the photographer wonders if it is only a matter of time before it will be literally impossible to track all of the uses of one's images.

The production of music and sound is equally amenable to electronic snipping and pasting. Using the ability to store recorded sound digitally and gain increased digital control of that sound, the musician can mix and match not only sounds, but also rhythms and pitch. According to composer Michael Kowalski, these new tools allow for:

> ... unprecedented access to reproducing, copying and editing sound— an ability to take tiny snippets of sound, anywhere from a twenty-thousandth of a second of a sound to the whole piece of music, and manipulate it to your heart's content."

These technological advances have the potential to damage creators' interests as well. The same images and sounds that the artist, photographer, or musician has stored to use, manipulate, revise, and reproduce can also be manipulated, revised, copied, and used in a multitude of ways by others, with or without permission. Some creators worry that a "cavalier attitude will develop toward taking whatever you want and doing whatever you want with it."[42] This attitude has already surfaced within the artistic community itself, as well as in the worlds of advertising and publishing." Although many of these innovative tools for cutting and pasting are still relatively expensive and unavailable, they may be more accessible in the future. With wider deployment of such techniques, artists, photographers, and musicians may find it increasingly difficult to track or trace the uses of their work. Notes Joyce Hakansson:

> Now, talent, creativity, works of art are also in an intangible fashion being transmitted and we are not aware of the fact that we are stealing; that we are, in fact, impinging. We are encroaching on somebody's rights. That has to be transmitted. The new technology is now putting things in a new format and we have to be taught to look at it in a new way.[44]

Thus one question for the creative community is: How do you proceed?

Computer Networking

Computer networking makes it possible to use distant computing power to analyze data or generate new images; to consult with one's colleagues and jointly write papers; and to exchange ideas or reports. However, such shifts in the way information and knowledge are cre-

'Steward Brand, Kevin Kelly, and Jay Kinney. "Digital Retouching," *Whole Earth Review, No.* **47,** July 1985, pp. 42-47.

' Bill Weems, OTA Workshop on the Impact of Technology on the Creative Environment, Apr. 24, 1985,

4 Michael Kowalski, OTA Workshop on Technologies for Information Creation, Dec. 6, 1984.

"Ibid.

"Interview with Lauretta Jones and Bonnie Sullivan, graphic artists in New York City, March 1985, For example, Jones worried about continued reuse of her images, done easily without her permission, once her client has a copy of her disk, on which the image was fixed. Sullivan found that using a very sophisticated computer graphics system that required that she store her images on hard disk, placed her image files in a computer system in which she had no control. Finding that other users had access to her files without her knowledge or acquiescence, Sullivan chose not to work on the system until users could agree to control and respect controlled access to one another's work.

[44]Jovce Hakansson, OTA Workshop on Technology and the Creative Environment, Apr. 24, 1985.

Box 5-4 Art of Digital Retouching

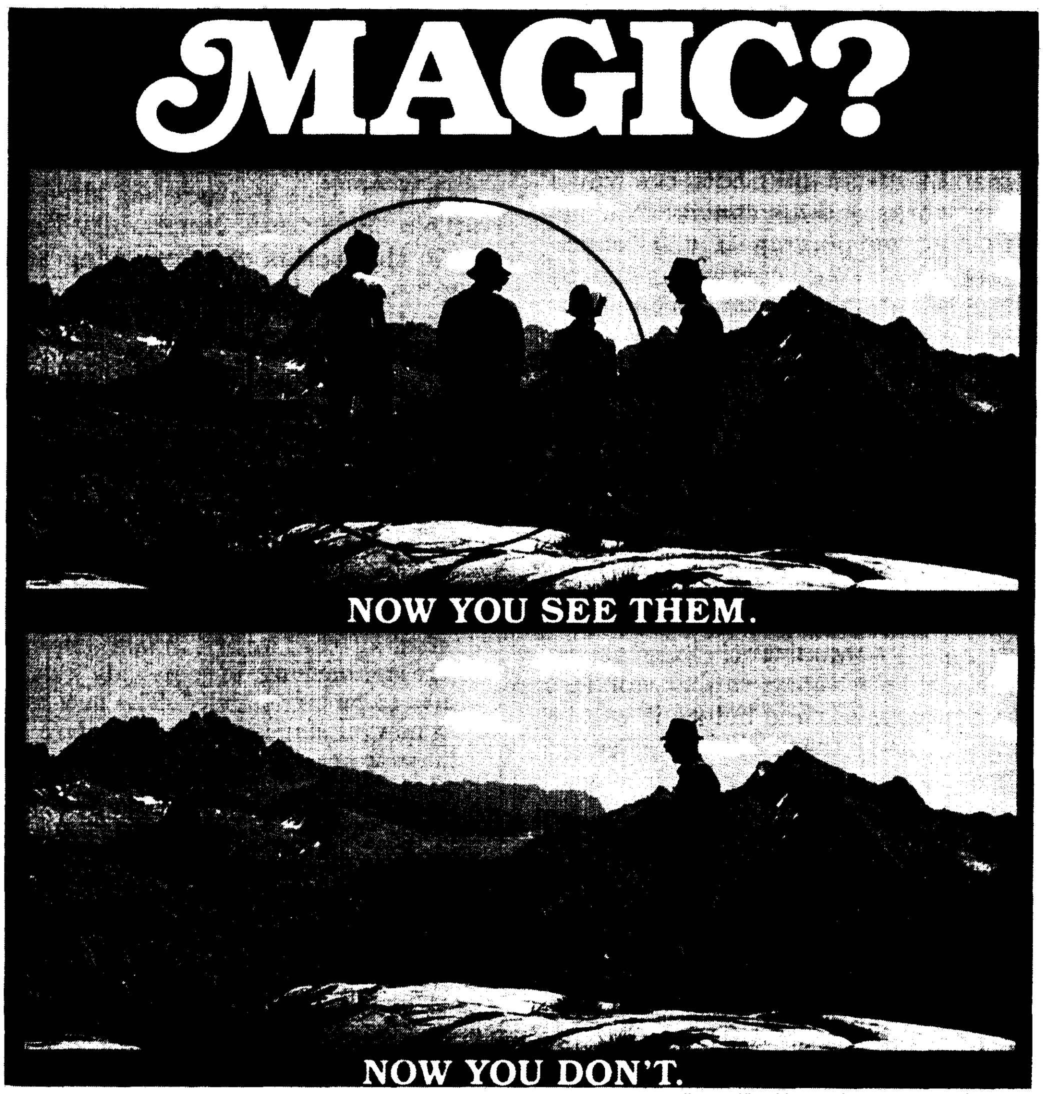


Photo credit: Pacific Lithograph Co., San Francisco, CA

This demonstration of digital retouching was put together by Pacific Lithograph Co. What appears to be two separate photographs is actually only one. By digitizing the photograph of the four hikers, it becomes possible to capture and then manipulate information about color, patterns, and texture.With a Chromacom machine, a computer-driven device, it becomes a simple matter to copy the color texture at one point and slide it over to another. Distinctive patterns are copied exactly. Thus the three people standing in the top-me were not remooved instead they were "washed over" with sky and mountain bits, taken from the scene. Each mow of the cursors brings the seams of the changes closer and closer together. While requiring skill, the digitizing process appears to be almost a routine operation.

ated and distributed can have a tremendous impact on the worlds of scholarship and creativity. For just as the centralization of bookmaking and publishing led to the development of authorship and standardized texts, so might electronic networking speed the decentralization of information distribution, which, in turn, may to lead changes in the processes by which research is conducted and art is created.

