Charles Eames and Communication: From Education to Computers

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ABSTRACT

This thesis looks at a variety of projects done by Charles and Ray Eames that emphasize their interest in communication leading up to their 1953 film *A Communications Primer*. The significance of this film is threefold: One, it is the first film the Eameses produced that showcased, albeit briefly, the modern digital computer. Two, it was made for an audience of architects to expose the profession to the concept of communication theory. Three, the Eameses's, and specifically Charles', interest in using computers in the architectural and city planning design processes can be traced back to this film.

The Eameses's interest in computers and architecture has been documented previously but for the most part, as separate interests. This thesis contributes to the current knowledge of the Eameses by elaborating further on Charles' interest in computers in relation to architecture. It will also present original evidence in the form of a letter that Charles Eames wrote in 1954 to Ian McCallum. The letter is located at the Eames Archives at the Library of Congress in Washington, DC.

The structure of this thesis traces the various nuances of the word "communication," and how these ideas either directly or indirectly influenced the making of the film *A Communications Primer*. First, parallels are drawn between John Dewey's philosophies on communication, education and democracy and the Eameses' earlier architectural proposals for "information centers" in which communication is encouraged. Second, the visual execution of the Eameses' educational projects is traced to the Bauhaus commitment to a universal visual language and Gyorgy Kepes' ideas of *visual communication*. Third, the parallels between the Eameses' hope for interdisciplinary exchange and the scientific movement, Cybernetics, are examined. Finally, the last definition of the word "communication" to be explored is the scientific and mathematical nuance of the word proposed by Claude Shannon's *mathematical theory of communication* and the various interpretations of it. This mathematical theory is of particular importance because it is the basis for the content of the film *A Communication Primer*.

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Contents

Introduction

Charles Eames' interest in computers

Charles Eames [1] and his wife and partner, Ray, are best known for their chair designs, their house, the *Arts & Architecture* Case Study House #8, in Pacific Palisades, CA, the film *Powers of Ten.* Because of these well known projects, their impact on Twentieth century design is unquestionable, but, unfortunately, their more famous projects tend to obscure the rest of their work, including more than fifty films, exhibitions and books for IBM.

> During the 1960s and the early 1970s the Eameses designed for IBM a series of exhibitions centered on scientific and mathematical themes and on famous individuals within those fields. Charles had a life long interest in all aspects of science, and he was one of the first laymen to recognize the importance of the computer. Indeed, his fascination approached passion. Ray was less passionate about computers, but she shared Charles' belief in their importance and used her talents to make them understandable and acceptable to ordinary people. As communicators, the Eameses saw an interesting and intelligible presentation of science and technology as an exciting challenge. 2

This thesis concentrates on the Eameses', and in particular, Charles' interest in computers *before* their collaboration with IBM and how he and Ray saw themselves first and foremost as "communicators." The first Eames project in which computers were briefly showcased was the 1953 film *A Communications Primer*. This film is significant for architectural history because it was intended to familiarize architects, as well as city planners, about "communications theory" (also known as "information theory"). As an applicable theory, communication theory has some functional and mathematical similarities with the digital computer, but they are not one in the same. This thesis will explore the differences in these concepts as well as key influences — political, social, aesthetic, scientific, mathematical and technological — that led to the making of this film.

1. The term 'Eames' will be used to denote Charles and the term 'Eameses' will denote the couple Charles and Ray. The differentiation must be made because it is highly unlikely that Ray had a major say in the political aspects of the earlier competition entries even though she must have surely believed in Charles' views. Also, in terms of the interest in communication theory, the mathematical theory of communication, game theory and linear programming, it was most likely the sole interest of Charles'. For the letters and lectures that are analyzed in this thesis, they were all written or delivered by Charles only; therefore, warranting the use of only his name.
2. Pat Kirkham, *Charles and Ray Eames: Designers of the Twentieth Century* (Cambridge, MA: The MIT Press, 1995), 297.

The various definitions of "communication"

This thesis is structured around a variety of the Eameses' projects in which they explicitly or implicitly refer to "communication." By tracing the ideas of John Dewey, Gyorgy Kepes, Claude Shannon, and Norbert Wiener, this thesis shows that the diversity of the Eameses' work can be read more cohesively and interpreted more productively as a *continuity* through the progressive layering of meanings of the word "communication." In the 1940s and 50s, the word *communication* meant many different things to different people and Charles Eames was influenced by several of them. The American pragmatist John Dewey promoted *communication*, coupled with education, as the key facilitators of a democratic society. Gyorgy Kepes, and the other Bauhaus members who immigrated to America promoted the belief in *visual communication* and notion of the European avant-garde aesthetic as a universal language. Claude Shannon laid the groundwork for the *mathematical theory of communication* that transformed information into a physical parameter that could be easily manipulated mathematically. Finally, the ideas of Norbert Wiener and the proponents of Cybernetics not only saw a correlation between biological and machine communication processes but also promoted interdisciplinary exchange between the sciences and social sciences.

"Communication" in the Eameses's work

The extent of Charles Eames' familiarity and level of understanding of all these nuances of the word *communication* did not effect his enthusiasm for the ideas nor did it effect the extent to which these ideas influenced the work that he and his wife, Ray, produced. Dewey's ideas of communication, education and democracy strengthened their commitment to their architectural proposals for "information centers" as well as their dedication to making didactic films and exhibitions; Kepes' *language of vision* influenced their dedication to communicating ideas *visually*. The newly formed disciplines of Information – Communication Theory and Cybernetics marked the start of the Eameses' commitment to teaching scientific concepts as well as influenced their commitment to interdisciplinary exchange; and the promise of the computer as a design tool for architects and city planners had an enthusiastic convert and unusual spokesperson in Charles Eames. In the light of the proliferation of computer usage in the architectural design and urban planning disciplines, this last point takes on particular weight today. Note that Charles Eames never felt that the computer could take the place of the designer. In the 1969 exhibit, "Qu'est ce que le <design>?", at the Musée des Arts Décoratifs in Paris, Charles Eames was interviewed by Madame L. Amic who asked "Can the computer substitute for the designer?" Eames answered, "Probably, in some special cases, but usually the computer is an aid to the designer." [3]

In this thesis, I will study several projects by the Eameses as well as a number of written documents. The thesis will start with an analysis of a commissioned proposal and a competition entry: *Architecture Forum Magazine City Plan* (1943) and the *"Jefferson National Expansion Memorial" Competition Proposal* (1947) which represent Charles Eames' interest in Deweyan concepts of communication, education and democracy. This is followed by projects that explicitly or implicitly refer to the ideas of Gyorgy Kepes: *A Rough Sketch for a Sample Lesson for a Hypothetical Course* (1953) and a "MIT Arts Commission Report" by Charles Eames. The next few chapters outline the various scientific and technological concepts that influenced the content of the film, *A Communications Primer:* communication theory, cybernetics, and game theory. This is followed by a close reading of the film *A Communications Primer* and the "Letter to Ian McCallum" in which Charles Eames' clearly establishes his interest in the computer as a potential tool for architects and city planners. (The "Letter to Ian McCallum" and "MIT Arts Commission Report" were found by conducting original research at the Charles and Ray Eames Archive at the Library of Congress Manuscript Division in Washington, D.C.) Finally, the thesis ends with the film *The Information Machine:Creative Man and the Data Processor* which is the first Eames film for IBM.

3. Neuhart, John, Marilyn Neuhart, and Ray Eames, *Eames Design: The Work of the Office of Charles and Ray Eames* (New York: Harry S. Abrams, Inc., 1989), 15.

A link to the Eameses's other work

A potential link between the Eameses' interest in computers and their interest in furniture lies in the fact that both were structural processes that could be broken down into key components. The Eameses always described their furniture in terms of its manufacture and production through films and axonometric renderings. Likewise, the computer was always described as a logical machine that could reduce almost anything to a series of binary choices.

> Philip Morrison believed that it was Charles' interest in theoretical structures and a belief that "you could take apart everything that had meaning and form and could show it as a simple combination of yes-no binary choices" that made him so enthusiastic about this new machine. [4]

The diversity of the Eameses's interests — furniture, science, math, computers, aesthetics, technology, photography, exhibits, toys and films — converge in one important way. In all their projects, they hoped to "communicate" through their work, the very beliefs and values that they themselves held.

Broader project

Throughout the course of this century, the impact of the word "communication" and all its nuances has had ramifications on everything from the programmatic layout of elementary schools to discourses on cyberspace. It is important to make the distinction between these definitions because the original sources give us clues as to where our convictions and assumptions about society and culture lie. I believe that *words* hold a lot of political weight, much more than is realized, and even the most simplest and ubiquitous words like "communication" can have social and even economic consequences. My primary interest is not in the linguistic or etymological structure of words, but how specific words have been and continue to be infused with powerful ideas and how these ideas play themselves out in society, culture, and politics.

4. From Philip Morrison, 'Eames Celebration,' quoted in Pat Kirkham, *Charles and Ray Eames*, 347.

A Communications Primer advertisement

The word "communication" and its impact on a wide range of disciplines can be seen in the Eameses' 1953 advertisement for their film *A Communications Primer.* The advertisement also shows that the Eameses's commitment to "communication" was very interdisciplinary in nature.

A COMMUNICATIONS PRIMER
in color and sound: running time 22 minutes
MADE BY CHARLES AND RAY EAMES
with music especially composed by Elmer Bernstein

The intention of this film is to
open some doors to the many
and various aspects of the
subject of communication
which is becoming increas-
ingly important to all of us.

The need for a broader concept of what
communication means and how it operates
has been simultaneously felt in many areas

[a very large arrow pointing downward to the following]

organization
regional planning natural science
medicine government music graphic arts
material programming sociology military research
painting labor merchandising business physical sciences
political science production economies tooling
logistics design psychology architecture
physiology mechanics philosophy
literature

This need so commonly felt may lead to the
first definite step in breaking down the barriers
that have grown up between fields of learning

A COMMUNICATIONS PRIMER
does not pretend to teach the subject, but we
hope that seeing it will help discourage ever
thinking of communication in a limited way.

The request for rental and purchase of
A COMMUNICATIONS PRIMER
have come from a broad cross section of the
areas indicated above – from the fields of
business, education, of science and of art. [5]

5. Reprinted in "ArchitectureCcreating Relaxed Intensity," Geoffrey Holroyd, *Architectural Design* 36 (September 1966): 461.

Democratic | Communication

Introduction

In Pat Kirkham's book on the Eameses, *Charles and Ray Eames: Designers of the Twentieth Century*, the Eameses' design approach is compared to the ideas of John Dewey, who was "committed to the integration of mind and body and 'learning by doing'". [1] Kirkham points out that these ideas are markedly similar to how the Eames Office was organized and how people who came to work for them were encouraged to do "many more tasks than they or society deemed them capable." [2] Kirkham also points to the writings of Geoffrey Holroyd who was one of the founders of the Independent Group, a group of British artists who are credited, among many other things, with launching "Pop Art". [3] Kirkham quotes Holroyd's article in *Architectural Review,* stating that he (Holroyd) compared "Dewey's notion of the school as a miniature workshop and community, teaching through practice, trial, and error, and the Eameses' understanding of a laboratory workshop."

What Holroyd actually said was:

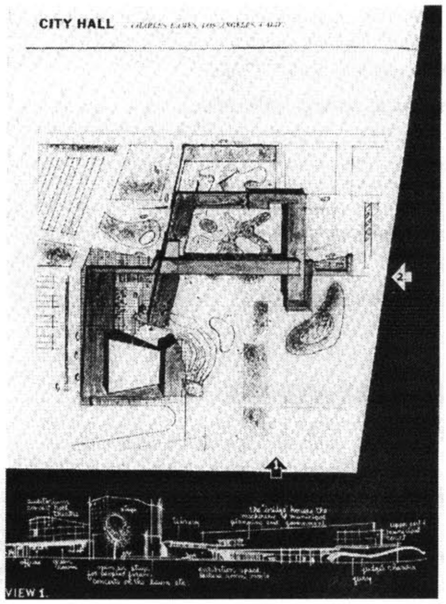
> ... Dewey believed in more science and less literature in education. Since we are all all involved in world industrialization, occupations more than books should provide us with our tools. Fellowship in occupation is a better guide to democracy than the snobbish scholastic culture of books and the fine arts. Compare this, for example, with the Eames' 1962 Science Exhibit film script:
>
> 'Today, as in the past, a laboratory can be many things and many places ... when animals or insects or birds or men live together in communities, then the society they form becomes a laboratory.'
>
> And then with the following, written by Dewey:
>
> ' ... the school should be a miniature workshop and a miniature community; it should teach through practice, and through trial and

1. Kirkham, *Charles and Ray Eames*, 147.
2. Kirkham, *Charles and Ray Eames*, 148.
3. The Independent Group was heavily inspired by the Eameses' "visual intuitions of a design theory based on assemblages of signs and symbols" due to the showing of the film *A Communications Primer* at the Institute of Contemporary Arts in London. See Geoffrey Holroyd's Retrospective Statements, in *The Independent Group: Postwar Britain and the Aesthetics of Plenty*, ed. David Robbins (Cambridge, MA: The MIT Press. 1990), 189.

> error, the arts and disciplines necessary for economic and social order.'
>
> According to Dewey's view, things have their place and function in the environment and this explains them. The more fully life is lived the more continuous the illumination of its purpose. This could account for the Eames' conscious pursuit of 'involvement'; the films, the multi-image of simultaneous projected stills, and the films [sic], are the instruments of involvement in this specific sense. [4]

Note that Holroyd does not make this connection between the Eameses' design approach and Dewey's notion of a laboratory. Rather it is Kirkham who interprets Holroyd's quote in this manner. This does not, however, diminish the accuracy of Kirkham's statement which is most likely true because the Eameses did in fact run their office like a "miniature workshop or laboratory." Holroyd's connections between the Eameses and John Dewey serve as a framework for this chapter which will also read the work of the Eameses through the ideas of John Dewey, especially his ideas on democracy, education, and *communication.* In his analysis, Holroyd neglects to explain the development of the Eameses' interest in democracy and how it relates to education. In this chapter, this relationship will be examined by looking at two early projects of the Eameses: the "New Buildings for 194X" Issue of *Architectural Forum* (1943) and the Jefferson National Expansion Memorial Competition (1947) in which the democratic nuances of the word "communication" are most explicit. It is also important to see their later works, especially the film *A Communications Primer* and their work for the IBM and for the United States Information Agency (USIA) in the context of "democratic communication."

4. Geoffrey Holroyd, "Architecture Creating Relaxed Intensity," 458. Note that the comparison between animals, insects, birds and people does not necessarily correlate with the Deweyan concept of the "school as a miniature community". The "animal" analogy most likely had its roots in the interdisciplinary pursuits of the Cyberneticians whose work greatly interested Charles Eames. See chapter "Interdisciplinary Communication."



"New Buildings for 194X" (1943)

In 1943, the magazine *Architectural Forum* dedicated an issue to "New Buildings for 194X". The exact year, denoted by the ambiguous "X", was purposely left out because the goal was to encourage a forward looking range of submissions that "showed how buildings might be improved through fuller and more imaginative resources." [5] The entry was entered under only the name of Charles Eames, but John Entenza and Ray Eames contributed as well. Entenza was also the editor for *California Arts & Architecture* [6], and subsequently reprinted the entry in his own magazine. [Shown above.] Entenza was a strong supporter of "the social function of architecture and planning," [7] and it is likely that Entenza's ideas influenced Eames' own thoughts on the subject more than vice versa.

In the competition entry text quoted below, the commitment to *communication* is central.

5. Neuhart, Neuhart, Eames, *Eames Design*, 37.
6. After 1994, the magazine was renamed *Arts & Architecture*.
7. Neuhart, Neuhart, Eames, *Eames Design*, 37.

In a typical American community with 70,000 people, about 27,000 are registered voters. In 1949 only 12,000 voted in a municipal election.

WHY?

Among the several important reasons:

A lack of the facilities by which the people can educate themselves to understand the techniques of government.

A city government should – must – be housed as the center of a mutually cooperative enterprise in which:

THE GOVERNMENT TALKS TO THE PEOPLE AND THE PEOPLE TALK TO THE GOVERNMENT.

The administration of government is the business of the people.

The obligation of the people in a democracy consists not only of an exercise of franchise, but participation in, and active direction of the rules or laws by which government exists.

The City Hall must properly be considered the heart of any community, the house of government. A building in which provision is made not only for the administration of rules and regulations, but a building which must contain facilities for the expression of the *idea* of government, which is never static and which can never be complete without the direct participation of the people who create it.

The facts or the functions of administration can not properly be considered as existing independently of one another.

It should be impossible to think in terms of the juvenile court without thinking in terms of the children's clinic, without thinking in terms of a Board of Education. Such a Board of Education can best function through activities within the house of government itself by presenting in active cooperation with all departments: exhibitions, motion pictures, study and lecture groups, open forums.

TO THE END THAT
WHEN THE GOVERNMENT TALKS TO THE PEOPLE AND THE PEOPLE TALK TO THE GOVERNMENT – IT IS ONE AND THE SAME VOICE. [8]

8. Charles Eames, "City Hall [for 194X]," *Architectural Forum* 86 (May 1943): 88–90.

The ideas of the American pragmatist John Dewey percolate throughout the proposal. At this time, Dewey's ideas on communication, education and democracy were already mature and beginning to have a major impact on the development of school curricula, on philosophical debates about American political culture, and on the growing criticism of industrialization. Even if Eames had not read any of Dewey's works, the ideas were in general circulation and as a result, Eames would be familiar with them, at least partially. Eames' predilection for incorporating the ideas of others without acknowledgement makes it very hard to trace his ideas directly to their source. For example, John Neuhart observed, "Once Charles learned the information, you'd say to him, 'Where did you hear about that?' — 'Well, I don't know where that came from.' He never could remember ..." [9] There are suggestive parallels, however, between the 1943 text and Dewey's writings and therefore it is possible to conclude that the ideas presented in the City Hall proposal may have been inspired by the ideas of John Dewey.

The participatory element of democracy was key to Dewey's political philosophy. He believed that it was only "through the give-and-take of communication" that "an effective sense of being an individually distinctive member of a community" [10] could form. In the proposal, this sentiment is echoed in Eames and Entenza's text when they state that democracy could only successfully operate when the "government talks to the people and the people talk to the government." [11] The project's aspirations for a community based on communication are very similar to John Dewey's thoughts on "the great community" upon which he elaborated in the article "Search for the Great Community" in *The Public and its Problems: An Essay in Political Inquiry* of 1927. Dewey states:

9. Joseph Giovannini, "The Office of Charles and Ray Kaiser: The Material Trail", *The Work of Charles and Ray Eames: A Legacy of Invention*, (New York: Harry Abrams, 1997) 66–67. From footnote 66: John Neuhart, Marilyn Neuhart, and Richard Donges, interview with Alexander von Vegesack, Oct. 13, 1988, Los Angeles.
10. John Dewey, *The Public and Its Problems: An Essay in Political Problems* (Chicago: Gateway Books, 1927), 154.
11. Charles Eames, "City Hall [for 194X]," 88–90.