These changes are already becoming visible in the academic world, where scientists are using computers and telecommunication links to conduct research and communicate with one another on networks supported by the Department of Defense (ARPANET), the National Science Foundation (NSFNet), and the Department of Energy (MFENET).[45] The number of networks and users are growing rapidly, not only for scientific communities, but also in other academic disciplines.

BITNET, for example, used by scientists and other scholars, provides linkages to more than 175 institutions of research and higher education in the United States and has direct links to networks in Canada and Europe. Users of BITNET and other networks send each other messages, text files, and computer programs. " Those who use computer networking describe it as an essential tool in their work. (See table 5-l.)

Some networks serve not only as mechanisms for exchange of data and information, they also provide the means to access distant computing power for conducting research. One such example is the National Magnetic Fusion Energy Network (see figure 5-2), which connects a total of 4,000 users in 100 separate locations, all of whom are involved in multi-institutional research efforts.[47]

Electronic networks can also provide access to vast electronic libraries. Although few researchers today report using their time on electronic networks to search on-line bibliographic and content databases, more are likely to do so in the future. Eventually, researchers conceivably might acquire all they need—people, research tools, current data and information,

Table 5-1.—Electronic Networking: Academic and Research Uses

"1 have found the network to be extremely useful thus far In furthering my collaborative efforts with researchers in other cities The ability to transmit both raw and transformed data and computer printouts of analyses rapidly between locations greatly facilitated the collaborative efforts. It was possible, indeed in cases easier than if we'd been in the same city, to receive data, run an analysis, ship results, discuss the results, and plot next strategies for analysis with colleagues in Boston and New York . Further, I am actively collaborating in a research grant at -–— with – -- – and we both have found the ability to send copies of measures, initial data, and other forms rapidly to each other has greatly facilitated our work

., "We use BITNET for electronic mail dialogues with authors in all stages of publishing business, Including the shipment of complete book manuscripts to our editors Two encyclopedia projects are underway at remote locations. We currently carry on conversations with the authors and editors of the projects, but when they move into the copy-editing stage we plan to have a constant flow of articles, back and forth project editors to our in-house manuscript editors, and vice versa"

"Last summer,... I moved shop from – to I was able to ship the majority of files from both the CS/SOM DEC-20 and the IBM 4341 quickly and effortlessly to —— via BITNET "

... "I have used BITNET on several occasions to send data to and receive data from users at [several different universities]. [It] has made the scientific interactions with researchers at these institutions much easier than it would be without the network. Unfortunately several institutions with which I regularly communicate are not on the network."

Other faculty members used the network while they were on academic leave to advise graduate students who were working on their dissertations. "Using BITNET, question and answer exchange or draft approval could take place within the same day. "

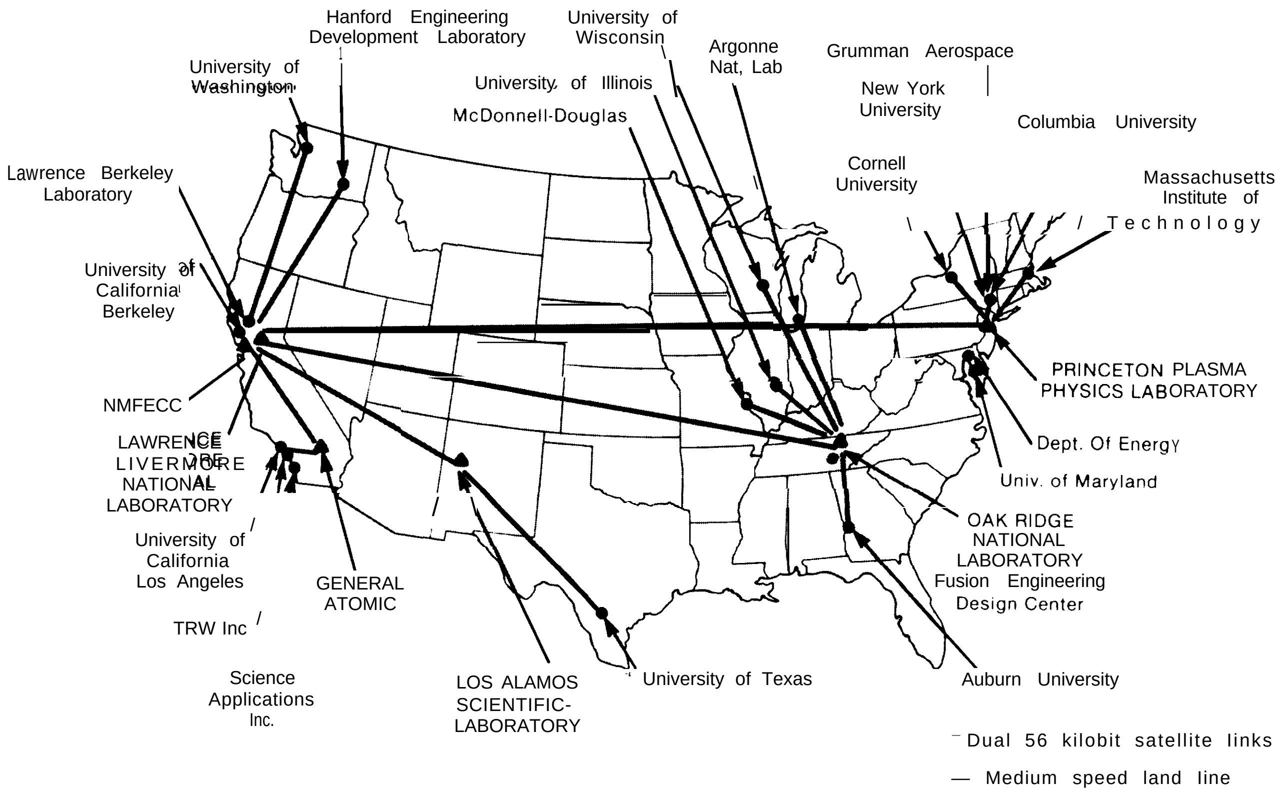
SOURCE BITNET Network Information Center. EDUCOM Princeton, NJ

[45] For a description of the operation and scope of those networks see, Dennis M. Jennings, Lawrence H. Landweber, I ra H. Fuchs, David J. Farber, and W. Richards Adrion, "Computer Networking for Scientists, Science, vol. 231, No. 4741, pp. 943-950.

[46] Files, for example, can include any type of machine-readable document, such as memoranda, research proposals, manuscripts, and letters. Just as networks transmit messages from one computer to another, networks also transmit information from one computer to another, in the form of data or computer programs. See Ira H. Fuchs and Daniel J. Obserst, *Report on Networking*, OTA contractor report, June 1985.

[47] Figures provided by the Office of Fusion Energy, U.S. Department of Energy, and the National Magnetic Fusion Energy Computer Center, Lawrence Livermore National Laboratory, University of California.