> We have but touched lightly and in passing upon the conditions which must be fulfilled if the Great Society is to become a Great Community; a society in which the ever-expanding and intricately ramifying consequences of associated activity shall be known in the full sense of that word, so that an organized, articulated Public comes into being. The highest and most difficult kind of inquiry and a subtle, delicate, vivid and responsive act of communication must take possession of the physical machinery of transmission and circulation and breathe life into it. When the machine age has thus perfected its machinery it will be a means of life and not its despotic master. Democracy will come into its own, for democracy is a name for a life of free and enriching communion. It had its seer in Walt Whitman. It will have its consummation when free social inquiry is indissolubly wedded to the art of full and moving communication. [12]

From this passage, it is possible to recognize Dewey's belief in a democratic community, facilitated by the free exchange of communication, but it also possible to detect Dewey's criticism of industrialization. This is where Eames and Entenza's position departs from Dewey's. Their commitment to and enthusiasm for the new technological, industrial, communication, and transportation advancements was in direct contrast to Dewey who believed that the "proliferation of popular cultural diversions from political concerns such as sports, movies, radio, and cars; the bureaucratization of politics; the geographic mobility of persons; and most importantly, the cultural lag in ideas, ideals, and symbols were the main obstacles to genuine communication." [13] Eames and Entenza believed that the process of communication, which was not only between the government and its citizens, but between the citizens themselves as well, could be facilitated by the very "diversions" that Dewey abhorred. These ideas were expressed programmatically in spaces like an auditorium for lectures, concerts and movies; a library; a restaurant; an outdoor amphitheater "for people's forum[s] and concerts on the lawn"; and an exhibition-gallery space. [14] The proposed city hall also included municipal courts; health, education, and employment offices; police department; jail; gun range; traffic court; juvenile court; attorneys' offices; law library and records division; engineers & inspectors offices; park department; city planning; city

12. John Dewey, *The Public and Its Problems: An Essay in Political Problems*, 184.
13. Cornell West, *The American Invasion of Philosophy* (Madison, WI: The University of Wisconsin Press, 1989), 105.
14. Charles Eames, "City Hall [for 194X]," 88–90.

council offices; licensing bureau, city clerk and administrative offices – all of which were well distributed throughout the complex.

In the 1940s and 50s, like the term "communication," another word, "information," became layered with nuanced definitions. The development of these two words is so interrelated that in some cases, the two became interchangeable, even if the definitions were not. Therefore this thesis will also track the term "information" as it impacts the Eameses and their work. In the book *Eames Design*, a compendium of all of the Eameses work collected by Ray Eames and John and Marilyn Neuhart, it is suggested that the City Hall proposal was the first of five "information centering proposals developed by the Eameses for various clients" [15] Note that Charles Eames has never been documented as referring to these projects as "information centers," but John Neuhart and Ray Eames have used this term on various occasions. John Neuhart used it in his lecture at the conference *Charles and Ray Eames: Quintessential Twentieth Century American Designers* at the Cooper-Hewitt National Museum of Design in 1989 to describe the City Hall project, and the Neuharts and Ray Eames use it numerous times in the book *Eames Design.* [16] Also, Ray Eames, in an interview with Pat Kirkham suggested that the term be used for projects other than their own by stating that the "Getty Museum [would] be best developed as an "information center". [17] At the foundation of the concept "information centering" for the City Hall was a commitment to democratic ideals in the form of nurturing and elevating each citizen's consciousness to a greater *democratic* good through education and awareness of *all* aspects of a community – political, social, and cultural. But in the later projects, the political overtones of the City Hall proposal would be lessened. Instead, the commitment to consolidating and disseminating information for the sake of educating the public, became the dominant theme.

15. Neuhart, Neuhart, Eames, *Eames Design*, 37.
16. Neuhart, "A Rough Sketch About a Lot of Work" *Charles and Ray Eames: Quintessential Twentieth Century American Designers*, Cooper-Hewitt National Museum of Design, New York, 1989, quoted in Kirkham, *Charles and Ray Eames*, 433.
17. Ray Eames, interviewed by Pat Kirkham, quoted in Kirkham, *Charles and Ray Eames*, 433.

Fig. 1

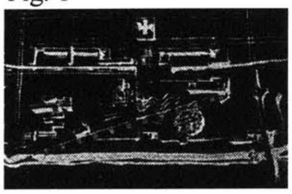


Fig. 2

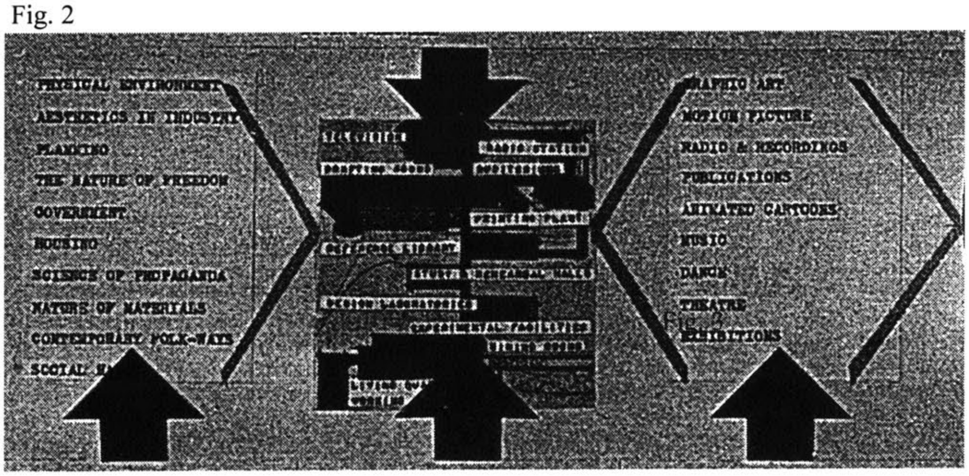


Fig. 3

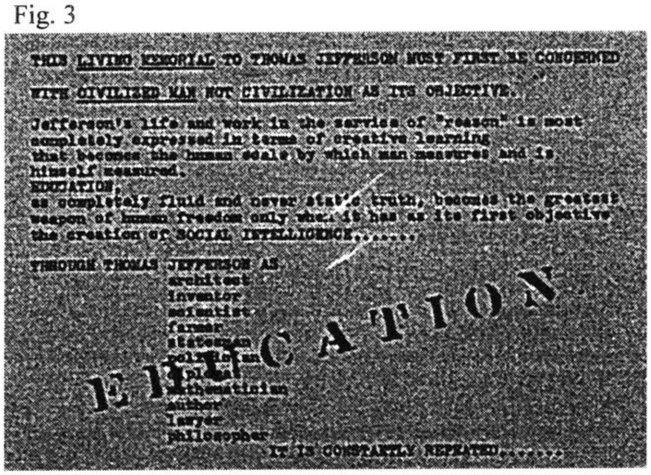
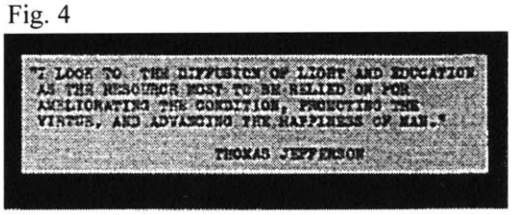


Fig. 4



"Jefferson National Expansion Memorial" Competition (1947)

The first revival of the "information center" was in the Jefferson National Expansion Memorial Competition (1947). The Jefferson National Expansion Memorial Association sponsored the open competition for a memorial to Thomas Jefferson and his "commitment to westward expansion." [18] The winning entry was Eero Saarinen's now famous stainless steel arch which was finally completed in 1965. Unlike Saarinen's entry which emphasized the representation of westward expansion and was to later be called a "Gateway to the West", the Eameses emphasized the competition program for an institution "that would provide social and cultural programs based on Jefferson's belief that men's knowledge of each other was 'the instrument' with which to 'improve the lot of men of all races and all creeds under Democracy." Along with the aid of John Entenza, the Eameses proposed an "information center" where "education could be encouraged and perpetuated." [19] (Fig. 1.)

The Eameses's proposal consisted of four parts: a park with a memorial mound and amphitheater; a new museum and existing historical structures; a "living memorial" complex; and a walkway lined with sculpture alluding to Jeffersonian ideas and his commitment to westward expansion. The "living" memorial complex is of particular interest to this thesis because it is the first time that the Eameses propose to use multi-media techniques to disseminate information as well as the first time they see a collaborative possibility between researchers and who the Eameses' would call "communicators." In many ways, this proposal foreshadows the Eameses's own work. Every educational film, exhibition or proposal that the Eameses completed after this competition entry had an outside research expert who aided the Eameses – "the communicators" – with the formulation of the content. The following passage is a quote from the competition entry.

18. Neuhart, Neuhart, Eames, *Eames Design*, 85. Note that the competition was an open one even though Neuhart implies otherwise, stating that "architects and designers, including the Eameses, were invited to submit proposals."
19. Hélène Lipstadt, "'Natural Overlap': Charles and Ray Eames and the Federal Government" in *The Work of Charles and Ray Eames: A Legacy of Invention* (New York: Harry Abrams, 1997) 157.

> THERE EXISTS GREAT THINKING WHICH PROPERLY PRESENTED, WILL BRING A GREATER RICHNESS TO MANY PEOPLE IF THIS THINKING CAN BE CREATIVELY INTERPRETED,
> not only through means and techniques most appropriate to it, ...
> but, more important
> IF IT IS DONE BY AND THROUGH INDIVIDUALS RECOGNIZED AS THE GREATEST AMONG THOSE WHO COMMUNICATE BY PRESENTATION IN ALL ITS FORMS THERE CAN BE A TRUE REPORT TO THE PEOPLE.
> This thinking, to be usefully creative, must also draw from these great original thinkers an added quality scaled to human measurement in order that it take on an immediate sense of public reality and not only make ENRICHING things important but IMPORTANT things more enriching.
>
> THE LIVING MEMORIAL CAN AND MUST POSSESS THE NATURE OF SANCTUARY FOR IDEAS AND PROJECTS WHOSE GREATEST PROOF CAN ONLY BE MADE RECOGNIZABLE THROUGH COMPLETE FREEDOM OF CHOICE. [20]

The Eameses proposed that the "an arranged cooperation between great thinkers and great communicators" would be the "means through which enriching ideas [would] be brought to many people in the language of all people." [21] These great thinkers and communicators would live together interacting in the various facilities on the site which included "a reference library, design laboratories, experimental facilities, dining room, living and working quarters for students and researchers, radio station, auditorium, drafting room, study and rehearsal halls, a television [room] and a printing plant." [22]

> Here materials and ideas will be subjected to processes of research and creative interpretation through which knowledge will become more malleable and more easily disseminated by media most appropriate to it. Where great ideas in cooperation with creative communication will relate facts to ways of life and human experiences.

20. Eames, Charles, and Ray Eames, Jefferson National Expansion Competition Entry, 1947. Reprinted in Neuhart, Neuhart, Eames, *Eames Design*, 84.
21. Ibid.
22. Ibid.

...

> This working center of the living memorial must possess complete independence ... must be free from all external pressure in order to express, an intellectual climate "open", as Jefferson has said, " to all the avenues of truth". This then is sanctuary within which no consideration other than the best thinking for the best "good" can be admitted ... where it will be freely developed without fear of consequences ... compromise ... control ... or reprisal ... [23]

In order to show the "open" nature of the working center, it was suggested that the researchers study subjects like "the physical environment, aesthetics in industry, planning, the nature of freedom, government, the science of propaganda, the nature of materials, and contemporary folk ways". Note that these subjects were freely chosen by the 'great thinkers' and that the ideas were to be "freely developed without fear of consequences, compromise, control, or reprisal." The 'great thinkers' were then required to translate their research, with the help of 'great communicators', into the medium best suited to communicate the ideas to the general public. The choices of media listed in the entry were "graphic art, motion picture[s], radio and recording, publications, animated cartoons, music, dance, theater, and/or exhibitions." [24] (Fig. 2.)

The commitment to education, which was the foundation of the 'living center', was tied back to Thomas Jefferson by linking two ideas: one, Jefferson's own interdisciplinary roles in a variety of fields and two, his idea of education as a facilitator of human virtue and happiness. The first reference to education was a vertical list of Jefferson's various roles (in this order) – architect, inventor, scientist, farmer, statesman, politician, diplomat, mathematician, author, lawyer, philosopher – with the word "EDUCATION" cutting diagonally across the list in a bold larger font. (Fig. 3.) In the proposal, the Eameses correlate Jefferson's wide range of interests with the variety of subjects that could be studied at the 'living center'. The second reference is a smaller quote set off from the rest of the proposal in a thick black border stating

I LOOK TO THE DIFFUSION OF LIGHT AND EDUCATION AS

23. Ibid.
24. Ibid.

> THE RESOURCE MOST TO BE RELIED ON FOR AMELIORATING THE CONDITION, PROMOTING THE VIRTUE, AND ADVANCING THE HAPPINESS OF MAN. – THOMAS JEFFERSON" [25] (Fig. 4.)

There are noteworthy parallels between Jefferson and Dewey, especially in terms of their philosophies on education and democracy, [26] but it is the Eameses's dedication to the concept of *communication* as an essential part of the educational process that was the crux of the proposal. The 'great thinkers' and 'great communicators' living together in a research and production environment were responsible for *communicating* ideas through the use of the most "appropriate" medium in order to facilitate a democratic community.

> Charles Eames believed that ... the memorial ... [should be] living, in the best sense of participation, not only in his [man's] great aspirations for his fellow human beings, but in his humor and richness as one of them. [27]

Charles Eames might possibly have seen a similarity between his own aspirations for the memorial and Dewey's position on the role of the individual within society: "To learn to be human is to develop through the give-and-take of communication an effective sense of being an individually distinctive member of a community." [28] Read in light of this quote, the 'living memorial' was one in which "participation" occurred at a quotidian level to not only symbolize the role of the individual in relation to a larger community but also to confirm it actively as well. But it must be noted that Dewey's model for the "Great Community" never included 'great communicators' because theoretically *everyone* would be able to communicate effectively with each other.

The difference between these two projects is important. The City Hall project emphasized Deweyan-type ideas of communication that promoted a participatory democracy in a give-and-take relationship between the government and its citizens. The Jefferson National Expansion Memorial project emphasized the dissemination of information using mass media techniques. For the Eameses however, both were inherently *communicative* processes that were inherently *democratic.*

25. Eames, Charles, and Ray Eames, Jefferson National Expansion Competition Entry, 1947.
26. Milton R. Konvitz, "Dewey's Revision of Jefferson," in *John Dewey: Philosopher of Science and Freedom,* edited by Sidney Hook, (New York: Dial Press, 1950), 164-76.
27. Neuhart, Neuhart, Eames, *Eames Design*, 85.
28. Dewey, *The Public and Its Problems*, 154.

"Information centers" in later works

The third "information center proposal" was presented more than twenty years later, in 1968. The proposal was for the IBM Museum and emphasized a place where "visitors could listen to orientation lectures and see multiscreen projections; get hands-on experience with computer operations and applications; and see demonstrations about the fundamentals of computing." [29] The fourth proposal, which Kirkham has also referred to as an "orientation center" [30] was for the Metropolitan Museum in 1975. The "orientation center" featured a "three-dimensional walk-through timeline of the museum's treasures; an aisle containing information about the museum's history, a computer-retrieval system where visitors could call up information about the museum's collections; glass kiosks for viewing videotapes; and a small theater for showing short films. [31] Finally, in the 1977 proposal for the IBM 590 Corporate Exhibit Center, an "information-access" area would have provided hands-on experience for visitors with computer programs and applications, "investigating the latest and best innovations in the world of computers." [32]

By the 1950s, the words "communication" and "information" were becoming intricately intertwined due to the advent of a new mathematical theory of communication that essentially viewed the communication process as a uni-directional flow of "sent" and "received" messages and viewed "information" as data. [33] Although the exchange of ideas would happen at the level of data, this does not mean that the Eameses favored information over communication. Rather the Eameses' saw communication and the dissemination of information as both inherently democratic processes, as long as the dissemination of information was not censored in any way. Though their commitment to "communication" seems to have explicitly lost its participatory element, it reappeared in an MIT Arts Commission Report [34] and in their later projects for interactive videodisc games. [35]

29. Neuhart, Neuhart, Eames, *Eames Design*, 329.
30. Kirkham, *Charles and Ray Eames*, 357.
31. Neuhart, Neuhart, Eames, *Eames Design*, 415.
32. Ibid., 439.
33. See chapter "Mathematical Communication."
34. See section 'MIT Arts Commission Report' in chapter "Teaching Communication."
35. Lipstadt, "Natural Overlap," 173.

Visual | Communication

Introduction

Even though the Eameses were aware of the experimental films that were being produced both in Europe and in California [1], they did not see their films as being particularly experimental.

> "They're not experimental films," Charles said, they're not really films. They're just attempts to get across an idea. Had a better medium for presenting ideas and objects to a larger audience been available then they would have grasped it: "You must be committed to the subject, to the discipline of the concept involved, not to the medium. In the process you may make a good film." [2]

In the context of the wide range of media that the Eameses used in their projects, this statement is appropriate. They were not interested in films as a medium, but as a way to communicate ideas. The commitment to computers, for example, was what lead the Eameses to accept their first commission for IBM, the film *The Information Machine*.

> It was the chance to develop a project related to computers that convince the Eameses that the IBM commission was worth of their attention. They never accepted commissions of which they did not whole-heartedly approve, and they always demanded the right to work in their own way, often plowing substantial amounts of their own money into an over-budget project. [3]

In terms of the visual aesthetics of the films, Kirkham points to "Ray's collage and decorating skills, Charles' ability to handle ideas as well as the camera, and their mutual concerns with structure, images, and connections *between images and ideas*." [4]

This chapter will explore the connection between *ideas* and *images*, a subject that Kirkham does not elaborate upon in her book. In particular, the question of aesthetics will be addressed: why did the Eameses used the avant-garde aesthetic in their work? Using original

1. Kirkham, *Charles and Ray Eames*, 309-313.
2. Ibid., 313.
3. Ibid., 317.
4. Ibid., 315, emphasis mine.

research done at the Eames Archives, I will trace two ideas: one, the use of avant-garde aesthetics to Charles Eames' interest in Bauhaus ideas as they were expressed by Gyorgy Kepes and presented in his 1944 book *The Language of Vision* and two, how Kepes's political statements of a universal language of vision served to legitimize both the the Eameses' use of the modern aesthetic as well as a distinctly *non-modern* one.

This last point is extremely important. Even though the Eameses adopted the *language of vision* as a way breaking down cultural barriers, whether between American and Russia or between the arts and sciences, they did not *fully* embrace the Bauhaus aesthetic. For many of the Eameses's critics, this was considered sacrilege. For others, the Eameses' "attempt to humanize the modern," [5] whether it was in their architectural and design work or their films, was highly commendable. [6] The Eameses essentially embraced and appreciated any object that demonstrated a heightened sense of craft or design, whether it was a fallen leaf, an Arts and Crafts chair, or folk art. This appreciation for distinctly un-modern objects explains the strange juxtapositions in their films that switch from a highly aestheticized avant-garde sequence to quick cuts of kitsch-like toys and natural imagery. The Eameses basically took the universalizing politics of the *language of vision* and expanded it to include the vernacular. This thesis posits that this liberal mixing of styles may have had its origins in the fact that both Charles and Ray studied at Cranbrook, where the design philosophy revolved around taking a deliberately open stance in relation to *all* aesthetic movements. [7]

5. Kirkham, *Charles and Ray Eames*, 347.
6. The Independent Group was heavily inspired by the Eameses' "use of pebbles, butterflies, feathers, driftwood, folk art, and playing cards [at the L.A. Herman Miller showroom] arranged to create a new image of modernism." From Geoffrey Holroyd, 'Retrospective Statements,' *The Independent Group: Postwar Britain and the Aesthetics of Plenty* (Cambridge, MA: The MIT Press, 1990), 189.
7. "... the design philosophy that was developed at Cranbrook encouraged diverse expressions linked not by appearance or even clearly specified principles of design, but rather by a consistent attitude toward place and materials. It was a philosophy that safeguarded both values of personal expression and public good, that was derived from a pragmatic rather than an intellectual approach." From David G. De Long, "Elliel Saarinen and the Cranbrook Tradition in Architecture and Urban Design" in Andrea P.A. Belloli, catalogue coordinator, *Design in America: The Cranbrook Vision 1925–1950* (New York: Harry N. Abrams, Inc., Publishers, 1983.) 47.

The Bauhaus in America (1930+)

In the 1930s, the modern aesthetic developed by the Bauhaus in Germany from 1918 to 1933 was becoming well known in America. Both Charles and Ray Eames were familiar with this movement and adopted many of its techniques and philosophical underpinnings. In America, the Bauhaus aesthetic became fused with the theories of Gestalt psychologists, with its major proponents being Bauhaus artists like Gyorgy Kepes and Làszlò Moholy-Nagy and psychologist Rudolph Arnheim.

In 1937, key members of the German Bauhaus emigrated to the United States, including Walter Gropius, Mies van der Rohe, Herbert Bayer, Làszlò Moholy-Nagy, Gyorgy Kepes and Joseph Albers. Due to the presence of these major figures in America, and the influential roles in universities that they were able to secure, the Bauhaus's commitment to identifying and promoting a *language of vision*, eventually became ubiquitous in both the educational design curricula of American universities as well as in the design of American corporate logos and advertisements. This is a very marked difference from the Beaux-Arts tradition that had until recently been the unique mode of instruction in American schools of architecture. The difference was not only formal, but it was philosophical as well. The Beaux-Arts tradition was criticized by the Bauhaus advocates for being rooted in stylistic traditions that required *intellectual* appreciation. [8] The Bauhaus however was in search of a "system of signs that was natural and universal, insured by biologically stable faculties of perception." [9]

The idea of a universal visual language that was derived rationally from the elementary forms of the triangle, square and circle also contained a very strong underlying political statement, namely, that of the validity of non-Western cultures, and especially of their art. After the second world war, the idea of promoting equality and peace was added. It is important to note,

8. Ellen Lupton, "Visual Dictionary," in *The ABC's of [triange, square, circle]: The Bauhaus and Design Theory from Preschool to Post-Modernism*, eds. Elllen Lupton and J. Abbott Miller (Princeton: Princeton Architectural Press, 1993), 23.
9. Lupton, "Visual Dictionary", 23.

however, that recognizing the validity of non-Western aesthetics did not elevate these cultures to the same status as Western artistic movements. Rather, the art of non-Western cultures were compared to "art" produced by Western children. The embracing of the "uneducated" eye essentially glorified innocence and primitiveness. The irony is that this uneducated eye was taught by a process of "un-learning" in design schools around the country. [10]

Of the original group that emigrated to America, Moholy-Nagy and Kepes were invited by a group of Chicago industrialists to found a new design school called the New Bauhaus. Later, the school was named the School of Design and then the Institute of Design. Gyorgy Kepes taught photography, graphic design, and drawing based on Gestalt psychology. [11] At this time, Charles Eames was at Cranbrook and on weekends, would visit Làszlò Moholy-Nagy, [12] from whom he learned about the "interplay of technology and modernist forms" [13] Moholy-Nagy's and Kepes' interest in Gestalt Psychology surfaced in two books: Gyorgy Kepes' book *Language of Vision* in 1944 and Moholy-Nagy's *Vision in Motion* in 1947. Both books were significant in that both books aimed to "lend a scientific rationale to the language of vision," [14] but Charles Eames found the ideas in Kepes' book particularly compelling. In the film *A Communications Primer* the Eameses used many of Kepes' ideas: simple shapes, still and moving diagrams, close-up abstract photographic techniques, examples of "primitive" art, children's toys and "universal" symbols to convey new mathematical, scientific and technological concepts. [15]

The Eameses however were never formally taught the Bauhaus aesthetic. Ray Eames studied under Hans Hofmann in New York and was a core member of the American Abstract

10. For more on the concurrent movement of aesthetic experientialism, which was also indebted to Gestalt Psychology, see Mark Jarzombek, "De-Scribing the Language of Looking: Wolfflin and the History of Aesthetic Experientialism," *Assemblage 23* (1994): 28–69.
11. Ellen Lupton, "The ABCs of [triangle, square, circle]: The Bauhaus and Design Theory" in Lupton, Elllen and J. Abbott Miller, eds. *The ABC's of [triange, square, circle]: The Bauhaus and Design Theory from Preschool to Post-Modernism*, editors (Princeton: Princeton Architectural Press, 1993), 3.
12. R. Craig Miller, "Interior Design and Furniture," Belloli, Andrea P.A., catalogue coordinator, *Design in America: The Cranbrook Vision 1925–1950* (New York: Harry N. Abrams, Inc., Publishers, 1983), 109.
13. Kirkham, *Charles and Ray Eames,* 207.
14. Lupton, "Visual Dictionary," 22.
15. See chapter on *A Communications Primer*, "Filming Architecture".

Artists group who started to exhibit work in 1937. They were influenced not only by pre-war European avant-garde movements, but by German abstraction, especially the work of the Bauhaus. [16] Charles Eames on the other hand had begun, and notably did not finish, his architectural education at Washington University in St. Louis which had a traditional Beaux-Arts curriculum. Even though he had seen the Weissenhof Siedlung in 1929, it did not make an impression on him when he visited it. [17] When both Charles and Ray were at Cranbrook, it too was not an environment in which the strict Bauhaus principles were taught. The design philosophy of Cranbrook, which stemmed directly from the philosophy of its director, Elliel Saarinen, was essentially to take an open stance in relation to all the diverse movements. "Alvar Aalto and Frank Lloyd Wright were considered as important as Le Corbusier, Gropius, and Mies van der Rohe. Arts and Crafts ideals as worthy as modernist ones, and sculpture and the decorative arts as important as architecture." [18] But it is definite that Charles Eames' interest in the International Style and the New Bauhaus were to grow intensely while at Cranbrook, not only from his visits to Chicago, but with his collaboration with Elliel Saarinen's son, Eero, who also had a penchant for new modern and specifically for "organic" forms of architecture.

It is therefore possible to speculate that Charles Eames' interest in Bauhaus concepts grew in the Forties as well, when the fusion of Gestalt Psychology and Bauhaus concepts was to become extremely popular in America. The first book to have a large impact was Gyorgy Kepes's book *Language of Vision,* which was released in 1944. Kepes' theory of art brought "two divergent cultural discourses within a single frame: science and art. Science [was] aestheticized by its association with art, while art borrow[ed] a sense of authority and explanatory power from science." [19] Rudolph Arnheim's *Art and Visual Perception: A Psychology of the Creative Eye* of 1954 also served to fuel this movement in the Fifties. [20]

16. Joseph Giovannini, "The Office of Charles Eames and Ray Kaiser: The Material Trail" in *The Work of Charles and Ray Eames: A Legacy of Invention* (New York: Harry N. Abrams, Inc., Publishers, 1997), 59.
17. Giovannini, "The Office of Charles Eames and Ray Kaiser: The Material Trail", 46-48.
18. Kirkham, *Charles and Ray Eames,* 50.
19. Lupton, "Visual Dictionary," 31.

Interestingly, the ideas of John Dewey once again come into play. Kepes quotes Dewey in his 1957 book, *The New Landscape of Art and Science,* which was a compilation of articles from a variety of persons in diverse disciplines. The contributors included the artists Naum Gabo, Fernand Leger and Jean Arp; the architects Richard Neutra and Walter Gropius; the historian Sigfried Gideon; and the mathematician Norbert Wiener. There were also articles written by an engineer, a physicist, a psychologist, a poet, a neurophysiologist, chemist, zoologist, and two educators. The quote from Dewey calls for a balance between the arts and the sciences.

> Surely there is no more significant question before the world than this question of the possibility and method of reconciliation of the attitudes of practical science and contemplative esthetic appreciation. Without the former, man will be the sport and victim of natural forces which he cannot use or control. Without the latter, mankind might become a race of economic monsters, restlessly driving hard bargains with nature and with one another, bored with leisure or capable of putting it to use only in ostentatious display and extravagant dissipation.
> John Dewey
> *Reconstruction of Philosophy*
> Tokyo 1919
> The Beacon Press, 1948 [21]

The fusion of American pragmatism and the *visual language* promoted by Kepes had enthusiastic believers in corporate America. Corporations like IBM, Westinghouse, and Mobil used the modern aesthetic to promote themselves as rational and even "natural" – due to the avant-garde's primitive and therefore "essential" geometric forms. The sans-serif typographies, used in the logos of American corporations, were in fact invented, designed and promoted by

20. Kepes recognized the following as major influences:
D'Arcy Wentworth Thompson, *On growth and form*; Làszlò Moholy-Nagy, *Malerei, Fotografie, Film*; Le Corbusier - *Vers une architecture*; Lancelot Law Whyte, *Accent on form: an anticipation of the science of tomorrow*; Hermann Weyl, *Symmetry*; J.J. Gibson, *The Perception of the Visual World*; Ernst Cassirer, *The Philosophy of Symbolic Forms*; Beaumont Newhall, *The History of Photography, Abstract Vision*; Charles Biederman, *Art as Visual Knowledge*; Susanne K. Langer, *Philosophy in a New Key*; Sir Kenneth Clark, *Landscape Painting*; J. Bronowski, *The Common Sense of Science*; M. Johnson, *Art and Scientific Thought.* From Gyory Kepes, *The New Landscape of Art and Science* (Chicago: Paul Theobald and Co., 1957), 11.
21. Gyory Kepes, *The New Landscape of Art and Science*, 28.

Herbert Bayer at the Bauhaus in the 1920s who hoped to "transcend the transient whims of culture by basing his designs on timeless, objective laws. Considerations of style and self-expression were subordinated to the 'purity' of geometry and the demands of function." [22] The irony is that Bayer's Universal type was intended to promote, like Kepes' *language of vision* twenty years later, a universal visual vocabulary that would break down class barriers and promote understanding between individuals and cultures. This view of course backfired in many ways. The corporate initiative to centralize and control individual style and tastes took the "universal" type and its rhetoric for its own. Roland Barthes accurately described this aesthetic appropriation not as an "obliteration but a distortion of the original vision so as to work for the ideology of the corporation." [23]

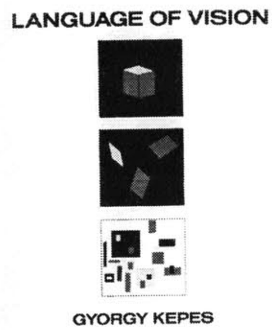
The role of film in the Eameses' collaborations with American corporations is best explained by Pat Kirkham in her book *Charles and Ray Eames: Designers of the Twentieth Century*, in which she states:

> After 1945 many firms reappraised their training and marketing techniques so as to better secure the large and lucrative markets for new products and materials. Seduced by the prospect of "1,000,000, new customers ... from one little reel," many firms became convinced that films which directly advertised their products, obliquely referred to their company, or even simply associated the company with a seemingly worthy or progressive cause were good for business – and very often they were. [24]

From this observation, it is easy to see how film as a medium meant very different things to the Eameses and the large corporations. For the Eameses, film was a very good method of educating people about specific ideas. But for the American corporations, film was merely a marketing tool. In the case of the computer, the relationship between IBM and the Eameses was one of

22. Mike Mills, "Herbert Bayer's Universal Type in its Historical Context," in Lupton, Elllen and J. Abbott Miller, eds. *The ABC's of [triange, square, circle]: The Bauhaus and Design Theory from Preschool to Post-Modernism*, editors (Princeton: Princeton Architectural Press, 1993), 38.
23. Roland Barthes, "Myth Today," *A Barthes Reader*, ed. Susan Sontag (New York: Noonday Press, 1982), 73-150 quoted in Mills, "Herbert Bayer," 44.
24. Pat Kirkham, *Charles and Ray Eames*, 316.

mutual cooperation, but their ultimate goals were very different. IBM was looking to expand their market; the Eameses, to expand people's minds.



The *Language of Vision* in the Eameses's approach

For many of their projects, including the film *A Communications Primer*, the Eameses used simple, abstract Bauhaus-inspired forms to explain scientific and technological ideas. They were particularly influenced by Gyorgy Kepes and the ideas that he laid out in his book *Language of Vision* that favored the use of visual techniques and Bauhaus aesthetics. The use of the visual language to communicate ideas is indicated by the following passage from *Language of Vision*.

> The **language of vision, optical communication**, is one of the strongest potential means both to reunite man and his knowledge and to re-form man into an integrated being. **The visual language is capable of disseminating knowledge more effectively than almost any other vehicle of communication.** With it, man can express and relay his experiences in object form. **Visual communication is universal and international**: it knows no limits of tongue, vocabulary, or grammar, and it can be perceived by the illiterate as well as by the literate. Visual language can convey facts and ideas in a wider and deeper range than almost any other means of communication. **It can reinforce the static verbal concept with the sensory vitality of dynamic imagery.** It can interpret the new understanding of the physical world and social events because dynamic interrelationships and interpenetration, which are significant of every advanced scientific understanding of today, are intrinsic idioms of the contemporary vehicles of visual communication: photography, motion pictures, and television. [1]

1. Gyorgy Kepes, *The Language of Vision* (New York: Dover Publications, Inc., 1944), 13, emphasis mine.

The Eameses took the *language of vision* very seriously as a technique for conveying information, but always remained committed to education and communication in the Deweyan sense of the word. [2] For the Eameses, and for Charles especially, the *visual language* was not only a way of communicating, it was also a facilitator of *social* communication and therefore imbued with democratic ideals. The first example of this was the Jefferson National Expansion Memorial competition entry where "researchers and students" used the most "appropriate form of visual communication" to convey a multitude of ideas and concepts to the visiting public. The next time the *language of vision* was used was in the *Rough Sketch* and then in *A Communications Primer,* which were both completed in 1953. This thesis argues that in these two projects, even if the democratic nuances of the word "communication" were not stated explicitly, they were always there as an important subtext, adding richness and *political* meaning to the projects.

In 1975, Eames gave a speech in which he quotes from Kepes' book. The lecture was given at the American Iron and Steel Institute Design Seminar in Atlanta. [3] In it, he quotes S.I. Hayakawa's preface to Kepes' book *Language of Vision*:

> "Visually, the majority of us are still "object-minded" and not "relation-minded." That was written in 1944, and I think that – (not because of any profound philosophical change) all sorts of things have been teaching us to read a scene in terms of relations. [4]

Eames continues the speech with examples of film montage and editing techniques that he argued would allow the director to "convey more in the same time." [5] But Hayakawa's statement had connotations that referred to more than the visual realm. For their whole career, the Eameses tried to break down the barriers between one, the art and sciences in accordance with the ideas of

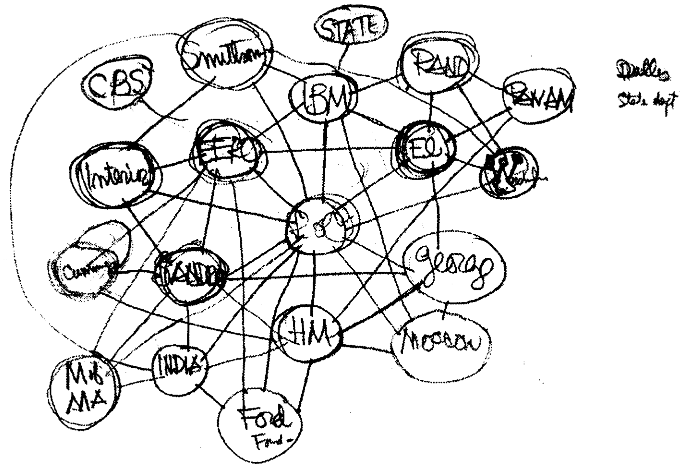
2. Kepes, like the rest of the members of the Bauhaus, valued the visual over the written. This had a major impact on the design schools in America, where classes in visual media were privileged over history and writing courses.
3. Charles Eames, "Design Seminar at the American Iron and Steel Institute", Atlanta, Georgia, lecture notes, WCRE, Box 217, Folder 15. Another reference to Kepes is a October 1974 lecture to the American Academy of Arts and Sciences, "Language of Vision: The Nuts and Bolts," WCRE, Box 217, Folder 12.
4. Ibid., 3.
5. Ibid., 3.

Gyorgy Kepes and John Dewey; two, between the various university and research disciplines [6] and three, between Western and non-Western cultures. Although this last goal of the Eameses will not be addressed in this thesis, the Eameses's desire to *communicate* on all these different levels was a fundamental belief that they held and carried through in many if not all of their projects.

Another aspect of Hayakawa's introduction ,which was not presented at the American Iron and Steel Institute Design Seminar but is important in understanding the Eameses, is Hayakawa's emphasis on the relationship of the individual to the larger community. Hayakawa states that "to see *relatedness* means to lose the deluded self-importance of absolute 'individualism' in favor of social relatedness and interdependence, [and] when we structuralize the primary impacts of experience differently, we shall structuralize the world differently." [7] There are strong parallels in this sentence to Dewey's idea that "to learn to be human is to develop through the give-and-take of communication an effective sense of being an individually distinctive member of a community." [8] The importance of seeing the individual in relation to a larger community greatly affected how the Eameses viewed their own position in society. This is seen most clearly in Charles' diagramatic web of office-client relationships [9] where all their clients, and client's clients, exist in the web as equal-sized bubbles connected to each other with lines, never as arrows. The commitment to dialogue among various professional, cultural and institutional organizations is also perfectly depicted in this diagram.