Figure 5-2.— National Magnetic Fusion Energy Network



SOURCE National Magnetic Fusion Energy Computing Center, Lawrence Livermore National Laboratory

and published literature-via these electronic networks.

In such a fluid, interactive system, the possibility of discovery or invention on-line, once a vision of the future, is now a reality. As scientists and researchers work in this environment, intellectual property concerns are likely to arise on such issues as determining originality and assigning patents. International transmission of data, software, and other information may further complicate this situation.

It should be noted, however, the information distributed on networks differs in one key way from information published in technical and scientific journals. Works transmitted electronically are likely to be still in progress, with multiple authors, each at a different stage of revising the work. Eventually, scientific research may actually be published on such networks instead of on paper. This practice would have far-reaching consequences for scholarship. As Ithiel de Sola Pool has noted, "The proliferation of texts in multiple forms, with no clear line between early drafts and final printed versions, will overwhelm any identification of what is the world's literature."[48] As in the days prior to the printing press, originality will be hard to verify and authorship hard to establish.

Who Can Participate

The new information and communication technologies and networks may determine, in part, who can participate in the creative process. These tools, like their earlier counterparts, can increase the need for some skills and reduce the need for others. In the past, for example, the invention of letters and the development of written language increased the need

[48] Ithiel de Sola Pool *Technologies of Freedom* (Cambridge, MA, and London, England: The Belknap Press of Harvard University, 1986), p. 212.

for analytic skills and diminished the need for some of the poetic skills that facilitated memorization. Similarly, the new information technologies are bringing about changes in the skills required to participate in the creative process, helping to determine in this way who can take part in this process. The effect, however, differs depending on the product. Although these tools decentralize and democratize some kinds of activities, they might be erecting barriers to entry for others.

Until recently, computer technology was the exclusive province of a technological elite. Use of computers required a special set of skills and knowledge held by highly trained computer scientists and a select group of self-educated computer hobbyists or hackers. Today, advances in hardware design and operation, as well as improvements in software design and applications, have brought computer technology to the public as well as to artists and scholars. Now everyone can use new technologies to expand and enhance their creative powers and vision.

Before the advent of computer synthesizers or software tools such as MacPaint, innate ability and years of training were needed to play a musical instrument, compose a tune, or create an illustration for printing, While today tools substitute for neither artistic talent nor training, they do open new avenues for creative expression and communication of the uninitiated. Using a personal computer, one can generate melodies, explore harmonies, and play an instrument, bypassing the study and practice that separated the musician from the nonmusician.[49] Digital synthesizers, sound systems, and recording systems can further extend the reach of both amateurs and professionals, and at increasingly lower costs.[50] Now a musician can create highly sophisticated sound in his basement or in a studio, using tools that were once available only in a university music research Laboratory.[51]

[49] "Music in the Computer Age, *Compute,* January 1985.
[50] Scott M ace, "Electronic orchestras in Your Living Room," *Infoworld,* Mar, 25, 1985, pp. 29-33.
[51] Michael Kowalski, OTA Workshop on Technologies for Information Creation, Dec 6, 1984.

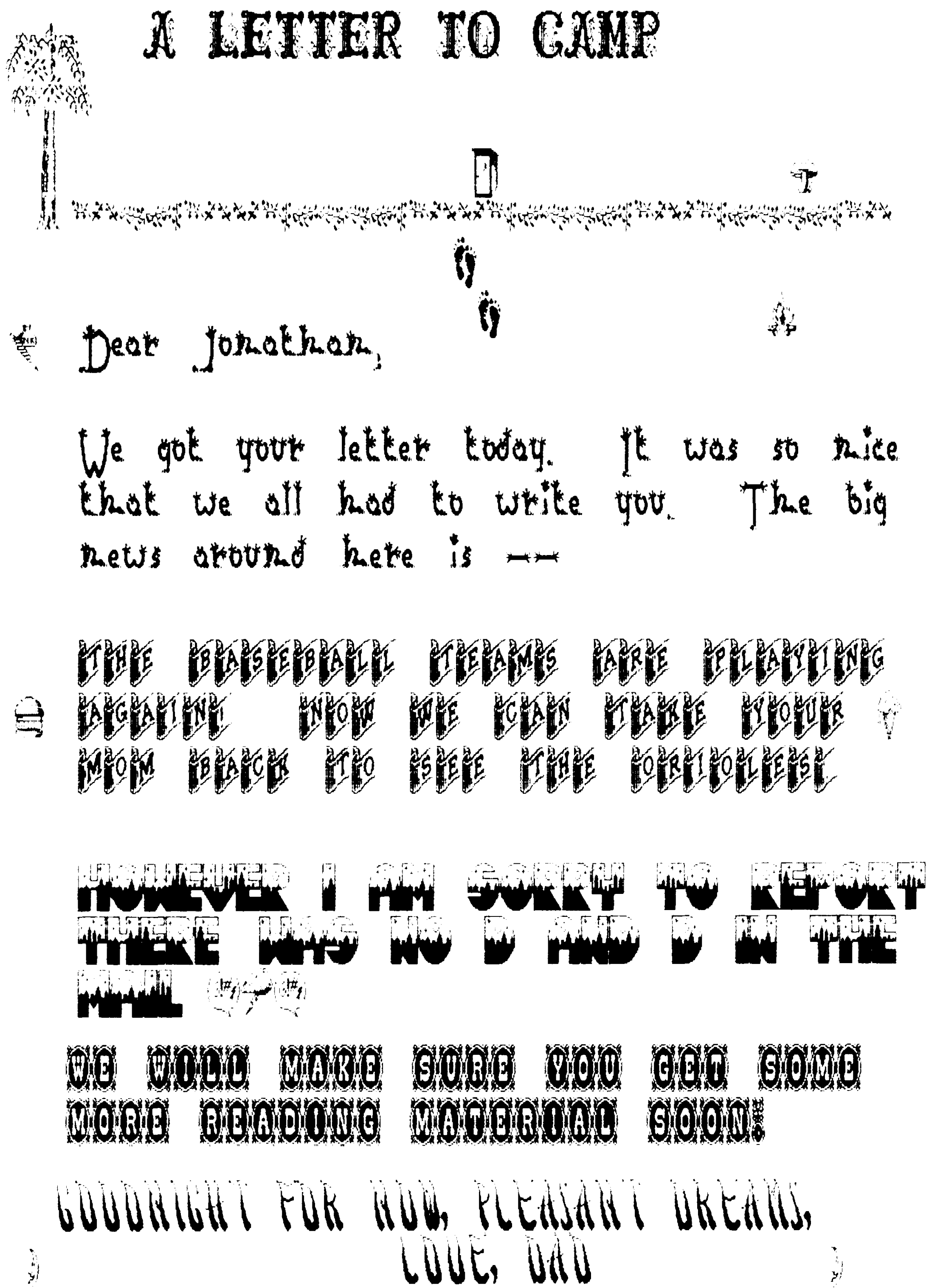
The technologies that make such things possible are now more widely available, as the case of computer graphics illustrates. A few years ago, these technologies were only available to computer scientists and engineers involved with computer-aided design, data analysis, and mathematical modeling. Now a wide range of software applications are readily available for use in diverse fields. This software does not pose problems for novices since they provide what has come to be called "a user-friendly operator-machine interface."[52] In this way, objects, ideas, and projects of study can be expressed and represented graphically for business, education, and personal use. For example, using stylized, highly professional fonts and figures that can be "called up" on a personal computer, one father, as figure 5-3 illustrates, composed a rather artistic letter to his son, off at camp.