Visualizing the communication process in a diagram like this one points to the Eameses' commitment, not only top visual communication to convey ideas but also to the give and take relationship of individuals, namely the Eameses and their clients.

6. See chapter "Interdisciplinary Communication."
7. Kepes, *Language of Vision*, 9, emphasis mine.
8. Dewey, *The Public and Its Problems,* 154.
9. Reproduced in "Natural Overlap," Hélène Lipstadt, 152.


STATE
CBS
IBM
RAND
INDIA
HM
Ford

Introduction

One of John Dewey's main ideas on education was the "learning-by-doing" approach. This method of teaching allowed the student to make decisions as well as mistakes and to therefore learn through the process of experience. According to Pat Kirkham, the Eames Office was an exemplary model of this Deweyan educational philosophy. This chapter will show that one, Deweyan ideas of educational reform were also evident in two projects: *A Rough Sketch for a Sample Lesson for a Hypothetical Course* and Charles Eames' MIT Arts Commission Report and two, like the Jefferson National Expansion Memorial submission, Charles Eames simply fused a Deweyan-type commitment to education with his enthusiasm for a Kepes-inspired commitment to visual communication. This chapter will begin where the the chapter "Democratic Communication" ended by exploring the influence of John Dewey's ideas of democracy and education in these two later projects. These projects are also similar in that they both overtly employ methods prescribed by Gyorgy Kepes in his book, *The Language of Vision.*

Pat Kirkham describes the intentions behind *Rough Sketch* in her book *Charles and Ray Eames: Designers of the Twentieth Century* but she does not make the connection back to Deweyan-inspired ideas.

> [George] Nelson and [Charles] Eames had reconsidered the whole approach to teaching and learning in the department, and they suggested a **move away from the delivery of detailed factual information in favor of developing the students' creative capacity and their ability to understand ideas.** They hoped to break down compartmentalization by helping students make links and cross-references between subject areas. Charles, for once, seemed unable to find much to praise in traditional methods, or to appreciate the complexities of the teacher-student relationship at its most stimulating and intimate, although he did acknowledge that certain exceptional teachers were able to convey knowledge well in lectures. [1]

1. Kirkham, *Charles and Ray Eames*, 318, emphasis mine.

The move away from the traditional lecture format through the bringing in of more experientially diverse educational methods was an attempt to stimulate the individual "students' creative capacity and their ability to understand ideas". The Deweyan emphasis on the individual student is obvious but instead of an active "hands-on" approach to learning, the educational process was accomplished by "experiencing learning" in a passive sense. This strikingly resembles the Jefferson National Expansion Memorial where there were 'great thinkers' and 'great communicators' working together on specific topics in order to disseminate information to as wide an audience as possible. Like the JEFFERSON NATIONAL EXPANSION MEMORIAL, the only people who were actually doing any "hands-on" work at all were the 'great thinkers' and 'great communicators'. In the MIT Arts Commission Report however, Charles Eames proposed that both the teachers *and* students learn how to communicate through multi-media techniques.

A Rough Sketch for a Sample Lesson for a Hypothetical Course

In 1953, Eames, George Nelson, and Alexander Girard, were asked by Lamar Dodd, the art chairman of the University of Georgia at Athens', to study and propose revisions to the university's educational policy. The first proposal was ill-received and as a result, the designers decided that the best way to convince the university was to literally teach a sample lesson. After receiving extra funding from the Rockefeller Foundation, this sample lesson was presented later again that year at the University of California at Los Angeles (UCLA). It was co-sponsored by the Engineering School and the University Extension in cooperation with the Department of Art, the School of Education and the Department of Theater Arts. [2] This list of sponsors is a potential indicator of not only what ideas were presented but *how* they were to be presented. The Department of Art was most likely familiar with the ideas of the New Bauhaus; the School of Education, the ideas of John Dewey; and the Department of Theater Arts potentially with the

2. The head of the Engineering program was Dean L.M.K. Boelter, who may have been the first person to introduce Eames to the possibilities of computers in regional planning. L.M.K. Boelter is listed in the credits of the film *A Communications Primer.* After 1954, he served as vice-president and then president of the Los Angeles City Planning Commission and at a 1964 festschrift in his honor, Melville C. Branch, a lecturer at UCLA as well as a member of the L.A. City Planning Commission, presented a paper on the uses of computers in city planning. His position on computers however is not one of full confidence: "The fallacy in this exclusive approach lies in the assumption that mathematical computation can encompass the diverse elements, aspects, and judgmental variables which must be included to describe the content the chief executive must consider." From Melville C. Branch, "A Missing Link in Planning" in *Boelter Anniversary Volume: Heat Transfer Thermodynamics and Education,* ed. Harold A.Johnson, (New York: McGraw-Hill Book Company, 1964), 465.

power of alternative media such as film. In terms of content, the *Rough Sketch* also included a section entitled *Communications Process and Communications Methods* which presented ideas most likely familiar to the professors and students in the Engineering School. This section eventually inspired the film *A Communications Primer*. Unfortunately, the only documentation of the content of the *Rough Sketch* is in the film *A Communications Primer* which will be discussed in the chapter "Filming Communication".

The diverse composition of the sponsors was not accidental, but was in fact an integral part of the driving goal of the *Rough Sketch*: interdisciplinary communication. [3] The following statement was printed on the invitation. Note that the interdisciplinary bent in this passage echoes the ideas of communication and education put forth in the previous chapters.

> *something new is happening ... a*
> *normal progression, perhaps, toward*
> *breaking down the barriers between fields*
> *of learning ... toward making*
> *people a little more intuitive ... toward*
> *increasing communication between*
> *people and things.* [4]

The "barriers between fields" were explicitly stated later on in the invitation as the barriers between "art and engineering; engineering and business; and business and art in technique and art in appreciation." [5] It is interesting to compare these statements with Dewey's quote in Kepes' book *The New Landscape of Art and Science* in which he states that "surely there is no more significant question before the world than this question of the possibility and method of reconciliation of the attitudes of practical science and contemplative esthetic appreciation." [6] Here, Kepes' influence can also be seen in the phrase – "toward making people a little more intuitive." Kepes, as a proponent of Gestalt psychology and the Bauhaus aesthetic, gave priority to the commonality and *intuitive* nature of vision. The end goal of Eames, Nelson and Girard was to increase com-

3. This idea will be elaborated upon further in the chapter "Interdisciplinary Communication".
4. Invitation brochure for "A Sample Lesson", WCRE, Box 225, Folder 4.
5. Invitation brochure for "A Sample Lesson."
6. Kepes, *Language of Vision*, 28.

munication and education, but a noticeable primacy to *visual communication* now became apparent.

The *Rough Sketch* proposal, with its "aim to replace the conventional lecture with new teaching techniques, including three concurrent slide images, film, a narrator, a large board of printed visual information, sound, and complementary smells piped through the ventilation system, was very radical." [7] In every way, Eames tried to incorporate every single type of communication device available. There is an interesting resemblance to the forms of communication listed in the Jefferson National Expansion Memorial submission: "graphic art, motion picture[s], radio and recording, publications, animated cartoons, music, dance, theater, and/or exhibitions." [8] Through these primarily visual methods, Eames, Nelson and Girard hoped to "break down compartmentalization by helping students make links and cross-references between subject areas." [9] This hope for an interdisciplinary approach to teaching and learning was strengthened as an argument by the very nature of the section that was developed by the Eameses entitled *Communications Process and Communications Methods.*

The content for this section was inspired by new scientific concepts like the mathematical theory of communication and cybernetics [10] which were explained in the *Rough Sketch* by comparing seagulls in flight formation; the concept of a "bit" of information and its manifestation as punched computer tape; the corporate logo of CBS as an abstraction of an eye; Chinese characters in relation to their English translation; and the millions of black dots in a half-tone photograph. Due to the research being done by scientists in the new fields of information theory and cybernetics, *communication* was no longer confined to human disciplines or even human activities and the word itself now expanded to include the natural processes of birds, human biological processes, and even computers.

7. Kirkham, *Charles and Ray Eames*, 318.
8. Neuhart, Neuhart, Eames, *Eames Design*, 84.
9. Kirkham, *Charles and Ray Eames,* 318.
10. See chapters "Mathematical Communication" and "Interdisciplinary Communication."

Ironically it was the mathematization of communication – and its elimination of the semantic– that created an interdisciplinary space where all professions and researchers had equal territorial rights. If the disciplines could not find anything else in common, they could gather around this new theory of communication. The purging of the semantic allowed the artist, scientist, computer programmer, layman, and even linguist to talk about his or her discipline as a communication process *equal in social and cultural value* to all the others. The end result was a way of dealing with communication as a *process*, breaking down the barriers not only between disciplines, but, it was hoped, between nations and cultures as well.

MIT Arts Commission Report (1969-1970)

Introduction

In 1969 and 1970, Charles Eames served on an Arts Commission committee at MIT whose goal was to focus on the lack of "sufficient representation of the arts in the institutional experience of the MIT student." [10] Although chronologically out of place in terms of the general progression of this thesis, the MIT report is important because it shows that the Eameses' interest in visual media techniques, especially those of Kepes', continued into the '70s. The report also shows that the Eameses's interest in education, which surfaced early on in the JEFFERSON NATIONAL EXPANSION MEMORIAL and *Rough Sketch*, would continue into their later work as well. The significance of this report in relation to the film *A Communications Primer* lies in the film's role as a precursor to the methods of education suggested in MIT report. In the Philip and Phylis Morrison's article "A Happy Octopus: Charles and Ray Learn Science and Teach it with Images", they point out the film as being more "theoretical and didactic than most of their other films ... [explaining] applied mathematics, [that] was then a source of new conceptual order of great importance." [11] What the Eameses did for applied mathematics is what they hoped MIT undergraduates would do for their own disciplines by teaching scientific and engineering concepts to the Boston–area elementary school students. In essence, what Charles Eames proposed was not only the teaching of science and technology, but the teaching of *communication*.

10. Charles Eames, "A report to President Howard Johnson from Charles Eames as one member of the 1969-1970 Arts Commission," WCRE, Box 218, Folder 6. To my knowledge this report has not been referenced previously. Not surprisingly, Ray was not appointed as well. The sexist climate of the day precluded her from being invited to sit on a variety of committees in which Charles participated. It should be noted as well that she gladly left the role of spokesperson to Charles. Kirkham, *Charles and Ray Eames*, 84.
11. Philip and Phylis Morrison, "A Happy Octopus: Charles and Ray Learn Science and Teach it with Images" in *The Work of Charles and Ray Eames: A Legacy of Invention* (New York: Harry Abrams, 1997) 112.

The influence of Kepes' *Language of Vision* on the MIT Report

The Eames proposal consisted of six parts: one, "The charge to the commission"; two, "An interpretation of the charge"; three, "The physical environment at MIT"; four, "Recommendation One"; five, "Recommendation Two"; and six, "Conclusion". In the first part, Charles Eames criticizes the original charge of the Arts Commission which was to incorporate "theatre and dance, music and poetry, film and photography, painting, sculpture, graphics and electronics" [12] into the undergraduate curriculum. In part two, Eames interprets this type of curriculum as a "dietary supplement, an esthetic vitamin concentrate." [132] In the third, he points out that the problem is not a "lack of art but lack of decision." [14] He ends with an example by comparing the lack of "bookshops, coffeeshops, stores, etc., around MIT with (for example) the same services around Harvard." [15] Although not stated explicitly, Charles Eames saw the problem lying directly in the indecisive nature of MIT's upper administration.

The fourth section, "Recommendation One", starts by proposing a "pragmatic present–day extension of an idea Gyorgy Kepes introduced 26 years ago in *The Language of Vision*." [16] Eames suggested that there be a "language of vision in each department". [17] This entailed the commitment of two or three teaching assistants who were primary researchers in the discipline but who were also skilled in "photography, film, sound, graphics, the use of the English language, and so on." [18] The information that these teaching assistants accumulated and documented were also to be hung on "the walls and corridors" to be "informative for those without as well as within." [19] The last paragraph in particular emphasizes the visual medium, not as an aesthetic accessory to the content, but an integral part of it.

12. Charles Eames, "Report to President Howard Johnson form Charles Eames as one member of the 1969-1970 Arts Commission", Box 218, WCRE. 1.
13. Eames, "Report," 2.
14. Eames, "Report," 3.
15. Eames, "Report," 3.
16. Eames, "Report," 4. In 1945, Gyorgy Kepes moved to Cambridge to teach at the MIT School of Architecture. He was invited to teach at MIT due to the publication of *The Language of Vision* a year earlier. From "Biography" page in exhibition catalog of "Gyorgy Kepes", Dartmouth College Museums and Galleries, October 21 - November 27, 1977. (no page numbers)
17. Eames, "Report," 4.
18. Eames, "Report," 4.
19. Eames, "Report," 4.

> In the communications that this recommendation calls for, esthetic considerations are not separable from functional ones. At this point, visual (or linguistic) discrimination presents itself as needed, for effective communication, and not just as an amenity. [20]

The next part entitled "Recommendation Two" proposed a curriculum that would "build a relationship between the student, his discipline, the institution, the larger community, and his own developing powers of discrimination." [21] The proposal suggested that MIT students use multi-media techniques to create and teach material to local Boston-area elementary students. It would also be required that the students *not* teach core elementary school subjects, but concepts and ideas relating to their own field of study.

> The student should *not* teach an elementary lesson; he should be asked to communicate, in effect, the essence of a subject in his own specialty. [22]

Through this process of learning to teach concepts in a way that would be "meaningful to children. [The] process has in it the essence of the creative act; if the MIT student is going to learn anything about art, he will learn it here." [23]

Dewey's influence on education

Through the communication of information from older to younger student, not only would s/he learn about art, the individual would be actively participating in, to quote Dewey, the "give-and-take of communication". Dewey's belief in communication was intimately linked to his ideas on societal reform through education.

> ... we are not born members of a community. The young have to be

20. Eames, "Report," 4.
21. Eames, "Report," 5.
22. Charles Eames, "Language of Vision: The Nuts and Bolts," *Bulletin of the American Academy of Arts and Sciences,* Vol. XXVIII, October 1974 No.1., WCRE, Box 217, Folder 12, 20.
23. Eames, "Report," 5.

> brought within the traditions, outlooks and interests which characterize a community by means of education: by unremitting instruction and by learning in connection with the phenomenon of overt association. ... To learn to be human is to develop through the give-and-take of communication an effective sense of being an individually distinctive member of a community. [24]

Dewey not only placed education above all other forms of democratic reform, he placed the process of learning how to *communicate* as the fundamental goal of education. If children, as well as adults, are taught how to communicate, then a democratic community could and would exist. Dewey was also a major advocate of the individual and of the idea that only through individual initiative and activism could society transform for the better. The idea of a participatory democracy through communication and education obviously affected the Eameses and therefore, it is important to remember their roles as communicators, not only in the sense of the media with which they conveyed their ideas, but also by the fundamental democratic underpinnings of their beliefs.

Conclusion

It is important to note that in 1974, in Charles Eames' speech to the American Academy of Sciences, he expresses a sincere disappointment in the failure of the *language of vision* to take hold in the university setting.

> Unfortunately, universities today are becoming discontinuity headquarters, with each department avoiding communication with the others and with the rest of the world. Used as it could be, the language of vision is a real threat to this discontinuity, and so it is avoided at all costs. [25]

In this quote, it is clear that Eames saw Kepes' method – the *language of vision* – as a very successful method to carry out a Deweyan-type project of greater communication among people.

24. Dewey, *The Public and Its Problems*, 154.
25. Charles Eames, "Language of Vision," 14.

It should be stressed that the Eameses most likely did not read Dewey's works and as a result, the ideas effected Eames in a very indirect way. This does not diminish the Eameses's belief in these ideas however. A Deweyan type conviction that "our culture must be consonant with realistic science and with machine industry, instead of a refuge from them" [26] essentially became the grounding for *Rough Sketch.* And this basis also helped account for the Eameses's lifetime commitment to science and technological education. Throughout their careers, the Eameses produced a variety of educational films, exhibitions, toys and books that promoted the acceptance of science and technology as a part of culture instead of apart from it.

26. John Dewey, *Characters and Events*, vol. II, 500-503, quoted in Joseph Ratner, ed., *Intelligence in the Modern World: John Dewey's Philosophy* (New York: The Modern Library, 1939), 725.

Mathematical | Communication

Introduction

The next three chapters do not deal specifically with any of the Eameses' work. Rather, these chapters present the ideas that influenced the content of the film *A Communications Primer*. These ideas came into the Eames Office through their scientist friends. Donald Albrecht in his introduction to *The Work of Charles and Ray Eames: A Legacy of Invention* describes this relationship.