Advances in hardware and software are also enhancing access to information itself, and to resources that can provide information. Electronic networks such as the Source or CompuServe can put people in touch with vast information resources such as on-line information services, electronic databases, and new forms of information sources, such as community bulletin boards.

Searching the literature with on-line computerized databases has, until recently, been done principally by trained information specialists, such as librarians or technical specialists employed by large companies. Such searches not only required the use of highly specialized and arcane computer commands but also highly specialized knowledge of the databases themselves. More accessible software designed to reach on-line databases makes it easier for users of personal computers to retrieve information. Similarly, improvements in the design interface of on-line systems themselves facilitate search and location of information. These developments enable medical professionals, market managers, or off-campus students to turn on their personal computers, connect with

[52] Andries van Dam, "Computer Software for Graphics, *Scientific American,* 101.251, September 1984, pp. 146-159,

Figure 5-3.—An Example of At-Home Publishing



A LETTER TO CAMP

Dear Jonathan,

We got your letter today. It was so nice that we all had to write you. The big news around here is --

THE BASEBALL TEAMS ARE PLAYING AGAIN! NOW WE CAN TAKE YOUR MOM BACK TO SEE THE ORIOLES

HOWEVER I AM SORRY TO REPORT THERE WAS NO D AND D IN THE MAIL

WE WILL MAKE SURE YOU GET SOME MORE READING MATERIAL SOON!

GOODNIGHT FOR NOW, PLEASANT DREAMS,
LOVE, DAD

SOURCE John Willis, Frederick, MD, 1985

on-line information providers, and obtain the materials they need.[53]

Information can be acquired electronically in other ways as well. Public bulletin boards allow individuals of all ages, interests, and levels of expertise to access information. Many hundreds of such bulletin boards are now operating nationwide. These facilities provide a variety of information, from answers to a user questions by other users, to digital information tidbits, opinions, articles, or even entire magazines. Many also provide access to public domain soft ware. Use of the board requires a phone line, a personal computer and disk drive, a modem, and software that makes the connection to the board. Most boards can be reached without charge by dialing a local phone number.[54] For many people, fellow bulletin board users become more than a source of information; they comprise a community.[55]

These new opportunities for both technical and nontechnical users have not diminished the need for training and education in various fields. Despite potentially broad and instantly available access to information, users still must learn to use these tools to their fullest capacity. Given this need, education and training might best be used to help progress from developing routine skills to adopting more innovative processes, focusing less on the transfer of facts, and more on understanding how to find and use information.[56]

As Ithiel de Sola Pool notes in *Technologies of Freedom:*

> The technologies used for self-expression, human intercourse, and recording of knowledge are in unprecedented flux. A panoply of electronic devices puts at everyone's hand capacities far beyond anything that the printing press could offer. Machines that think, that bring great libraries into anybody's study, that allow discourse among person's a half-world apart, are expanders of human culture. They allow people to do anything that could be done with communication tools of the past, and many more things too.[57]

[53] See for example, "A New Shortcut to Electronic Libraries," *Business Week*, May **28,** 1984, **p.** 106

[54] See Steven Levy, "Touring the Bulleting Boards,' *Popular Computing*, February 1984.

[55] At the OTA Workshop on Students Perceptions of the Intellectual Property Rights Issue, May **20,** 1985, one high school student explained that he had two sets of friends: 1) friends from school that he might call on the phone and talk about homework or other things; and **2)** friends from the computer whose real names might not be known but who are a constant source of conversation and recreation on-line. Notes this student: "My computer probably doesn 't stay off more than half an hour after I get home. and before I go to bed. So it's on for essentially 6 hours "

[56] For example, some companies provride corporate training in on-line searching to give the end user. such as the research chemist, the skills that would enable him to use highly technical on-line databases, such as Chemical *Abstracts.* I n learning to use such search systems, researchers find they understand more fully both the possibilities and limitations of the database, and are able to use information professionals even more effectively for more complicated searches. See "on-Line Literature Searching Catches on Among Researchers, *('heroical & Engineering News,* May **7,** 1984, pp. 29-31,

[57] -Pool, op. cit., p. 226.

IMPACT OF TECHNOLOGY ON RESOURCES AND MATERIALS

In the process of creating, artists, scholars, and others build on the works of the past and draw on those of their contemporaries. In preliterate societies, the poets, storytellers, and artists drew their content from national lore. The epic poem served, in effect, as a cultural database. In more recent times, the university and other institutions of learning have housed a nation's accumulated wisdom. Individuals gained access to this knowledge either through their own education and training or through informal or self-initiated activities. Modern information technologies are greatly expanding our capacity to store, input, search, and distribute any type of information that can be represented in digital form.

Traditionally, the library has been a key repository for information resources. Today, the Nation's approximately 110,802 libraries supported by universities, education, research, and business institutions, and by local communities (see table 5-2), remain committed to organizing knowledge, supporting continuing scholarship and learning, and offering open-ended access to the universe of knowledge.[58]

This universe of information has grown exponentially, doubling steadily every 15 years or so.” Scientific journals now number 50,000 worldwide and 6,500 in the United States. Similarly, scientific books published in the United States now number 20,000 annually. ’()

Works in other fields have grown as dramatically as those in science. For example, between 1900 and 1970, the libraries of major universities in the United States doubled their book holdings every 17 years.[61] The Library of Congress, the “Nation’s Library,” has more than 80 million items in its collection, including over 20 million books and pamphlets, Its collections continue to grow at the rate of 7,000 items a day.[62]

[58]See, for example, *Scholarship. Research and Access to Information,* A Statement from the Council on Library Resources, Washington DC, January 1985,

[59]See King Research Inc., *Impact of Information Technology on information Service Providers and Their Client tele, OTA* contract report, July 1985.

[60]Derek de Solla Price, Little *Science, Big Science (New* York: Columbia University Press, 1963).

[61] Isabel Cilliers, 4 Impact of the Information Society on the Information Profession, ” *Information Age, vol. 7,* No. 2, April 1985,

[62]See Peter T. Rohrback, *FIND: Automation at the Library of Congress, The First Twenty-five Years and Beyond* (Washington, DC: The Library of Congress, 1985).

Table 5-2.— Libraries in the United States

Libraries	Number
Public (Central)	8,768'
Total public outlets = 70,956 which "includes branch libraries	6,056
Academic	4,924
School, public	70,400
School, private	14,300
Special	12,410
Includes. Federal Law Medical Religious Corporate	
Total	110,802

SOURCE National Commission on Libraries and Information Science

As the amount and use of information increases in all sectors of society, other public and private institutions have joined libraries to provide information and services.[63] These new institutions describe and synthesize information, provide logical access to it, evaluate and analyze information, and store and preserve materials. (See figure 5-4.)

Dramatically affecting the ways information is stored, organized, accessed, reprocessed, and used, the new technologies may have a radical impact on libraries and analogous institutions, They permit libraries and information providers not only to enhance and expand the services they offer, but also to provide new services that were previously unavailable.[64] Using electronic networks and databases, location or size are no longer the sole determinants of the services that such institutions can provide.[65]

Computer databases, themselves, now constitute a new kind of library. Members of the legal profession, for example, now rely extensively on on-line databases such as WESTLAW and LEXIS (see figure 5-5). Users can access many different kinds of information ranging from bibliographic, full text, or abstracted materials to compendiums of processes on physical and chemical properties. These data may be compiled separately or jointly by government agencies, academic institutions, libraries, information analysis centers, clearinghouses, publishers of books, journals, newspapers, newsletters, and business and industry.

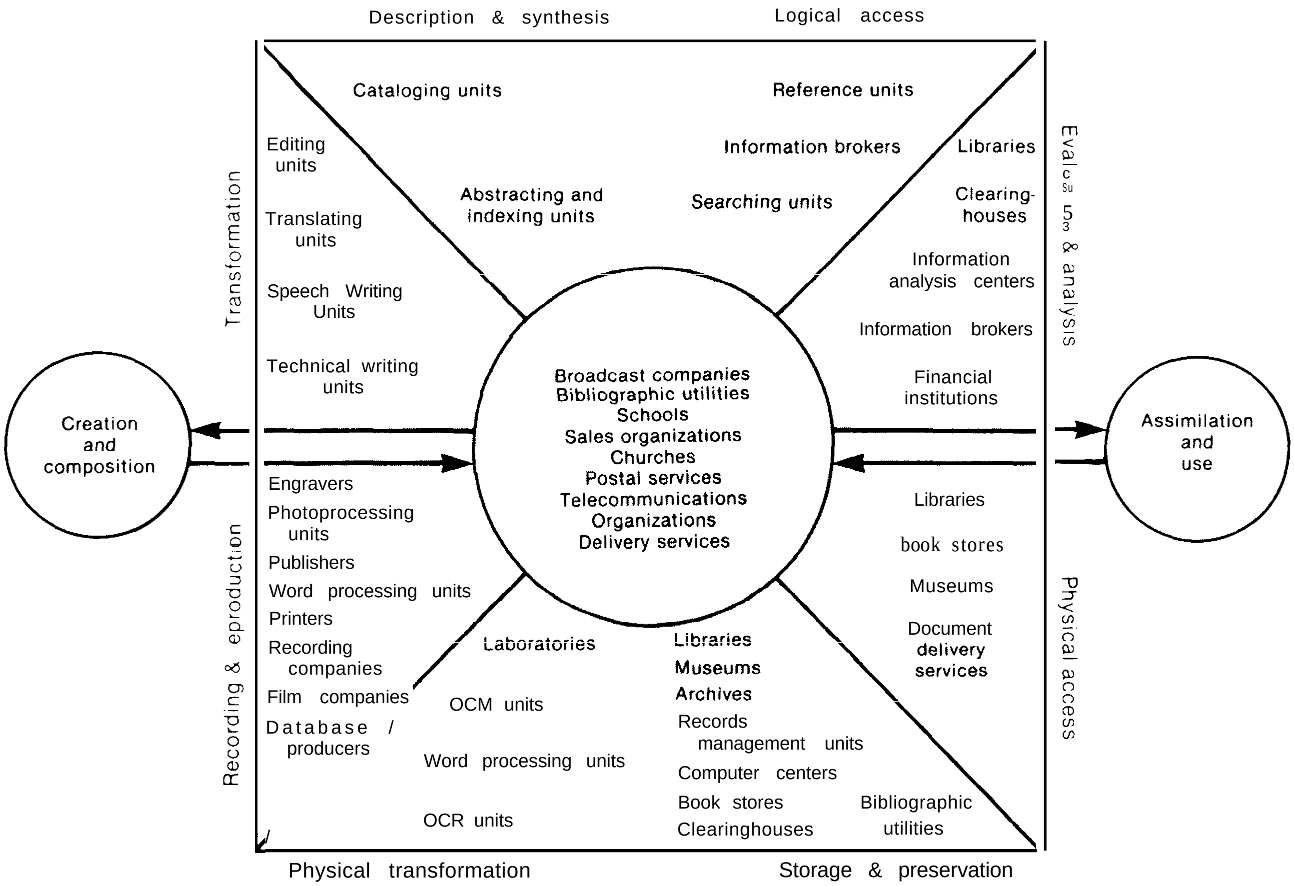
Databases have also been created by individuals, small groups, and communities of users with shared interests. Developed to meet particular needs, they have often come to life spontaneously and informally. Some are acces-

[63]See H.R. Brinberg, “Information in the U.S.–An Industry Service Industry, ” *Information and the Transformation of Society,* G.P. Sweeny (cd.) (New York: Elsevier North- Holland Publishing Co., 1982).

[64]See for example, Patricia Battin, “The Electronic Library: A Vision for the Future, ” *EDUCOM Bulletin,* summer 1984. Battin describes the application of computer and communication technologies to library processing activities over the past 15 years. In addition see, Peter T. Rohrbach, *FIND: A utomation at the Library of Congress, The First Twenty-five Years and Beyond* (Washington, DC: Library of Congress, 1985).

[65]See Battin, op. cit.

Figure 5-4.— Public and Private Institutions Providing Information Products and Services



SOURCE Kinq Research Inc June 1985

sible only to authorized individuals; others are open to the public. Spurred by the desire to share ideas or obtain needed information, users create these new information resources on electronic bulletin boards or computer networks.[66] Computer engineer and software designer Lee Felsenstein envisions thousands of such user communities providing information within and across communities and serving as the community memory" owned and shared by all participants.[67]

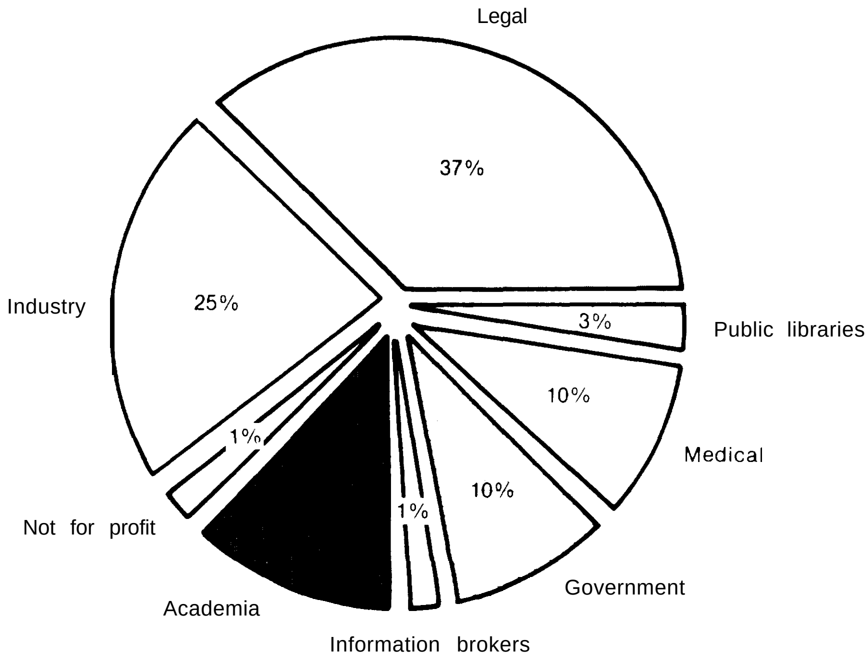
Other kinds of technology-driven resources are also emerging. Laser-read optical storage systems are being used to store and retrieve visual images, such as photographs, maps, drawings and paintings. At the Smithsonian National Air and Space Museum, for example, videodisks derived from 1 million photographs currently stored at the museum will be used to capture the entire history of aviation.[68] Ten archival videodisks are planned, each containing color and black-and-white photographs of U.S. and foreign aircraft, as well *as the ar-*