> Charles Eames's interest in science and technology can be traced to his youth, when he taught himself the principles of photography, and to his and Ray's experiences during World War II, when scientists were major players in efforts to win the war. Out of that conflict came the Eameses' plywood chairs — elegant and forthright applications of new techniques and technologies. The war also fostered networks of scientists working in concert with universities, corporations, and the government to meet society's urgent needs. Inventions and phenomenon as diverse as radar, jet propulsion, and the atomic bomb quickened the pace of technology and permanently altered American life. After the war the Eameses remained committed to this scientific community and their positive notion of progress. They counted many scientists as colleagues and friends and joined their community — their "house of science," as the Eameses' 1962 film was entitled — as visual communicators. [1]

The Eameses' role as 'visual communicators' of scientific ideas has already established by many scholars and in the *Jefferson National Expansion Monument* project, it is already apparent that by 1947, they were seriously interested in communicating ideas and concepts visually. In the late Forties and early Fifties, a new mathematical theory of communication sparked the interest of the Eameses, and in particular Charles. Pat Kirkham accurately attributes Charles Eames' interest in

1. Donald Albrecht, "Introduction," in Kirkham, *Charles and Ray Eames*, 38. Footnote 40. *The House of Science* was commissioned by the State Department to be shown in the U.S. Exhibit at the 1962 World's Fair, in Seattle. It was a multiscreen presentation on the history of science. One can speculate that these ideas may have in fact come from friends the Eameses made while they were working on plywood gliders and leg splints for the United States Air Force during the war. In terms of the Eameses interest in computers, the Air Force was the first and largest supporter of computers research immediately after the war. Their knowledge of the discipline of "military strategy" may have come from the fact that the RAND Corporation was based in Santa Monica, not far from the Eames Office. The RAND Corporation was "the Air Force think tank where natural scientists, social scientists and mathematicians worked side by side to anticipate the future of war." Paul Edwards, *The Closed World: Computers and the Politics of Discourse in Cold War America* (Cambridge, MA: The MIT Press, 1996), 113.

communication theory and computers as a "result of thinking about the wider questions of architecture and city planning." [2]

> Charles realized that to arrive at optimum solutions on questions of major importance to large cities and the environment in general one had to "master" data across a wide range of disciplines, including demography, sociology, and economics – a task that daunted most architects. [3]

but she does not explain the connection between communication theory and the advent of the modern computer. For the Eameses' interest in communication theory, Kirkham only credits Claude Shannon and Warren Weaver. This is partially misleading because the ideas that were presented in the film *A Communications Primer* were not only from Shannon and Weaver, but from a whole range of scientists who were writing on the subject. The following two chapters will introduce the people who were credited at the end of the film: Claude Shannon, Warren Weaver, Norbert Wiener, Oskar Morgenstern, John von Neumann as well as other written sources that the Eameses most likely knew first hand. [4]

2. Kirkham, *Charles and Ray Eames*, 346.
3. Kirkham, *Charles and Ray Eames*, 346.
4. Note that Kirkham is inaccurate on two other counts as well. She states that "Charles' research revealed a lack of suitable material on communications" and recounts Charles' story of Bell Labs not having any information to give him. The fact that Bell Labs in particular did not have any information on Shannon's theory of communication does not mean that the ideas were not in general circulation. The book *Automatic Control* which will be presented in the chapter "Automating Communication" was in its seventh reprint by 1954, when the film *A Communications Primer* was made. Many of the ideas presented in *Automatic Control* are found almost verbatim in the script to *A Communications Primer.* Kirkham also implies that Warren Weaver was working for Bell Labs with Shannon. This is untrue. Weaver was at the Rockefeller Foundation. Chester Barnard, who was the president of the Rockefeller Foundation asked Weaver to write an article that would "explain [Shannon's ideas] in less formally [sic] mathematical terms." This lay the ground work for Weaver's article on the subject in the book *Automatic Control* as well as in the co-authored book with Shannon. Barnard probably knew of Shannon's work because he had been president of Bell Telephone before taking the position at the Rockefeller Foundation. From Warren Weaver's autobiography *Scene of Change: A Lifetime in American Science*. (New York: Charles Scribner's Sons, 1970), 111.

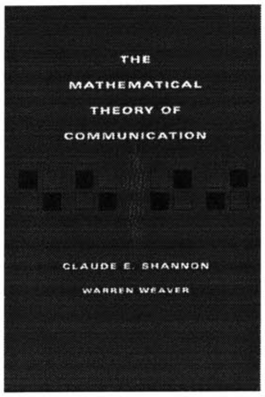
The Origins of Communication and Information Theory

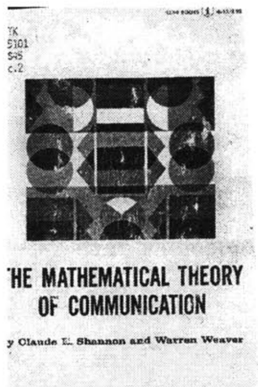
Before and during World War II, there were many researchers in various disciplines studying communication processes, but it was not given the umbrella term communication theory, or information theory, until after the war. The reason for these disciplines coming together can be explained by the sequence of events that provided an environment for the major researchers in various fields to exchange ideas. Most notably this was due to the consolidated war effort and federal and military research contracts flooding into the universities at this time. The main figures in this interdisciplinary exchange were Claude Shannon, Norbert Wiener, Warren S. McCulloch, Walter Pitts, Alan M. Turing, and John von Neumann. Their fields were as varied as mathematics, electrical engineering, psychology, biology and physics, but despite their diverse backgrounds and research specialties, they recognized the importance of communication and information not only in their own research, but in the research of the others. [5]

> The seminal idea was that an interdisciplinary approach is appropriate to solve problems in both biological and physical settings in cases where the key to the problems is the manipulation, storage, or transmission of information and where the overall structure can be studies using mathematical tools. For these scientists, both the human brain and the electronic computer were considered types of complicated information processors whose similar laws of functioning could be better understood with the help of the abstract results deduced from the mathematical models of automata theory [processing of information]. [6]

The quick growth and legitimization of this interdisciplinary science could be seen in the frequent conferences on communication and information, in which many of the scientists mentioned above actively participated, as well as in the proliferation of books on the subject: *A Mathematical Theory of Communication* in 1949, *Cybernetics* in 1949, and *Automatic Control* by Scientific American in 1948, all of which are quoted from or alluded to in the film *A Communications Primer*. The Eameses's interest in social communication had now expanded to include the scientific conceptualization of information.

5. William Aspray, "The Scientific Conceptualization of Information: A Survey," *Annals of the History of Computing*, Vol. 7, No. 2, (April 1985), 118.
6. Aspray, "The Scientific Conceptualization of Information," 118.





far left - 1998 cover
near left- 1968 cover

Claude Shannon and *The Mathematical Theory of Communication*

In 1948, Claude E. Shannon, an electrical engineer and applied mathematician at Bell Labs [7], published his paper, "A Mathematical Theory of Communication", in the *Bell System Technical Journal.*[8] The groundbreaking concepts of communication theory that Shannon put forth in this article “provided the basis for interdisciplinary information studies carried out by many others on electronic computing machines and on physical and biological feedback systems.” [9] These ideas also influenced Charles Eames, so much so that he based a section of the *Rough Sketch* and credited the film *A Communications Primer* on the ideas presented in the 1949 book form of the paper, *The Mathematical Theory of Communication*. Not all of the film’s ideas came from this book alone, however, and I will discuss these other ideas in the chapter “Automating Communication.”

The impact of Shannon’s ideas and their contemporary impact today are discussed in the introduction of the 1998 printing. Richard E. Blahut and Bruce Hajek, professors of electrical and computer engineering at the University of Illinois at Urbana-Champaign, state:

> One measure of the greatness of this book is that Shannon’s major precept that all communication is essentially digital is now commonplace ... [Another is] Shannon’s presight to

7. Later, Shannon returned to MIT professor (1958-1978). He had received his PhD at MIT in 1940.
8. Shannon’s ideas were in fact a combination of concepts presented by Harry Nyquist and R.V. Hartley presented in the 1920s. See Ashby’s article “The Scientific Conceptualization of Information: A Survey”.
9. Apray, “The Scientific Conceptualization of Information,” 124.

> overlay the subject of communication with a distinct partitioning into *sources, source encoders, channel encoders, channels,* and *associated channel and source decoders. ...* Shannon further saw that channels and sources could and should be described using notions of entropy and conditional entropy... [And finally,] Communications systems ranging from deep-space satellite links to storage devices such as magnetic tapes and ubiquitous compact disks, and from high-speed internets to broadcast high-definition television, came sooner and in better form because of his work. [10]

The ideas of "digital information" and breaking down the communication process into sender-receiver components were to become very important parts of the script for *A Communications Primer*, but it was Warren Weaver's introduction to the book that broadened the connotations of the original theories to encompass what Weaver called the "semantic problem". In many ways Warren Weaver's ideas had an even greater impact on the Eameses. Blahut and Hajek describe Weaver's influence as well:

> The exposition by Warren Weaver that introduces the book is one of his many and diverse contributions toward promoting the understanding of science and mathematics to a broad audience. It illustrates how Shannon's ideas have implications that were (at least fifty years ago) well beyond the immediate goals of communication engineers and of Shannon himself. These include insights for linguists and for social scientists addressing broad communication issues. [11]

Interestingly, the 1963 paperback edition of the book was promoted as a book "intended for social scientists who are concerned with one or more aspects of the broad communication problem, and for students of language ... and how this may be extended to include semantics and pragmatics." [12]

The difference between Shannon's theories and Weaver's interpretation of them is very important. Shannon's aim was to distinguish "meaning" from "information." He reserved the

10. Blahut, Richard E., and Bruce Hajek, "Foreword" *The Mathematical Theory of Communication* (Chicago: University of Illinois Press, 1998), vii–ix.
11. Blahut and Hajek, ibid., viii.
12. Shannon, *The Mathematical Theory of Communication*, back cover.

term "meaning" for what was actually semantically embedded in the message, or the content. "Information" on the other hand, referred to "the number of different possible messages that could be carried along a channel." [13] He then proceeded to explain how "information" was a physical parameter, as opposed to a semantic one, that could be manipulated mathematically. Weaver, on the other hand, reinstated the semantic problem by asking two fundamental questions in his introduction: "How precisely do the transmitted symbols convey the desired meaning?" and "How effectively does the received meaning affect conduct in the desired way?" [14] By reinstating the semantic problem that Shannon had purposely taken out, the difference between "meaning" and "information" became very confusing. This confusion continued when these theories were applied to the social sciences, where the word "information"essentially reverted back to its traditional definition as "meaning" but now with the value-added characteristic of being a scientific concept as well.

Coming back to the Eameses interest in this field, it is helpful to turn back to the *Primer* advertisement, where the connections between all the disciplines vis a vis their relation to *communication* should start to become clearer.

organization
regional planning natural science
medicine government music graphic arts
material programming sociology military research
painting labor merchandising business physical sciences
political science production economies tooling
logistics design psychology architecture
physiology mechanics philosophy
literature

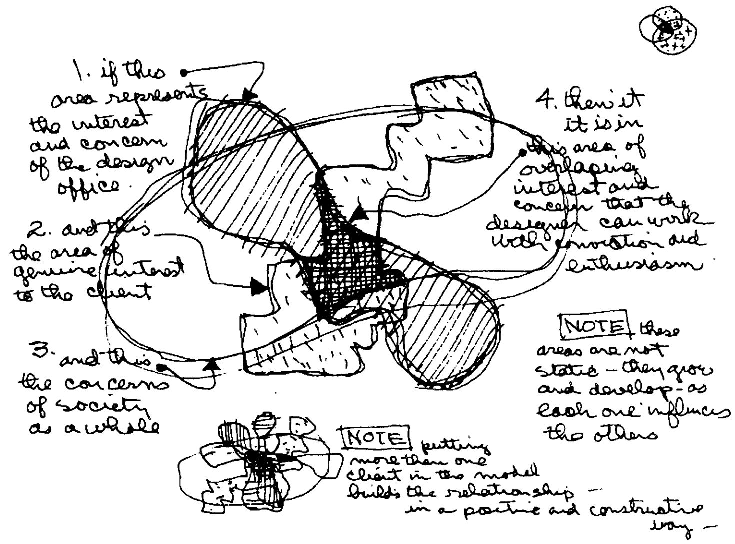
Shannon's flattening of the communication process into mathematical formulae allowed all these different disciplines to gather around the common interest of "communication" and communication theory which quantified "information" so that it could be equally applied to

13. Apray, "The Scientific Conceptualization of Information," 119.
14. Shannon, *The Mathematical Theory of Communication*, 24.

"conversations between humans, interactions between machines, and even to communication between parts of an organism. Properly interpreted, the communication between the stomach and brain and between the target and the guided missile could be seen as examples of a communication system." [15] Even though it was the *math* that universalized communication, it was Warren Weaver's explanation of the ideas in 'plain English' that would make the impact on the social sciences as well as on Charles Eames. Weaver wrote two articles: "The Mathematics of Information" in the book *Automatic Control* and the introduction to Shannon's book, *The Mathematical Theory of Communication.* In both of these articles, Warren Weaver left out most of Shannon's mathematical equations and instead give a simple but accurate and concise summary of the key concepts. In addition to this explanation, he contemplated the cultural and societal impact of these theories. The first half of the book was in fact an expanded version of Weaver's *Scientific American* article and the second half was a minimally altered version of Shannon's original article "A Mathematical Theory of Communication." The impact of these ideas on the content of the film *A Communications Primer* will be discussed in the chapter "Filming Communication".

15. Apray, "The Scientific Conceptualization of Information," 123.

Interdisciplinary | Communication



Introduction

The design process of the Eameses can be summed up in this diagram drawn by Charles Eames for the 1969 exhibition *Qu'est-ce que le <design>?* at the Musée des Arts Décoratifs in Paris. [1] The four main points are as follows:

> 1. if this area represents the interest and concern of the design office
> 2. and this the area of genuine interest to the client
> 3. and this the concerns of society as a whole
> 4. then it it [sic] is in this area of overlapping [sic] interest and concern that the designer can work with conviction and enthusiasm.

In the corner is a small Venn diagram [2] that most probably inspired the larger diagram. The analogy to mathematical logic also suggests that Charles Eames believes there is an intimate relationship between the *design process* and *mathematical logic.* When Charles Eames drew this diagram, the analogy was already becoming a reality. In the 1960s, systems analysis and the com-

1. Neuhart, Neuhart, and Eames, *Eames Design,* 13. The diagram is reprinted in Hélène Lipstadt's article "Natural Overlap: Charles and Ray Eames and the Federal Government" in *The Work of Charles and Ray Eames: A Legacy of Invention* (New York: Abrams, 1997)
2. The Venn diagram (first used in 1918) is named after its founder John Venn, an English logician who died in 1923. A Venn diagram is a "graph that employs closed curves and especially circles to represent logical relations between and operations on sets and the terms of propositions by the inclusion, exclusion, or intersection of the circles.

puter were being used to analyze large amounts of data regarding city infrastructure as well as architectural problems. The following two chapters will set the stage for how the Eameses, and especially Charles, were intellectually fascinated by the sciences and new technological developments surrounding the computer. In these two chapters, the seemingly naive nature of this design diagram will be explained within the context of interdisciplinary developments in the 40s and 50s. The two notes in this diagram are of particular significance to this chapter. The two notes read as follows:

> Note: these areas are not static – they grow and develop – as each one influences the others.
> Note: putting more than one client in the model builds the relationship – in a positive and constructive way.

The influence of the designer and client on each other and the addition of more clients in order to "build the relationship in a positive and constructive way" are ideas that are strikingly similar to the interdisciplinary exchanges that were occurring between the sciences, and in particular, the sciences that were directly related to the theory of Cybernetics, established by Norbert Wiener, a mathematics professor at MIT.

In the credits of the film *A Communications Primer*, Norbert Wiener is mentioned immediately following Claude Shannon and Warren Weaver. Within the film proper as well, there are references to cybernetic ideas. This chapter will outline the ideas of Norbert Wiener and cyberneticians that influence the film *A Communications Primer* as well as how the Eameses were affected by the cybernetic charge of interdisciplinary exchange.

Physiology and Logistics (1930+)

After World War II, interdisciplinary interaction was gaining momentum in the universities due to the fact that during the war, many scholars had been brought together into the same laboratories and projects to work in a collaborative environment. The most famous of these was the Manhattan Project that brought engineers and theoretical physicists together in order to build the atomic bomb, but laboratories at MIT and Harvard were also places instrumental in promoting interdisciplinary research. This brief section will describe the connection between between physiological processes and the workings of a digital computer because a section of the film *A Communications Primer* is dedicated to a brief explanation of this concept.

In 1943, Warren McCulloch, a neuropsychiatrist, and Walter Pitts, a logician, co-authored an article entitled “A Logical Calculus of the Ideas Immanent in Nervous Activity” which presented a mathematical model of neural networks. They applied Boolean logic to the operation of neurons, comparing these cells to on-off valves that corresponded to the two-state true-false Boolean system.[3] The discipline of physiological psychology was important to information science because “it contributed the idea that one can understand the brain by examining its material functioning [and] that this functioning was amenable to scientific study and mathematical analysis. [4] At this time, both McCulloch and Pitts worked at MIT with Norbert Wiener at the Research Laboratory of Electronics (RLE). Through their relationship with Wiener, the three became very interested in the similarities between the fledgling computers and their “modern vacuum tubes” and how this “ultra-rapid computing machine represented an ideal model of the problems arising in the nervous system.” [5]

3. Edwards, *The Closed World*, 188.
4. Apray, “The Scientific Conceptualization of Information,” 127.
5. Norbert Wiener, *Cybernetics: or Control and Communication in the Animal and the Machine* (Cambridge, MA: The MIT Press, 1948), 22. Claude Shannon’s contribution should be noted here as well because it was Shannon’s mathematical theory of communication that “provided the basis for interdisciplinary information studies carried out by many others on electronic computing machines and on physical and biological feedback systems.” Apray, “The Scientific Conceptualization of Information,” 124.

Wiener's interest in biological processes however can be traced back to the 1930s, when he attended informal monthly sessions on scientific method at the Harvard Medical School. Here he was to meet physiologist Arturo Rosenbluth with whom he and Julian Bigelow [6] wrote the joint paper "Behavior, Purpose, and Teleology" in 1943 in which they used "cybernetic principles to examine the functioning of the mind." [7] Rosenbluth moved to Mexico City to teach at the medical school there and Wiener split his time between Cambridge and Mexico for the rest of his life continuing their joint research.

The Cybernetics Group (1946-1953)

> A group of men who had, during the war years, formed a network based on common scientific interests included several mathematicians (Norbert Wiener, John von Neumann), engineers (Julian Bigelow, Claude Shannon), neurobiologists (Rafael Lorente de Nó, Arturo Rosenbluth), a neuropsychiatrist (Warren McCulloch), and a polymathic genius (Walter Pitts). Some members of this group had proposed that their concepts, useful in engineering and biology, had more general significance, perhaps even could provide tools for a transdisciplinary synthesis that might be of particular interest to researchers in the human sciences. For lack of a better collective name we shall refer to this group as the cyberneticians ... [8]

Cybernetics in fact was an attempt to create a meta-science that thoroughly accounted for and explained every aspect of society, culture, technology and nature. Its interdisciplinary approach was key. It was also arguably more encompassing in scope that Shannon's mathematical theory of communication because of its explicit interdisciplinary message. Remember, Shannon's main interest was how communications theory related to the communications industry: telegraph, telephone, radio, and television. Cybernetics, however, allowed for the study of

6. Bigelow moved to Princeton to become John von Neumann's chief engineer on the IAS Machine, one of the first stored-program computers.
7. Apray, "The Scientific Conceptualization of Information," 126.
8. Steve Joshua Heims, *Constructing a Social Science for Postwar America: The Cybernetics Group, 1946-1953* (Cambridge, MA: The MIT Press, 1993) 11.

anything that had to do with control and communication processes. Wiener's conviction that "the most fruitful areas for the growth of the sciences were those which had been neglected as a no-man's land between the various established fields" [9] grounded the discipline of cybernetics in the interstitial spaces between disciplines. As a result, it was picked up by thinkers in a variety of disciplines – from the arts and architecture, via the Situationalists and Archigram, to artificial intelligence researchers. [10]

From 1946-1953, the Cybernetics Group [11] met at a series of conferences sponsored by the Macy Foundation. Note that the term *cybernetics* was not "invented" by Wiener until 1947 and that many participants of these meetings did not call themselves *cyberneticians,* but because of their interest in interdisciplinary research, it has since become accepted to refer to them as a collective. The original members of the group included Gregory Bateson, a social scientist; Julian Bigelow, an engineer; Gerhardt von Bonin, a neuroanatomist; Lawrence K. Frank, a social scientist and Macy foundation executive, who was incidently influenced by John Dewey [12]; Ralph Gerard, a neurophysiologist; Molly Harrower, a psychologist; George Evelyn Hutchinson, an ecologist; Heinrich Kluver, a psychologist; Paul Lazarsfeld, a sociologist; Kurt Lewin, a social psychologist; Rafael Lorente de No, a neurophysiologist; Warren McCulloch, a neuropsychiatrist; Margeret Mead, an anthropologist; John von Neumann, a mathematician; Filmer S.C. Northrop, a philosopher; Walter Pitts, a mathematician; Arturo Rosenbleuth, a physiologist; Leonard J. Savage, a mathematician; Norbert Wiener, a mathematician; Alex Bavelas, a social psychologist; Henry W. Brosin, a psychiatrist; Heinz von Forster, an electrical engineer; Donald G. Marquis, a psychologist; Thomas C. Schneirla, a comparative psychologist; and Han Lukas Teuber, a psychologist. [13]

9. Wiener, *Cybernetics,* 8.
10. This paper will not trace the full impact of these ideas on other disciplines.
11. The term "Cybernetics Group" is taken from Steve Joshua Heims, *Constructing a Social Science for Postwar America: The Cybernetics Group, 1946-1953* (Cambridge, MA: The MIT Press) 1991.
12. The effects of John Dewey were also felt at these conferences where "some echo of John Dewey's pragmatism and focus on education," would permeate the discussions. Ibid., 170.
13. Ibid., 285.