[66] Take the example of database teaching ideas brought together by members of the math/science forum on CompuServe. The database came about when one participant in the forum asked others if they had examples of effective approaches to teaching physics. Almost immediately, several members of the forum responded. In turn, other suggestions and revisions or expansions of the original set of ideas were shared. Thus the entries in this database increase just as they do on databases which compile information about published literature or laws and legal decisions. In this instance information is upgraded and revised, not by professional editors, librarians, or researchers, but by users themselves.

[67] "Interview, Apr. 15, 1985.

[68] See M. Woodbridge Williams, " 100,000 Photos on a Platter," *Photo District News,* July/August 1984.

Figure 5-5.— Institutional Users of Computer Readable Databases



SOURCE Martha Williams (ed), Information Market Indicators, September 1985

tifacts and people associated with the development of aviation and space flight.[69]

The use of videodisk for this and similar projects offers significant advantages over print technology. Once they have been stored on videodisk and indexed by location on the disk, subject matter, and cross references, the photographs become database entries—interactive, and easily accessible. Searching becomes a dialog between the searcher and the database or electronic library. In this dialog the searcher is not limited by old structures of knowledge that have been built into traditional library indexes; he can put together whole new combinations of ideas.[70]

Electronic databases and libraries are powerful tools and important resources because they provide greater access to more indices and source material than single libraries contain. Like computer databases, videodisks make resources such as photographs more accessible to more people. Similarly, digital libraries of software routines and tools, and optical disk libraries of motion pictures, offer these materials to larger audiences. Eventually, libraries of audio data may be compiled for musical composition.

In creating new ways to capture and handle information, the use of information technologies may conflict with traditional methods of scholarship, which require a clear record of each contribution and a published work that is fixed. A computer-readable database, for example, can archive information in permanent form. But at the same time, this information will be in constant flux if it is continuously updated, revised, and deleted. These capabilities raise concerns for many in the research community. As the Council on Library Resources recently described the problem:

> Scholarship is personal, but its results are not private. To judge the validity of scholar-

[69] It is interesting to note that most of the photographs are in the public domain. Some, however, are still under copyright and will require permission for use by the photographer. As a research project, the developers hope that such permission will be given. But there are some members of the photography community who view the “precedents” of this project with alarm. (Interview with Philip Leonian, New York City, November 1984.)

[70] James Ducker, “Electronic Information–Impact of the Database,” *Futures*, April 1985, vol. 17, No. 2, pp. 164-169.

ly work, the records of past and present research must be open to scrutiny. This is the *only* way the intellectual audit trail that is at the heart of discovery can be maintained. Limitecl or conditional access to bibliographic records (or information about information in any form) is of particular concern .[71]

A second problem arises out of the increased capacity to manipulate information in computer databases. Accuracy, reliability, and quality are concerns for both author and publisher when they enter their works or products in a database. Although in some instances, the author may cooperate with the publisher in developing abstracts of technical works or books, in others, the author does not play a role. Instead, teams of editors and research librarians, or others who are developing or assembling the database, may abstract the works. In all cases, authors and publishers want to assure that the abstracted or summarized work maintains its integrity.

The issue of information presentation, integrity, and documentation of sources is also becoming a problem for artistic creators, such as photographers and artists whose images may become part of large electronic libraries. Although most creators want others to learn and benefit from their works, they also want assurance that their personal contribution *is* recognized and kept intact.

A final concern for all creators, be they scientists, scholars, artists, or individual learners, is one relating to cost and access. As more databases and electronic libraries develop, information that was once available in journals or other paper forms may now appear only in computer-processable forms. Now providing computer database services, academic and public libraries face new and increasing costs. Some have been able to pass on costs of on-line searching to users rather than subsidizing those costs within the library budget. But, while grants and subsidies may fund the work of many scholars and scientists and, therefore, cover these additional costs, they will not fund others, who will be disadvantaged. And those who can pay, cannot only tap into electronic resources, they can also take advantage of information brokers and information on demand services now available at additional cost.[72]

‘*Scholarship, Research, and Access to Information, A* Statement from the Council on Library Resources, Washingt`on, D.C. January 1985.

‵See for example, David Streitfeld, “Ask and They Shall Retrieve,” *The Washignton Post,* Aug. 16, 1985, p. B5. A typical information on demand research project may cost a client about $300. Clients include businesses, foundations, hobbyists, and ini'enters, even writers who are “reasonably successful''—and can afford to pay, for these services,

IMPACT OF TECHNOLOGY ON ROLES, RELATIONSHIPS AND REWARDS

Roles and Relationships

The use of technology in society involves individuals working in relation to one another. The characteristics of the technology they use help to define the roles people play in these relationships. Again, the case of printing illustrates how this might take place. Before publishers became established, authors depended on patrons to support their work. With the advent of publishers, this dependency ended, to be replaced by another. The author became dependent on the publisher who had a monopoly on the distribution of works.[73]

New information technologies, too, can make creators more or less dependent on others, altering the relationship between author and publisher, film maker and producer, database compiler and distributor, and inventor and manufacturer. Whether this change in the rela-

‘Benjamin Kaplan, An Unhurried *View of Copyright {New* York and London: Columbia University Press, 1967).

tionship occurs depends on how technological advances affect the *costs* of new tools, the *location* of tools and resources, the *restructuring* of roles, and the *control* over the mechanisms for distribution. The nature and scope of creative endeavors also help to shape the relationships among creators and others. Where creators must work in expensive, large-scale, centralized operations, they will be more interdependent.

As tools based on new technology become cheaper, more powerful, more available, and easier to use, a greater number of creators can use them to explore and manipulate images, sounds, and information, The increasingly sophisticated tools also enable the artist to produce a more polished professional work. Musicians, for example, who once depended totally on recording studios, now may have equipment in their basements for performing, recording, mixing, and producing musical works.[74] This technology can be used to produce tapes that, on the basis of quality, are indistinguishable from commercial studio tapes.

Such tools and technologies will also open new avenues for distribution. As musician, Richard Green, explains:

> . . . musicians can for very small amounts of money do their recording project, print unlimited cassettes and distribute them, totally bypassing the larger aspects of the music business as we call it, Totally bypassing, among other things. . . . copyright laws [and] government regulations. There are a lot of bad things about this. The good point about this is that it allows the individual to disseminate his work.[75]

In film making, too, highly sophisticated cameras and audio equipment are no longer the exclusive domain of major studios. Dropping in price, this equipment is more widely available to a growing number of independent film makers. These creators find they are able to work cheaply and have the creative freedom they say would not be possible in Hollywood, where the average film budget is $11 million.[76] Just as audio technologies enable musicians to create finished products, so too have the tools to create and edit images allowed the film maker to produce professional and appealing products, on modest budgets, with funds scavenged from foundations, government, individual investors, and even relatives. Moreover, with their greater sophistication and appeal, and their more extensive distribution mechanisms, these films are being extended beyond traditional audiences on college campuses and in art houses. Public and cable television, as well as local multiplex theaters, are now showing independent films alongside first-run Hollywood features.[77]

The world of publishing has similarly been affected by the new technologies. Using a state-of-the-art printing system, a publisher such as Westview Press can quickly produce books in limited editions of between 100 to 2,000 copies. This kind of production run allows the publisher to rapidly accommodate the needs of the market and to produce highly specialized books for limited markets.[78] The number of small, independent publishing houses has increased while the older, larger, commercial publishing industry is becoming more centralized through mergers and acquisitions. It is estimated that as many as 200 new publishers start operations every month. In the last decade, the number of publishing houses has quadrupled and now stands at about 20,000.[79]

Whether creating and publishing computer-readable databases, monographs, or full manuscripts, both authors and publishers can use computer-driven tools and resources. At the same time, technology itself is changing the

'Richard Green, OTA Workshop on the Impact of Technology on the Creative Environment, Apr. 24, 1985.

"'Ibid.

"Kathleen Hulser, "Ten Cheap Movies and How They Got That Way, " *American Film*, May 1984, pp. 22-25, 53.

[77]See for example, Julie Salamon, "It's Boomlet Time for Moviedom's Little Guys, " *Wall Street Journal*, Mar. 28, 1985. Notes Salamon, the number of such film makers is growing: the Association of Independent Video and Filmmakers has grown to more than 3,000 members from 700 in 1980.

[78]See for example, Lisa See, "Frederick Praeger: Portrait of a Publisher, " *Publishers Weekly*, June 14, 1985.

[79]See Marc Leepson, "The Book Business, Editorial Research Reports," *The Congressional Quarterly*, Washington, DC, June 28, 1985.

relationship between the author, publisher, and user of copyrighted works. Some observers see this as a dramatic change, where products and services can be tailored with increasing specificity to meet the needs and requirements of users:

> The user, in turn, becomes more than just a buyer of titles. Through his selective use of the databases, he signals to the publisher his specific interests, and through user-driven publishing he can become a publisher in his own right. . . . In fact, one can say that there is no true end product until the user tailors the data into his unique set of ideas, for example, his own published product.[80]

With an estimated 20 million printers now available, xerography has "made everybody a printer, according to Paul A. Strassman, former Xerox Vice President.[81] Each improvement in reprographic technology, such as image clarity, color reproduction, speed, and compilation, makes it more feasible for creators to publish and distribute their own work. In particular, where traditional modes of publishing and distribution are either not accessible or financially impractical, this mechanism can make it much easier to disseminate information and images. Thus, for example, one can easily publish a newsletter for a special-interest group, a community association, or a group of scholars. Moreover, the technology permits more people to share their work—be it a collection of poems, a book of recipes, or a series of drawings.

The development of electronic networks that transmit text, numerical, or graphic images to printers at remote locations can further expand authors' publishing and distribution capabilities. The result is that roles once held by several people are now all held by one person. Starting with a single copy of a letter or article composed at a computer and transmitted to readers at the other ends of the network, one person can become author, printer, publisher, and distributor of a work.

While an increasing number of computer-driven tools are dropping in cost, some will always be prohibitively expensive for the individual artist, scientist, or inventor. Moreover, hand-held calculators or portable computer-aided design systems now exist that are more powerful than the early mainframe computer systems that occupied whole rooms, certain classes of artistic work, or scientific problems demand even more power and sophistication than even these systems provide. Thus, some creators find that to do their work, they must be part of a well-equipped facility, such as a computer graphics production studio. In other instances, the writers, programmers, and artists who choose to work in a highly innovative and capital-intensive venture, such as videotex, may need to join a corporate entity to work in that field. And the scientist whose research requires access to a multimillion dollar supercomputing facility has to be affiliated with industry, government, or academic institutions.[82]

Other factors may also limit use of new tools and mechanisms of distribution. Taking full advantage of these technologies may require technical expertise not normally held by authors, artists, or dancers. Thus, technology can require the creator to interact with people with whom he has never dealt with before.

The System of Incentives and Rewards

The granting of rewards requires that creators and inventors be given a special status in society. Historically, this did not happen until the time of the Renaissance. Before then, creativity was considered the prerogative of God. Because the Renaissance *notion* of creativity deemed the work of any major poet, artist, or inventor as a product of a special creative genius, which most mortals lacked, it became something to be rewarded. "

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[80] Herbert R. Brinberg, "The Brave New World of Electronic Publishing, " *Publishers Weekly*, Nov. 23, 1984, pp. 32-35.

[81] See Michael Kernan, "The Deans of Duplication, " *The Washington Post*, Aug. 21, 1985.

[82] The capital costs of buying and maintaining a supercomputer facility requires sponsorship by large institutions. Once established an individual user could simply buy time in small amounts still supporting only a fraction of the true costs of maintaining the facility.

[83] Pacey, op. cit, p. 87.

The technology of printing fostered this notion of the individual, as creator. With the invention of the printing press it was possible for a single author to produce a work, no longer dependent on communal efforts. Moreover, conventions such as standardized texts and a title page were developed, making individual attribution practical. Today, the new information technologies are affecting society's attitudes about creativity, regarding both how it treats the creative genius and how it assigns rewards.

The intellectual property system can be conceived of as a societal device to foster creativity. To be most effective, however, it requires that an author's particular contribution and work can be clearly identified. The new technologies are undermining this assumption. They foster multiple authorship and intangible works. Thus, instead of a situation in which a single author, artist or scientist creates one single product, such as a book or mechanical device, now many authors work jointly and their individual contributions are often difficult to distinguish from one another. Moreover, to the extent that they are working in and on electronic media, their materials may be constantly changing.

Examples of multiple authorship are found in the world of arts and entertainment, as well as in research and development. Whereas traditionally, a song was the work of a composer and a lyricist, whose particular contribution was easily discerned and rewarded by the intellectual property system, today the creation of a song, the production of a film, the development of computer software or an electronic database, and the design of a new hardware system, may involve many different creative inputs, connected in a myriad of ways. Creating a seaside landscape with computer-generated imagery, for example, may entail one artist creating the atmosphere, another texture, and others rocks and beaches. In the final execution, a software program will "glue" it all together.

When designers, artists, musicians, and programmers are parts of teams that receive joint remuneration as teams, individual authorship may not be an issue. To avoid problems of dividing rewards, some creative teams have formed their own companies or economic units, jointly sharing their creative expertise, the development costs, and eventually, the profits. Many computer software efforts have been built by such creative entrepreneurial teams.

In other cases, teams of creators and scientists are salaried and supported by an institution such as a software development company, an advertising agency, a hardware manufacturer, or a university or a government laboratory. In these circumstances, the creative contribution of the employed inventor or artist is often treated as a work-for-hire. The work of the individuals in the team might be recognized in the process of applying for an institutional patent or copyright. In scientific fields, technical papers are commonly authored jointly.[84]

Although there are many independent writers, artists, composers, and poets involved in creative activities, most information products and services are developed by employee working teams who rarely receive financial rewards in direct proportion to their particular contributions.[85] Attribution is normally to the source of publication, not to the writer. Profits flow for the most part to the investors, not to those who found the data, organized the presentation, or created an efficient expression.