The influence of the Gestalt school originators – Max Wertheimer, Wolfgang Kohler, Kurt Koffka – were also felt at the the conferences, especially at the early meetings. Kurt Lewin was the seminal social psychologist of the Gestalt school; Molly Harrower had been the only American Ph.D. student to study under Koffa, and Heinrich Kluver had been a student of Kohler's in Berlin. To a lesser extent, Freudian and neo-behaviorist psychology were also influential at the conferences. [14] The fact that Gestalt psychology became extremely influential in the fifties and sixties in the discipline of art appreciation, through people like Rudolf Arnheim and Gyorgy Kepes, only served to strengthen the interdisciplinary movement.

One should note that in the enthusiasm for interdisciplinary approaches, many things were translated incorrectly in the process of exchange. For example, Claude Shannon was interested in cybernetics as a general theory but he did not see the link between his own theories of communication and those of the Gestalt psychologists. The most evident was Shannon's reservations to cybernetic group member Alex Bavelas' work that attempted to incorporate information theory terminology into psychology experiments. [15] But this did not mean that Shannon was completely averse to working with researchers in other disciplines. When Shannon returned to MIT as a professor, he worked with the linguist Noam Chomsky on the study of the "human as X system, performing complex transformations on 'kernels' of information, decoded by reverse transformations in the listener," [16] and Shannon also mentored John McCarthy, who later coined the phrase "artificial intelligence." [17]

Norber Wiener's interest in communication processes and how it applied to various disciplines was put forth in two of his books: *Cybernetics:or Control and Communication in the Animal and the Machine,* published in 1948, and the lay man's version, *The Human Use of Human Beings: Cybernetics and Society*, in 1950. In the credits of the film *A Communications*

14. Heims, *Constructing a Social Science for Postwar America,* 202-205.
15. Heims, *Constructing a Social Science for Postwar America,* 221.
16. Edwards, *The Closed World*, 70.
17. Edwards, *The Closed World*, 70.

Primer, Norbert Wiener was credited third, after Claude Shannon and Warren Weaver. This credit is partially given due to the references to cybernetic theories in the film, which will be discussed in the chapter "Filming Communication," but it was also the cyberneticians and their commitment to interdisciplinary exchange that was of key importance. On one side, in the arts, there were people like Kepes who were calling for indisciplinary exchange. On the other, in the sciences, it was the cyberneticians.

Automating | Communication

Introduction

At the end of the film *A Communications Primer*, the Eameses credit the following people: Claude Shannon, Warren Weaver, Norbert Wiener, Oskar Morgenstern, and John von Neumann. From a viewing of the film, the influence of Shannon and Weaver is obvious, but Morgenstern and von Neumann's influences are not as explicit. Only in his letter to Ian McCallum does Charles Eames lay out why he saw von Neumann and Morgenstern's ideas on the computer application of game theory and its mathematical counterpart, linear programming, as the perfect tools for architects or planners. This chapter will explain the work of Morgenstern and von Neumann, and why their work was important to the Eameses. The difference between Morgenstern and von Neumann's ideas and Claude Shannon and Warren Weaver's ideas is of extreme importance. Both were mathematical concepts, but they influenced Charles Eames in very different ways.

The application of Shannon's mathematical ideas were of no interest to Charles Eames. In the *Primer* advertisement, he qualifies the film in this respect.

> A COMMUNICATIONS PRIMER
> does not pretend to teach the subject, but we
> hope that seeing it will help discourage ever
> thinking of communication in a limited way.

But the ideas of Morgenstern and von Nemann however were very interesting to Charles because of their mathematical applications to architecture and planning. These sentiments were never expressed in *A Communications Primer* so it becomes very confusing when Charles Eames promotes *A Communications Primer* as the first time he and Ray made an effort to introduce these ideas to architects. How could the Eameses' be promoting Morgenstern and von Neumann's ideas without explicitly or even implicitly referring to them? This thesis will suggest that Eames wanted to expose architects to computers, which were relatively new machines in 1953, before ever suggesting that the architect could use the computer, and game theory, as an analytical design tool. [1]

1. The first mention of using the computer in the design process occurred in the film *The Information Machine*, but there is no mention of architecture. (See chapter Incorporating Communication.)

John von Neumann and Game Theory

John von Neumann was a mathematician whose career and interests incorporates many disciplines. A quote from Ashby's article will suffice to understand how he fit into the circle of information scientists:

> He had social contacts as well as intellectual interests in common with the other scientists studying information. He discussed computers and artificial intelligence with [Alan] Turing when they were together in Princeton in 1937 and 1938. He had an active correspondence with Wiener [with whom] he organized the interdisciplinary meetings at Princeton in 1943 on cybernetics and computing. [And] a paper by Pitts on the probabilistic nature of neuron nets started von Neumann on his research in probabilistic automata. [2]

But his work on game theory would affect Charles Eames more directly than any of his work in information theory. In a series of papers, written in the 1920s and 30s, while still in Germany, von Neumann developed a way to quantify game strategies based on probability. These theories were later used during World War II in areas like logistics, submarine warfare and air defense. [3] After the war, the theory was also applied to fields such as politics and sociology and, of significant importance to Charles Eames, economics. [4] In the list of credits at the end of the film *A Communications Primer*, Oskar Morgenstern and John von Neumann are listed immediately after Norbert Wiener. [5] Charles Eames felt that Morgenstern and von Neumann's co-authored book *Theory of Games and Economic Behavior* published in 1944 was so filled with potential that he wrote a letter to Ian McCallum, editor of *Architectural Review*, describing the potential applications of game theory to architecture and city planning. [6]

2. Apray, "The Scientific Conceptualization of Information," 133. John von Neumann also attempted to surpass Wiener's all-encompassing theory of cybernetics with his own meta-science called "The General Theory of Automata", which allowed a comparison between "computers and the human nervous system."
3. "Game Theory" *Microsoft Encarta 98 Encyclopedia*, 1993-1997.
4. See " Letter to Ian McCallum" in chapter "Promoting Communication."
5. Notably, Morgenstern is listed before von Neumann, implying that the economic applications of game theory might have influenced Charles Eames more than game theory itself. Game theory was simply the tool. Its promise lay in its application.
6. See " Letter to Ian McCallum" in chapter "Promoting Communication."

The key concept of game theory, whether it is being applied to military strategy, a game of tic-tac-toe or economics, is the ability to probabilistically determine the optimum or most likely outcome given that the parameters are either incomplete or unknown. Game theory can basically be applied where "the decision maker is not in complete control of all the variables that affect the outcome." [7] When applied to economics the variables include "such things as substitution, complementarity, superadditivity of value, exploitation, discrimination, social "stratification," symmetry in organizations, power and privilege of players, etc." [8] Like the information theories and cybernetic visions explained previously, the interdisciplinary nature of these parameters were all subsumed into a mathematical world of statistics and probabilistic numbers to be manipulated and analyzed.

John von Neumann is also credited for many of the advances made in computer technology, the most important being the stored program which was first implemented in the computer that he constructed with James Pomerene, Julian Bigelow, and Herman Goldstine at the Institute of Advanced Studies in Princeton, New Jersey. The "fully automatic, digital, all-purpose computing machine" was known as EDVAC, Electronic Discrete Variable Computer. The automation of the program tasks marked the beginning of the gradual phasing out of punched paper tape as the instructions could be directly stored on the computer in the same way the data was stored. The EDVAC was conceived to not only calculate scientific equations, but automate the business task of sorting information, as well as predict the weather. [9] In addition, von Neumann's work on the computer was also connected to his work on game theory. The federal government needed advice on weapons policy and global strategies and John von Neumann's interests were directly aligned with the government's interest in finding a viable analytic approach to the problem.

The analytic approach incorporates besides game theory the use of

7. Leonard Silk, "The Game Theorist," *The New York Times*, 13 February 1977, Financial Section, WCRE, Box 70.
8. Oskar Morgenstern, "The Collaboration Between Oskar Morgenstern and John von Neumann on the Theory of Games" *The Journal of Economic Literature*, vol. VIX, No.3, September 1976, 813.
9. The Office of Charles and Ray Eames, *A Computer Perspective,* Glenn Fleck, ed., Robert Staples, prod., I. Bernard Cohen, intro. (Cambridge: Harvard University Press, 1973), 136-139. See also, Paul Edwards, *The Closed World.*

> the new computers and also "systems theory" and quantitative "operations research," all of which were within von Neuman's repertoire. [10]

With the advent of the computer, these ideas were given even more credibility because the computer was seen as the only device capable of running the large amount of calculations necessary. Morgenstern recognized as much when he wrote that both he and von Neumann were waiting for "the electronic computer Johnny [von Neumann] was then designing [at the Institute for Advanced Studies]" [11] so that they could compute on a large scale. Later, the RAND Corporation incorporated game theory, linear programming and systems analysis techniques to solve a variety of problems. [12]

> The RAND Corporation became the world center for studies in and promotion of game theory, and retained von Neumann as a consultant. RAND researchers authored not only an enormous number of monographs and reports on game theory but also several books on the subject, ranging from popularizations to advanced textbooks. [13]

Von Neumann was a regular consultant to RAND and it was there that he met George Dantzig, a RAND mathematician who is credited for the development of linear programming and its uses to "mechanize the planning process for deployment, training, and logistical supply" for the U.S. Air Force controller. [14] Dantzig actually credits von Neumann with "providing him with a suitable

10. Heims, *John von Neumann and Nobert Wiener*, 318. Footnote 59: "A statistic confirming the continued role of computers in the military is that 'when 1972 began, the Federal Government was utilizing 5,400 computers, and 88% of them were accounted for by the Department of Defense.'" *The Progressive*, (February 1972): .33-34, quoted by H.I. Schiller, *THe Mind Managers* (Boston: Beacon, 1973).
11. Morgenstern, "The Collaboration Between Oskar Morgenstern and John von Neumann on the Theory of Games," 814.
12. The RAND Corporation published one of Morgenstern and von Neumann's articles on economics in 1961.
13. Steve J. Heims, *John von Neumann and Norbert Wiener: From Mathematics to the Technologies of Life and Death* (Cambridge, MA: The MIT Press, 1980.), 314.
14. Apray, William, *John von Neumann and the Origins of Modern Computing* (Cambridge, MA: The MIT Press, 1990.), 115. Interesting note: this book is part of a series called "History of Computing" for which I. Bernard Cohen and William Aspray are co-editors. I. Bernard Cohen served as consultant for the Eameses' IBM exhibition *A Computer Perspective*. (*Eames Design,* 369) The Eames book *A Computer Perspective* contains many entries that discuss the concepts presented in this thesis including Morgenstern and von Neumann's book *Theory of Games and Economic Behavior*, Linear Programming, Information Theory, and Cybernetics. There are no references, however, to the potential use of the computer in the architectural or planning design processes.

mathematical foundation for the theory of linear programming by noticing the equivalence of some game theory problems and linear programming. [15]

Von Neumann never published any papers on the relationship between linear programming and game theory except for a privately circulated paper called "Discussion of a Maximum Problem" written in November 1947. [16] Dantzig's report "A Theorem on Linear Inequalities" was written in January 1948 and, like von Neumann's paper, was only circulated privately to his Pentagon associates. The first proof was finally published by Tucker, Kuhn, and Gale in 1950 and it was not until 1953, that a book would be published on the subject by William W. Cooper. His book *An Introduction to Linear Programming* in 1953 laid out the economic applications of linear programming as well as the mathematical theory of linear programming. [17] Also in 1953, the RAND Corporation started a system of deposit libraries in the United States, Canada, and Western Europe for the distribution of unclassified materials for use by scholars and teachers. [18] Unfortunately, it is unknown how Charles Eames came upon these ideas.

In his letter to Ian McCallum, Charles Eames specifically pairs game theory with linear programming and promotes the use of both in the architectural and city planning design processes. One can only speculate that Charles Eames made the connection by reading the book *An Introduction to Linear Programming* because there is no proof of this fact. The letter will be analyzed in detail in the chapter "Promoting Communication".

15. Steve J. Heims, *John von Neumann and Norbert Wiener: From Mathematics to the Technologies of Life and Death*, 314. The applications of dynamic and linear programming include "aircraft time-to-climb calculations (minimizing time or fuel consumption), communications-network-flow studies (maximizing capacity in communications lines), logistics problems (inventory and allocation decisions, production smoothing, cargo loading, and the like), satellite-trajectory problems, equipment-replacement policy, the analysis of the atmospheres of other planets, the equilibrium composition of complex chemical mixtures, and the assignment of repair personnel and equipment at missile site and depot to maximize equipment readiness, routing and re-routing of communications networks under attack, and automatic-weapons assignment." Bruce L.R. Smith, *The Rand Corporation: Case Study of a Nonprofit Advisory Corporation* (Cambridge, MA: Harvard University Press, 1966) 110.
16. Published later in *Collected Works* by John von Neumann (New York: Pergamon Press, 1961-63). 6:89.
17. Apray, William, *John von Neumann and the Origins of Modern Computing,* 291. footnote 76. It is possible that Charles Eames was familiar with this book, but it is not mentioned in the letter to Ian McCallum whereas the book *Theory of Games and Economic Behavior* is.
18. Smith, *The Rand Corporation,* 95.

Automatic Control

The book *Automatic Control,* like the book *An Introduction to Linear Programming,* is never mentioned or credited by the Eameses, but the book is being presented because many of its ideas and examples used in the film, *A Communications Primer,* seem to be taken almost verbatim from this book. Even if they were not taken from this book, the book's eight printing from 1948 to 1953 is a good indicator of the extent in which these ideas were in circulation.

Automatic Control was published in 1948 by Scientific American, the same publishers of the magazine with the same name. Its significance is on par with the publication of Claude Shannon and Warren Weaver's *The Mathematical Theory of Communication* of 1949 and Norbert Wiener's *Cybernetics: or Control and Communication in the Animal and the Machine* of 1948.The publication and re-printing of these three books had major ramifications on the popularization of scientific and technological concepts. *Automatic Control* and *Cybernetics* were printed eight times and *The Mathematical Theory of Communication* sold more than 40,000 copies and continues to sell 700 or more copies per year." There is no proof that Charles Eames read this book, nor is there any proof that Hamilton Wright, the consultant on the film, had either, but the similarities are too compelling to ignore. This book can be considered another layman's version of the *Cybernetics* and *The Mathematical Theory of Communication*, if not the ultimate layman's version, because the ideas are expressed in very simple terms with almost no mathematical explanations.

> One misunderstanding which this book clears up at the outset is that which confuses automatic control with mechanization in the familiar sense. Mechanical energy has long since displaced the biologically generated energy of man and beast in the day's work of our economy. The hewer of wood and the drawer of water has become the machine tender and the processor of paper. It is, in fact, the nervous systems, not the muscles, of men and women that out technology principally employs today. And it is the nervous system that is in process of replacement by automatic control. [19]

19. Gerard Piel, Dennis Flanagan, Leon Svirsky, George A.W. Boehm, Robert Emmett Ginna, Jean Le Corbeiller, James R. Newman, E.P. Rosenbaum, James Grunbaum, eds., "Introduction" *Automatic Control: a Scientific American Book* (New York: Simon and Schuster, Inc., 1948), vii-viii.

Today, the fact that computers help us regulate everything from our daily lives in the form of Palm Pilots to waste water treatment plants makes the statement plausible but in 1948, however, these ideas were new and to many, very frightening. The Scientific American book *Automatic Control* was one of the first steps to explain to the American public this new phenomenon of *automation* as well as try to de-bunk some of the mystique surrounding it. The book was written in very plain English and even today would be considered a good introduction. Ironically, it would be a good introduction because these ideas have become *so* commonplace as to become almost second nature. In their commitment to communicating ideas visually, the Eameses' contributed to the dissemination of these ideas by the use of images, which the book had used only sparingly.

The ideas that were expressed in the book are best described quickly via a quick review of the contents. There were four main sections of the book, each of which were broken down into two to five chapters. The first section entitled "Feedback: The Principle of Control" was divided into two chapters: one, "Self-Regulation" by Ernest Nagel and two, "Feedback" by Arnold Tustin.

The second section "The Second Industrial Revolution" had five chapters: one, "Control Systems" by Gordon S. Brown and Donald P. Campbell; two, "An Automatic Chemical Plant" by Eugene Ayres; three, "An Automatic Machine Tool" by William Pease; four, "The Automatic Office" by Lawrence Lessing and five, "The Economic Impact" by Wassily Leontief. These chapters give examples of automation techniques as well as elaborate upon how the most advanced types of digital automation use techniques based on information theory. Many of the categories and disciplines that were listed in the *Primer* advertisement are actually explained in this section; "organization", "medicine", "material programming", "merchandising", "business", "production","tooling", and "mechanics" are all mentioned in these chapters.

The third section entitled "Information: The Language of Control" is of particular importance to this thesis because it presents many of the ideas that were to be used in *A*

Communications Primer. The section is divided up into three chapters: one, "What is Information?" by Gilbert King; two, "The Mathematics of Information" by Warren Weaver, and three, "Information Machines" by Louis N. Ridenour.

The fourth section "Machines and Men" consisted of two chapters: one, "An Imitation of Life" by W. Grey Walter and two, "Man Viewed As a Machine" by John G. Kemeny. This section is much more theoretical and speculative and therefore, not of much interest to this thesis since the Eameses were much more interested in the practical attributes of the computer.

Part 1. Feedback: The Principle of Control

The book starts off with the most accessible of the concepts: feedback. The first chapter "Self-Regulation" draws the analogy between self-regulatory systems found in nature, like the brain's function to regulate one's body temperature, and those that are man-made, like a fly-ball governor. The chapter ends by speculating what the future consequences of these systems might be. The final paragraph, however, addresses some of the fears that many Americans had about the new tools of automation.

> The crucial question is not whether control of social transactions will be further centralized. The crucial question is whether, despite such a movement, freedom of inquiry, **freedom of communication** and freedom to participate actively in decisions affecting our lives will be preserved and enlarged. It is good to be jealous of these rights; they are the substance of a liberal society. The probable expansion of automatic technology does raise serious problems concerning them. But it also provides fresh opportunities for the exercise of creative ingenuity and extraordinary wisdom in dealing with human affairs. [20]

This passage is significant because it is exemplary of the fears of the computer that were widespread in the Fifties and Sixties. The Eameses were instrumental in trying to allay some of these fears through their work with IBM.

20. Ernest Nagel, "Self-Regulation," *Automatic Control, A Scientific American Book,* 9, emphasis mine.

During the 1960s and the early 1970s the Eameses designed for IBM a series of exhibitions centered on scientific and mathematical themes and on famous individuals within those fields. Charles had a life long interest in all aspects of science, and he was one of the first laymen to recognize the importance of the computer. Indeed, his fascination approached passion. Ray was less passionate about computers, but she shared Charles' belief in their importance and used her talents to make them understandable and acceptable to ordinary people. As communicators, the Eameses saw an interesting and intelligible presentation of science and technology as an exciting challenge. [21]

Part 2. The Second Industrial Revolution

The next section of the book, "The Second Industrial Revolution" touted the real applications of automation. It was no accident that three out of six of the authors were from MIT. Much of the initial war-time work as well as post-war research on both information theory and its applications in automation were done at MIT. Within these chapters, the list of applicable automation techniques is seemingly endless. Automation was already being used in "process controllers [that] supervise the manufacture of plastics, synthetic fibers, drugs, ..." [22] It was also responsible for many military advancements, including the self-guided missile and it was speculated that "feedback controls [would help facilitate] homemaking, salesmanship, education, research, medicine, contract-writing, designing, and entertainment" in the future. [23] Computers were seen as the contemporary inheritor of these automation techniques and would "make possible a new level of speed and flexibility in the whole economy." [24]

Charles Eames, or Hamilton Wright, knew of these applications, for they are all listed in the *Primer* advertisement as well.

organization
regional planning   natural science
medicine   government   music   graphic arts

21. Kirkham, *Charles and Ray Eames*, 297.
22. Gordon S. Brown and Donald P. Campbell, "Control Systems," *Automatic Control,* 26.
23. Brown and Campbell, "Control Systems," 26-27.
24. Lessing, Lawrence P., *The Automatic Office*, 71.

material programming sociology military research
painting labor merchandising business physical sciences
political science production economies tooling
logistics design psychology architecture
physiology mechanics philosophy
literature [25]

Part 3. Information: The Language of Control

The first chapter entitled "What is Information?" by Gilbert King starts off with the phrase "The 'LIFEBLOOD' of automatic control is information. To receive and act on information is the essential function of every control system." [26] Up until this point, the chapters in the book had simply concentrated on the very real concrete manifestations of automation. This section concentrates on the theoretical foundations of information theory. [27] The second chapter, "The Mathematics of Information" is particularly important because it was the precursor to the introduction that Weaver would write to the joint-authored book with Claude Shannon *The Mathematical Theory of Communication*, released the following year in 1949.

Even though the title read "The Mathematics of Information", Weaver never referred to the theory as such. Rather throughout the entire article, he called it the "mathematical theory of communication" reflecting the original 1948 title of the Shannon's paper "A Mathematical Theory of Communication" in the *Bell System Technical Journal* (which was released on its own without any introduction). Shannon's original paper was purely based on the mathematical principles behind communication theory and as a result, did not receive much attention. The 1949 book version, with Weaver's introduction, however, proved to have much better success, due to Weaver's interpretation of the socio-cultural impact of these theories. In his article, Weaver divided the problem of communication into three components: one, the technical problem; two,

25. Reprinted in "Architecture Creating Relaxed Intensity", Geoffrey Holroyd, *Architectural Design* 36 (September 1966): 461.
26. Gilbert King, "What is Information?," *Automatic Control*, 83.
27. Many examples in this chapter are echoed in *A Communications Primer* and will be discussed in the chapter "Filming Communication."

the semantic problem; and three, the influential problem. [28] According to Weaver, the technical problem was adequately solved by Shannon's mathematical theory, but this theory did not sufficiently address either the "semantic problem" – the interpretation of the message by the receiver. Furthermore, it did not solve the "influential problem" – whether or not the message evoked the intended response or action. Even though an essential premise of mathematicizing the communication process was the deliberate ignorance of the semantic, the semantic problem as put forth by Weaver, and would be very important to the Eameses who dedicated a fair portion of *A Communications Primer* to this issue.

Another key aspect of this new mathematical theory that made an impact on the Eameses was the idea that communication could include and refer to *all* types of communication.

> The mathematical theory of communication is so general that one does not need to say what kinds of symbols are being considered – whether written letters or words, or musical notes, or spoken words, or symphonic music, or pictures. The relationships it reveals apply to all these and to other forms of communication. The theory is so imaginatively motivated that it deals with the real inner core of the communication problem. [29]

For the Eameses, the all-encompassing nature of communication fit nicely with the previous meanings of communication that had influenced their early work. Whether related to a political theory, a *language of vision*, or a mathematical concept, *communication* was the overarching theme that connected all of them. Charles Eames, however, would take his enthusiasm one step further and try to predict how this new "information machine" would affect the design processes of city planners and architects. It was clearly evident in the City Hall and Jefferson Memorial projects that Eames was very interested in designing for a community. Now there was a tool that had the potential of gathering the large amounts of information that factor into the process of design, sort through all of it using linear programming and game theory, and ultimately help the architect and/or city planner *design*.

28. The influential problem was renamed "the effectiveness problem" in the book *The Mathematical Theory of Communication*.
29. Warren Weaver, "The Mathematics of Information," *Automatic Control*, 107. These sentences would be re-written in the book a year later but the meaning would more or less stay the same.

Introduction

Philip and Phylis Morrison's article "A Happy Octopus: Charles and Ray Learn Science and Teach It with Images" in the book *The Work of Charles and Ray Eames: A Legacy of Invention,* describes the significance of the film *A Communications Primer* for the architectural profession.

> *Primer* set the office on a new path. Certainly, the Eameses, who had met at Cranbrook, had long felt the attraction of teaching and had tried their hand at it. They knew that this film was a pioneering piece of exposition, and Charles published a letter in an architectural journal to **point out how relevant the new mathematical discipline was for students of design and architecture. The film was widely shown, and it reinforced the value of Eames films in the professional schools.** [1]

This is sharp contrast to Charles Eames' sentiments on the same subject during an interview with Digby Diehl of the Los Angeles Times in 1972.

> "Our first real try, though, came when **we wanted to make a statement about communications theory for architects**. We did a film called *A Communications Primer*, which was shown as a part of a multimedia show at UCLA in 1951 [sic, 1953]. **Few architects ever saw it,** but the Department of Agriculture bought a large number of prints. [2]

Given the current fact that communication theory, and especially its mathematical foundation, is most likely *not* part of the core curriculum of any architecture school in America, Charles Eames' statement is the more accurate one. As stated previously as well, Eames was not interested in the mathematical part of the theory of communication. Charles' words seem more accurate: "we wanted to make a statement about communications theory for architects." In the end, as Charles also mentions, few architects did see the film and even fewer actually decided to learn

1. Philip and Phylis Morrison, "A Happy Octopus: Charles and Ray Learn Science and Teach it with Images," 112, emphasis mine.
2. Charles Eames, "Charles Eames: Q&A," interview with Digby Diehl, *Los Angeles Times WEST Magazine*, Oct. 8, 1972, 16-17. Reprinted in Digby Diehl, *Supertalk* (New York: Doubleday, 1974), emphasis mine.

the mathematical side of the discipline. [3]

The difference between which ideas the Eameses thought would be useful for architects in the practical sense – namely, game theory – and which concepts they just wanted architects to be aware of – communication theory – is very confusing. Both were mathematical theories but Charles Eames' interested in communication was along the lines of Warren Weaver's semantic interpretation of Shannon's mathematical theory while his interest in game theory was more in its real application to problems involving analysis of complicated situations. Note that even though Eames promoted game theory, as will be shown in his letter to Ian McCallum, he feels that the math is a little daunting: "Many of its pages are so filled with mathematical symbolism that they look like (and are for many of us) pages of a foreign language." [4]

This chapter will outline the script of the film *A Communications Primer* by closely looking at the influence of ideas presented in the previous chapters on visual, mathematical, and interdisciplinary communication as well as the ideas presented in the book *Automatic Control* from which many of the examples may have been taken almost verbatim.

3. The Morrison's statement also references a letter published in an architectural journal where Charles points out the relevance of communication theory to architecture. In my research for this thesis, I have not been able to locate this letter.
4. Charles Eames, "Letter to Ian McCallum, editor of the Architectural Review," WCRE, Box 218.

A Communications Primer (1953)

A Communications Primer was based on material presented in *A Rough Sketch,* but as was shown in the previous two chapters, the ideas presented were already in general circulation through books like *Automatic Control, The Mathematical Theory of Communication, Cybernetics,* and possibly *The Human Use of Human Beings* which was the layman's sequel to *Cybernetics*. This chapter will show that the Eameses were not only knowledgeable about these ideas but also that they had enough faith and conviction in them to make a film about these ideas as well as use many of the examples practically verbatim. It must be remembered that the intention of the Eameses was not primarily to present original ideas, but to disseminate ideas that they felt were important for people to understand.

There is a key difference between *A Rough Sketch* and *A Communications Primer*. *A Rough Sketch* was made to bring visual communication into the university curriculum, like the MIT Report that Charles Eames wrote to the MIT President. *A Communications Primer*, on the other hand, was directed at a very specific audience ... architects. The reasons for this were never made explicit in any of the advertisements for the film and in the end, not many architects saw it. Charles Eames' hope that architects would use the computer was only expressed a few times. It was first expressed in a private letter he wrote to Ian McCallum in 1954. [5] It was only later in a 1957 lecture at the USC School of Architecture [6] and in a speech in 1975 that Eames publicly

5. See chapter "Promoting Communication"
6. See page 127.

voice the original intentions of *A Communications Primer*. In the 1975 lecture at American Iron and Steel Institute, Charles Eames held that the best use of the computer for architects and planners was to tap into its ability to store and analyze large amounts of information.

> [*A Communications Primer*] was not intended for a university context, but aimed chiefly at an audience of architects. It appeared to us that the real current problems for architects now – the problems that a Brunelleschi say, would gravitate to – are problems of organization of information. For city planning, for regional planning, the first need is clear, accessible models of current states-of-affairs, drawn from a database that only a computer can handle for you....
>
> So "Communications Primer" was a recommendation to architects to recognize the need for more complex information – **not raw printout but information organized so it could be read and used** – for new kinds of models of information. There again – it wasn't an approach that promised to make the practice of architecture any easier. [7]

Since 1953, when *A Communications Primer* was released, the field had in fact blossomed quickly. By 1975, however, the emphasis was moving in the direction of Computer Aided Design (CAD) and "printout techniques" instead of "information so it could be read and used." Charles Eames, however, was not promoting a technique that did not have any followers. As will be shown in the letter to Ian McCallum, Charles Eames was very interested in using game theory and linear programming in the architectural and planning design processes exactly in this manner. Corporations like RAND, who played a major role in developing game theory, linear programming and systems analysis, adapted military computer techniques to analyzing city infrastructure and planning in general. According to a 1970 study,

> *The Conversion of Military-Oriented Research and Development to Civilian Uses*, eighty substantial "systems-related contracts" performed by defense-related organizations, most of which are corporations, but some of which are nonprofit research centers. Aerojet-General, Lockheed Missiles & Space, North American Aviation, TRW, Inc., and the System Development Corporation figure prominently on the listing. The majority of the contracts pertain to urban

7. Charles Eames, "Grist for Atlanta paper version," for lecture at the American Iron and Steel Institute, Design Seminar, Atlanta, GA, 1975, WCRE, Box 217, Folder 15.

> and regional information, education, health, transportation, crime, and waste-disposal studies. [8]

In 1969, the RAND Corporation already had a specific division called the "urban center" which examined problems of "New York City's police, hospitals and fires. [9] There were also researchers in architectural schools who were involved in this type of research but it is difficult to trace the Eameses' impact on this movement. In general, Charles Eames' interest only took form in his written correspondence and lecture appearances. Also, Charles Eames never participated directly in any of the conferences where computer applications were discussed. As early as 1964, the First Boston Architectural Center Conference was entitled "Architecture and the Computer." Many of the key people in the development of computer applications for architecture and planning were present at this conference. Even Christopher Alexander presented a paper titled "A Much Asked Question of Computers in Design" in which he expresses severe reservations of using the computer as an analytical tool in the design process. The application of computers in architectural design however was seemingly unstoppable and in the same year of the conference, to cite only two of many examples, W.A. Fetter published *Computer Graphics in Communication* and P.H.Levin published an article "The Use of Graphs to Decide the Optimal Layout of Buildings in *The Architect's Information Library.* [10]

In light of the proliferation of computer applications for architectural purposes, it is difficult to make the connection between the sadness Charles Eames expressed in the interview with Digby Diehl and his desire to use game theory and linear programming in the architectural and planning design processes. If anything, he should have seemed happy. This thesis will speculate that this sadness was coming from a disappointment in the lack of interest in computers by pro-

8. Thomas Hughes, *Rescuing Prometheus* (New York: Pantheon Books, 1998), 187.
9. Marvin Berkowitz, "The Conversion of Military-Oriented Research and Development to Civilian Uses," Prager Special Studies in U.S. Economic and Social Development (New York: Praeger Publishers, 1970), 256.
10. Christopher Alexander. "A Much Asked Question of Computers in Design" in *Architecture and the Computer*. Given at the First Boston Architectural Center Conference, 52-56. 5 December 1964. W.A. Fetter, *Computer Graphics in Communication*. New York: McGraw-Hill, 1964. P.H. Levin, "The Use of Graphs to Decide the Optimal Layout of Buildings." The Architect's Information Library, 140, No.15, 809-815, 7 October 1964.

fessional architects. In this light, the statement in the Diehl interview is justified. The Eameses had wanted "to make a statement about communications theory for architects," [11] and unfortunately, it was never picked up in any significant way.

The next few sections will be a "close reading" of the film. Each section will start with the appropriate script text followed by an analysis. The full script in its entirety is reprinted in Appendix A. Similarities in the various texts will be highlighted in bold. Note that the headings of each section are my own.

A Close Reading

Although the Eameses use many avant-garde techniques throughout the film, they never make a direct link between the visual aesthetic of the film and a universalist political agenda. The international connotations of the avant-garde aesthetic that were made explicit in both Hayakawa's and Kepes' introductions to *Language of Vision* had gained enough momentum in artistic and graphic design circles to make the universalist case implicitly. The aesthetic was even being appropriated by American corporations to marketing and advertising. The Eameses were very much a part of this aesthetic movement, having many corporate clients for whom they did graphics and informational films. The most obvious example of course was their relationship with IBM. As Hélène Lipstadt shows, the Eameses were not naive accomplices to corporate and U.S. political domination but were very actively pursuing their own political agenda. [12] For the film *A Communications Primer,* the Eameses fused their Deweyan ideas of democracy and education; New Bauhaus theories of a universal visual language; the mathematical theory of communication, and Cybernetic influences of interdisciplinary exchange. More than any other project, *A Communications Primer* is an exemplary manifestation of all the Eameses' political influences and ideals.

11. Charles Eames, "Q&A Charles Eames," 16-17.
12. Hélène Lipstadt, "'Natural Overlap': Charles and Ray Eames and the Federal Government", 172.

FIG. 1

FIG. 2

FIG. 3

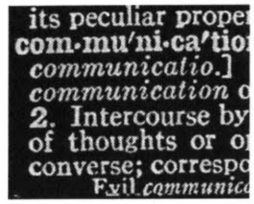


FIG. 1-A

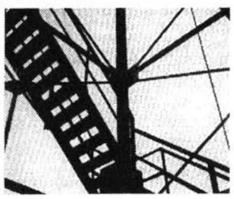


FIG. 3-A

Introduction

> Communication – from the Latin "Communication".
>
> One – act or fact of communicating: as communication of smallpox, of the secrets of power.
>
> Two – Intercourse by words, letters, or messages; {interchange of thoughts or opinions, by conference ...}
>
> In the broadest aspects of communication, much work has recently been done to clarify theories and make them workable. The era we are entering might well be characterized as an era of communication. This film will touch in the most elementary way some aspects of the subject that are of daily concern to all of us.
> — script of *A Communications Primer*

The film starts with the panning of telephone poles silhouetted against a blue sky, accompanied by the "ticking" of telegraph sounds. The visual closeness of the telephone lines in relation to the picture plane implies that we, the viewer, are close enough to hear the busy communication signals travelling across the wires as well as suggests an intimacy with the technology. This first sequence is an example of avant-guard compositional techniques. The abstract criss-crossing diagonals are exemplary of a compositional technique described in the book *Language of Vision* as an "open network of lines [that] lead out to various directions in space [so that] a kind of optical cantileverage is achieved – a dynamic space construction. [13] In *Language of Vision*, Kepes used a steel structure silhouetted against the sky as an example of what Kepes called a "dynamic space construction." (Fig. 1-A) [14]

The next sequence is a slow de-magnification of the printed words of a dictionary definition of the word "communication". Here the Eameses use the close-up technique again, but instead of focusing on telephone wires, the focus is on the letters themselves. Because it is impossible to read the text until the very end of the sequence, it forces the viewer to look at the letters as if they were artistic compositional elements. Kepes discusses the positive and negative space of the printed word in *Language of Vision,* explaining that the "single character gains clarity and meaning by orderly relationship of the space background which surrounds it." [15] (Fig. 3-A) He also states that in "every clear concept of the nature of vision and in every healthy approach to the visual world, this dynamic unity of figure and background has been clearly understood." [16] The implication here is that many cultures use the concept of foreground-background in their "visual world". This universality of visual techniques is then confirmed by two examples: Chinese calligraphy and a large letter "a". (Fig. 3-A) To emphasize the figure of the calligraphy, as well as the letter "a", Kepes inverts the colors. The background is black; the writing white. The Eameses also use this technique in this sequence, using the negative of the printed dictionary page.