Nevertheless, there are many creative efforts that go unrewarded or unrecognized, and it is these examples that free-lance creators often cite when calling for changes in the present system. Some free-lance graphic artists and photographers believe, for example, that as creators, they should maintain control over their images even when their materials have been

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[84] Like creators employed by businesses, scientists are paid salaries, but the relationship between this compensation and the incentives to create intellectual property is weak. Gaston studied the reward system in British and American science and affirmed what has generally been believed: that scientists are rarely motivated by salary or other compensation. Rather, they operate more under nonpecuniary incentives such as distinguished titles at universities, distinguished levels of membership professional associations, honors, prizes, and fellowships, editorships of journals, and citation in journals. See Jerry Gaston, *The Reward System in British and American Science (New* York: John Wiley & Sons, Inc., 1978).

[85] See Christopher Bums and Patricia A. Martin, *The Economics of Information,* OTA contractor report, 1985.

commissioned as works-for-hire. This attitude is becoming more pronounced as creative materials become easier to manipulate and reuse." While creators want their works to be widely seen and distributed, they also want adequate compensation for derivative uses, which bring additional profits to publishers. They are concerned, moreover, that the images attributed to them are, in fact, of their own creation.

The new information technologies can also affect how society views the work of the creator and the values it attributes to his work. The growing economic value of information in the arts and entertainment industries fuel public perceptions of superstars, superbooks, computer millionaires and the like. In focus group sessions conducted by Yankelovich, Skelly & White for OTA, participants pointed out that rock stars, movie actors, and information industries were making a lot of money. They were skeptical of the claim that such individuals or companies would be seriously affected by personal copying.[87] And yet many book, film, and computer companies are small, high-risk, low-profit operations. Similarly, many free-lance artists and performers barely make ends meet.

It should be noted that the intellectual property system is only one means by which society supports the creative environment. In addition, there still exists public and private programs providing grants and patronage. To the extent that alternative mechanisms will affect public policy choices about intellectual property rights, they are discussed in other chapters of this report.

"See the Graphics Artists Guild and the American Society of Magazine Photographers, *Testimony Regarding Work-for-Hire Under the Copyright Act,* before the Judiciary Committee, U.S. Senate, Oct. 1, 1982. See also additional testimony presented by Robin E3rickman, Graphic Artists Guild Member.

[87]Yankelovich, Skelly & White, Inc., Focus Group Sessions in Philadelphia, PA, and Greenwich, CT, October 1984.

IMPLICATIONS FOR THE INTELLECTUAL PROPERTY RIGHTS SYSTEM

As we have seen in this chapter as well as in previous ones, the intellectual property system governs the relationships among individuals involved in the creative environment. It determines who are creators, what tools and resources are available to them, and how and under that circumstances their work will be distributed to the public.

Technology is affecting the creative environment in a number of ways that are likely to have implications for the intellectual property system. These can be summarized under two major headings: 1) changing players in the creative environment, and 2) the emergence of new opportunities.

Changing Players in the Creative Environment

Traditionally, the intellectual property system was a simple one, involving only a few players–the creator, publisher/distributor, and user. New participants have come on the scene as new technologies have emerged. Thus in addition to the writer and artist, we now have the composer, photographer, and the film maker. In addition to the publisher, we now have the record company, the television producer, and the cable operator. And added to the reader, we have the radio and record listener, the television viewer, and the computer user.

With the new information technologies, the number and variety of players have increased many fold. Moreover, now more than ever before, technology is affecting the roles that each player plays and his relationship to others in the system. Today the user, whether he is dealing with audio, visual, or computer-generated materials is not just a passive receiver. He can at the same time be a creator or a distributor of his own or others' materials. In this sense, for example, the personal computer user who make copies of software for several of his friends while making one for himself, is, in fact, acting as a distributor. And the university that houses educators and researchers is increasingly claiming rights as the creator of their works.

Above all, these changing roles and relationships may affect the consensus on which support for the system has traditionally rested. Many of the new players, not a party to the agreements of the past, may hold different values about who should have access to what materials and who should be provided rewards. One such newcomer on the scene is the computer hobbyist who finds the thrill of creating something useful and successful more important than either owning the copyright or being recognized as the author.[88]

Given the trend identified in this chapter towards joint authorship and the increasingly fluid creative process, controversies may also emerge among players about the distribution of rewards. Describing the culmination of the development of the Data General Eclipse MV/8000, Tracy Kidder depicts the dilemmas around the distribution of rewards:

> Long before it disbanded formally, the Eclipse Group, in order to assist the company in applying for patents on the new machine, had gathered and had tried to figure out which engineers had contributed to Eagle's patentable features. Some who attended found those meetings painful. There was bickering. Harsh words were occasionally exchanged. Alsing, who during the project had set aside the shield of technical command, came in for some abuse—Why should his name go on any patents, what had he done? Someone even asked that question regarding West. Ironically, perhaps, those meetings illustrated that the building of Eagle really did constitute a collective effort, for now that they had finished, they themselves were having a hard time agreeing on what each individual had contributed. But, clearly, the team was losing its glue. 'It has no function anymore. It's like an afterbirth, ' said one old hand after the last of the patent meetings.[89]

As the economic value of information-based products and services increases, disagreements such as these may become more intense.

The technology will also affect the expectations of the user, making him more or less willing to comply with the rules of the system. As the Yankelovich study suggests, the more technology to which people have access, the more they expect of technology. Youth have particularly high expectations. Often they take the new technologies for granted. As one young user recounted at a recent OTA workshop, he was willing to pay for work only if "it was really awesome. '[90]

The Emergence of New Opportunities

As this chapter points out, the new technologies greatly enhance the creative environment, providing new and powerful tools and new opportunities for artistic expression, societal advancement, and financial gain. As in the past, the intellectual property system will establish the rules by which these opportunities will be taken advantage of and who will get to benefit from them. Because of the enhanced social and economic value of creative and scientific works, intellectual property law becomes an important public policy tool in an information age. It will determine, for example, whether new technologies are used to increase access to the Nation's information resources and if so, by whom, and at what cost.

By virtue of their ability to increase access, these technologies may pose problems for the intellectual property system and for the integrity of the creator's work. As noted in the chapter, they allow users to access and manipulate creative works with ease and speed previously unheard of. While this may enhance their ability to work jointly and create new products and services, it will also make it more difficult to identify or trace cases of copyright infringement or plagiarism that may occur. This is significant for the creator's motivation. For, as we have seen, the creator is as often concerned about the integrity of his works as he is about his own financial gain.

[88] Stephen Levy, *Hackers: Heroes of the Computer Revolution* (Garden City, NY: Anchor Press/Doubleday, 1984), pp. 43-44.

[89] Tracy Kidder, The Soul *of* a New Machine (Boston, MA: Little, Brown & Co.), p. 288.

[90] OTA Workshop on High School Students Perceptions of Intellectual Property Issues, May 20, 1985.