13. Kepes, *Language of Vision*, 115-116.
14. Kepes, *Language of Vision*, 116. The second image to appear is the title sequence. It is important to note that even the sans-serif font that the Eameses used for the title had an aesthetic, and therefore, political meaning. (See the previous chapter "Visual Communication".)
15. Kepes, *Language of Vision*, 32.
16. Kepes, *Language of Vision*, 32.

FIG. 4

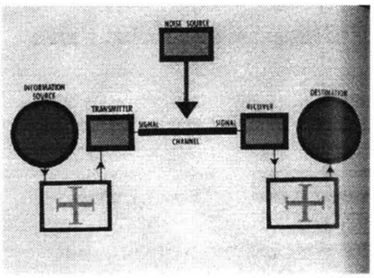


FIG. 4-A

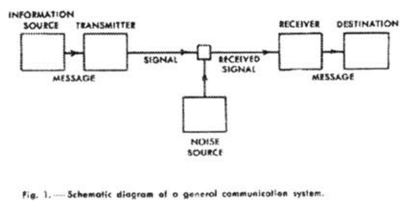
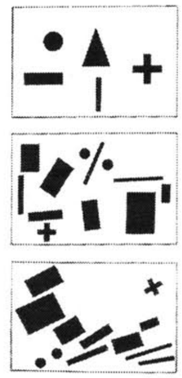


FIG. 4-B



Claude Shannon's Diagram

Here is Claude Shannon's diagram by which almost any communication process can be schematically represented. **The information source selects the desired message out of a set of possible messages. The transmitter changes the message into the signal which is sent over the communications channel to the receiver where it is decoded back into the message and delivered to the destination.**
— script of *A Communications Primer*

The communication system considered [referring to Shannon's diagram] may be symbolically represented as follows:
The information *source* selects a desired *message* out of a set of possible messages ... The selected message may consist of written or spoken words, or of pictures, music, etc. **The *transmitter* changes this *message* into the *signal* which is actually sent over the *communications channel* from the transmitter to the *receiver*. The *receiver* is a sort of inverse transmitter, changing the transmitted signal back into a message, and handing this message on to the destination.**
— Weaver, introduction, *The Mathematical Theory of Communication,* 7.

---

1. An information source which produces a message or sequence of messages to be communicated to the receiving terminal ...
2. A transmitter which operates on the message in some way to produce a signal suitable for transmission over the channel ...
3. The channel is merely the medium used to transmit the signal from transmitter to receiver ...

> 4. The receiver ordinarily performs the inverse operation of that done by the transmitter, reconstructing the message from the signal.
> 5. The destination is the person (or thing) for whom the message is intended.
> — Shannon, explanation in *The Mathematical Theory of Communication*, 34.

Both Shannon's diagram and Eames' interpretation of it seem to be very elementary to the contemporary reader but in the early 1950s, it was actually a very new and different way of conceptualizing the communication process. In Richard E. Blahut and Bruce Hajek's introduction to the 1998 reprinting of *The Mathematical Theory of Communication*, they state that

> Shannon had the presight to overlay the subject of communication with a distinct partitioning into *sources, source encoders, channel encoders, channels* and *associate channel and source decoders.* Although his formalization seems quite obvious in out time, it was not so obvious back then. [17]

It is interesting that Shannon's explanation of his own diagram (the third quote above) was not used and in fact, none of Shannon's original examples are mentioned in *A Communications Primer*.

The visual difference between Shannon's diagram and the Eameses' shows the influence of Kepes's ideas as well. Shannon's consisted of similar rectangles, with the functional distinction of each rectangle made by the accompanying text. The Eameses however, relies on other geometric forms like circles; different sized arrows; and the abstract form of a cross. The desire to change the rectangles to geometric forms, as well as differentiate the different arrows, is linked to Eameses's interest in Gyorgy Kepes' ideas on a visual universal language. The simple shapes were considered universal symbols and therefore, theoretically, understood by everyone. The Eameses were also interested in the limits of visual recognition or as Kepes called it, "the space span of plastic organization." According to Kepes, the space span was limited to "only five or six optically distinct elements". Any more than that jeopardized the integrity of the "individ-

17. Blahut and Hajek, *The Mathematical Theory of Communication,* viii.

ual characteristics and relationships" of each shape. The example given in the book is reprinted here in Fig. 4-B. Kepes also stated that when "confronted with a complex optical field, one will reduce it to basic interrelationships." [18] The Eameses took this into consideration when redesigning the communications diagram. Recognizing the similarities in function between the source and destination, they designated them both by a circle; the transmitter and receiver by rectangles; and the message by a cross. Due to the symmetry, the diagram was efficiently divided into "basic interrelationships" that made the concepts easier to understand. [19]

18. Kepes, *Language of Vision*, 44.
19. The interpretation of Shannon's ideas and diagram started with Warren Weaver and the Eameses and would continue to have an impact on many others as well. Even as his ideas were being co-opted by many fields including linguistics and the other social sciences, Shannon acknowledged his influence although he did not agree with their liberal analogies and applications. In the end, however, he used the film *A Communications Primer* in his classes at MIT. Neuhart, Neuhart, Eames, *Eames Design*, 183. Shannon and the Eameses' diagrams had a major influence on many people and movements including the British art movement,The Independent Group. The most obvious manifestation occurred in the IG's 1956 exhibit this is tomorrow in which another variation of Shannon's diagram appears. In it, two larger circles each entitled "field of experience" are drawn. Appropriately the two circles overlap at the "signal". *The Independent Group: Postwar Britain and the Aesthetics of Plenty.*

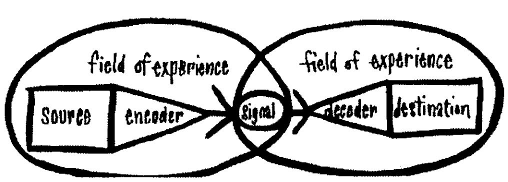


FIG. 5

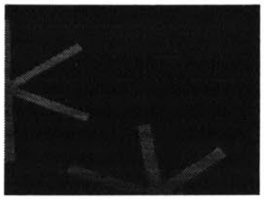


FIG. 6

FIG. 7

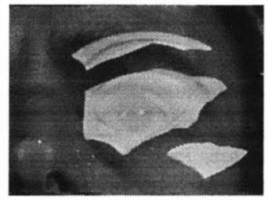


FIG. 8

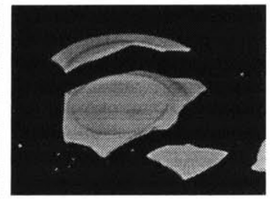


FIG. 9

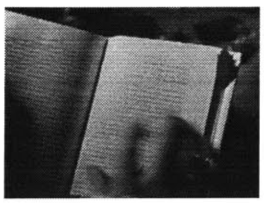


FIG. 10

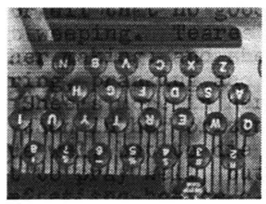


FIG. 11

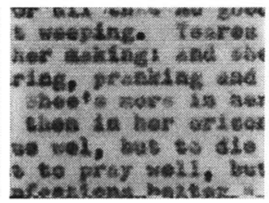
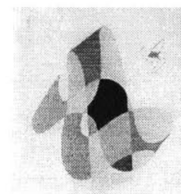


FIG. 7-A



Noise

Every such system contains noise.[20] Noise is the term used in the communications field to designate any outside force which acts on the transmitted signal to vary it from the original. In this usage, noise does not necessarily mean sound.

Reading is a form of communication where the word is the signal, the printed page the transmitter, light the channel, the eye the receiver.

Here sound can act as noise and interfere with the message.

But in some situations, like reading on a train where the sound level is normally high, it is not the sound that interferes with the communication process, as much as the motion and the unpredictable quality of the light source.

Quality of light and motion then become noise.

In radio, noise could be static.
In television, noise is often the distortion of the picture through transmitting or receiving.
In a type written passage, the noise source could be in the quality of the ribbon or the keys. And we are all familiar with the carbon copy that keeps getting progressively worse.

If anything acts on the signal, so as to vary it in an unpredictable and undesirable way in the communications system, it is noise.
— script of *A Communications Primer,* emphasis mine.

---

20. It is interesting to note that the symbol for noise in the film is an asterisk that would later be modified to become the Eameses signature symbol.

> In the process of being transmitted, it is unfortunately characteristic that certain things are added to the signal which were not intended by the information source. **These unwanted additions may be distortions of sound (in telephony, for example) or static (in radio), or distortions in shape or shading of picture (television), or errors in transmission (telegraphy or facsimile), etc. All of these changes in the transmitted signal are called *noise*.**
> — Weaver, introduction, *The Mathematical Theory of Communication,* 7-8, emphasis mine.

Visually, the Eameses were masters at using the temporal nature of film in order to explain a concept. In the first reading example, (Fig. 6-8), even though the sound of the plate is the source of the noise, it is the man's eye and the process of reading that is disrupted, *not* the man's ear and respective aural processes, even though the source of the noise is a sound. (Figs. 6 – 8) In the train example, the train travels through a tunnel breaking the light source. (Fig. 9) And in the facsimile example, "noise" is the progressive worsening of the printed word as depicted through a series of carbon copies getting blurrier with each successive reproduction.

Throughout the film, the transparent transition technique is used extensively. It is most apparent in Figure 7, where the eye and the plate are superimposed on each other. This technique is commonplace today, but in the context of Kepes' book, transparency and interpenetration take on a very distinct interdisciplinary overtone. Kepes stated in the section entitled "Transparency, interpenetration" that "Today, there are hardly any aspects of human endeavor where the concept of interpenetration as a device of integration is not in focus. Technology, philosophy, psychology, ... physical science ... literature, painting, architecture, motion picture and photography, and stage design ... [and even] radio waves are clear examples of this." [1] Kepes uses Clifford Eitel's *Study of transparency* [Figure 7-A.] as an artistic example of transparency and interpenetration. Whether between abstract artistic forms or between professional disciplines, these transparent relationships were all part of the same cultural phenomenon. For Kepes, as well as the Eameses, the inherent transparency of a piece of art or film transition was *not* self-referential, rather it was an exemplary analogy to broader social connotations of cross-disciplinary research not unlike the ideas put forth by the cyberneticians.

FIG. 12

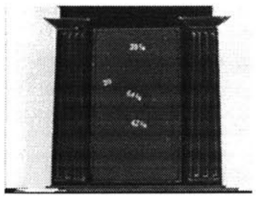


FIG. 13

FIG. 14

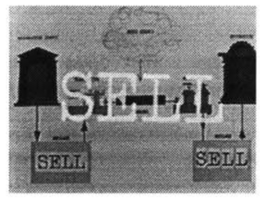


FIG. 15

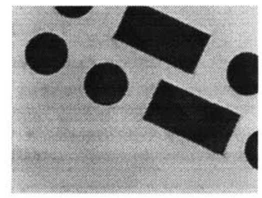


FIG. 16

The Stockbroker Example

We can consider telegraphy in terms of this same diagram. **We will use a New York stock broker's office as the information source and a Los Angeles stock broker's office as the destination.** There may exist at the information source just two possible messages: buy or sell.

From these two, the message sell is selected, then coded by the telegraphic key, which is the transmitter, and sent over the channel as electrical impulse signals, decoded by the receiver back into the message sell and delivered to the destination.

Noise of course is there. This time acting electrically. It could distort the signal in such a way as to change sell into self. But as there are only two possible messages buy and sell, there is sufficient redundancy in the spelling of the words that even if it did read "self", the information would still be clear.

Naturally, this example has nothing to do with the stock broker's office of today, because of all organized communication, market information is perhaps the most efficiently handled. **The New York information enters the signal channel in this form and is automatically decoded in Los Angeles in this form.** Here we find redundancy counteracting noise.
— script of *A Communications Primer,* emphasis mine.

The financial structure of the country is to a large extent controlled automatically (but not, as yet, mechanically) by the messages sent on ticker tape to hundreds of brokers, whose reactions affect the capital structure.
— Gilbert King, "What is Information?," *Automatic Control,* 84.

The connection between King's example and the Eameses' might not be a direct one, due to the fact that the Eameses example is much more elaborate. The Eameses would visually revise Shannon's original communications diagram once again, this time to explain the chosen message and its transmission to the destination [Fig.14]. The use of consistent symbolism makes the script very easy to understand. The classical porticos symbolizes both the sender and destination; the message is literally spelled out "SELL"; the transmitter and receiver are telegraph machines that transmit morse code; and the noise is depicted as an ephemeral cloud. The duality between "Buy" and "Sell" would become very important later on in the film, when the concept of the "bit" is explained.

FIG. 18

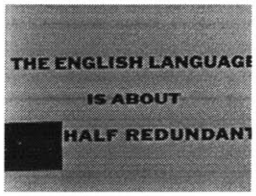


FIG.19

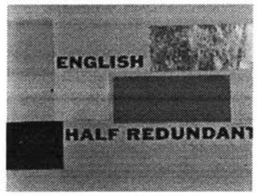


FIG.20

spatial organisation is the vital
factor in an optical message

sp atialor gani sationist hevital
fa ctorin an optical message

spatial organisation is the vital
fa ctorin an optical message

"English is one-half redundant"

The English language is about one-half redundant. This extra framework helps prevent distortion of the message in the written language, or in the spoken language.
— script of *A Communications Primer,* emphasis mine.

It is interesting to note that **the redundancy of English is just about 50 per cent**, so that about half of the letters or words we choose in writing or speaking are under our free choice, and about half (although we are not ordinarily aware of it) are really controlled by the statistical structure of the language.
— Weaver, introduction, *The Mathematical Theory of Communication,* 13, emphasis mine.

The film suggests an inextricable relationship between content and visual explanation. With each edit cut, a new box appears, masking another word in the sentence. The meaning of the phrase however would still be retained even though more than half of the words had been blocked out by the end of the sequence. The relationship between content and its visual explanation may have been inspired by a similar example in Kepes' book. (Fig. 20) The maxim – "spatial organization is the vital factor in an optical message" – is "operated" upon spatially as well as temporally, in order to prove the accuracy and truthfulness of the maxim.

FIG. 21

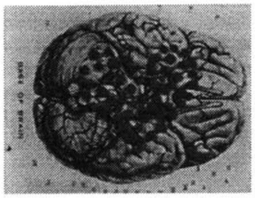


FIG. 22

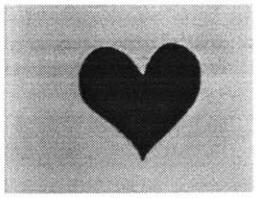


FIG. 23

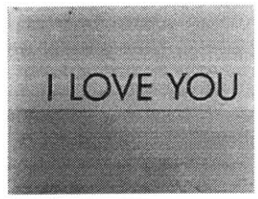


FIG. 24

FIG. 25

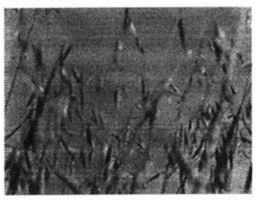
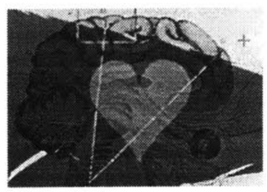


FIG. 26

FIG. 27



Speech

In speech, the **brain is usually the information source**. From it, the message is selected. The message is the thought, not the words. **The vocal mechanism codes the words into vibrations and transmits them** as sound across the communications channel which is of course the air. The sound of the word is the signal. **The ear picks up the signal and with the associated eighth nerve, decodes the signal and delivers the message to the destination.**
— script of *A Communications Primer,* emphasis mine.

When I talk to you, my brain is the information source, yours the destination; my vocal system is the transmitter, and your ear and the associated eighth nerve is the receiver.
— Weaver, introduction, *The Mathematical Theory of Communication,* 7, emphasis mine.

The visual representation of the script is again extremely effective. The shape of a heart starts off as a series of individually appearing dots that gradually take final form as a heart. Then the idea, which is represented by the symbol, goes through an encoding process to be transmitted as spoken words. The air is inferred by the wind's effect on a corn field, the receiver, a close-up of an ear and the final destination mimics the original sender, another brain with the same heart shape superimposed onto it.

FIG. 28

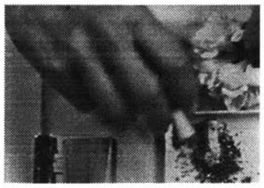


FIG. 29

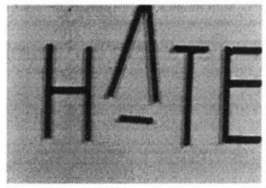


FIG. 30

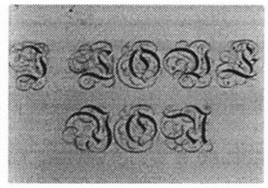


FIG. 31

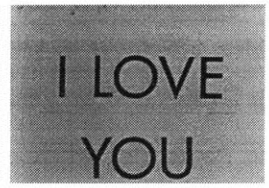


FIG. 32

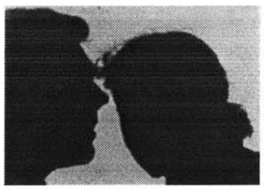


FIG. 33

FIG. 34

Counteracting noise

This time noise could originate in the transmitter, or in sound vibrations that disturb the channel – Or it could be a nervous condition on the part of the receiver, and it could **change the message from "I Love You" to "I Hate You".**

How do you combat it? **One way is through redundancy**. "I love You" "I love You" "I love You". Another is increasing the power of the transmitter. This combats noise as does the careful beaming of the signal or duplicating of the message via other signals.
— script of *A Communications Primer,* emphasis mine.

A magnetic storm can **garble the telegram "I love you" into "I hate you."** In fact, there is absolutely no way of being certain of transmitting a given message. Nothing is certain except chance.

One method of reducing the probability of error is to repeat the message. ... **A more economic procedure for reducing probability of error is to use redundancy.** For instance, the message could be set as "I love you, darling." This increases the chances of correct reception of the meaning without requiring as much extra time or bandwidth as mere repetition of the message would.
— Gilbert King. "What is Information?," 86-7, emphasis mine.

The nervous condition is visually clarified by a shaking hand holding a cigarette; the inadvertent change of the message is explained by a stop animation rearrangement of black toothpick-like letters; the repetition of the phrase "I love you" is shown by a series of the same words in different fonts; and redundancy is shown by a whisper, a hug, and a kiss. In this section, the influence of Kepes' ideas are in fact less. Instead the Eameses dedication to communicating ideas effectively overrides any pre-disposition or biases to only use avant-garde aesthetics. This is important because the Eameses would never become stalwart advocates of the modern aesthetic. Rather, they would embrace a wide variety of aesthetics in their work, ranging from the vernacular to organic modernism.

FIG. 35

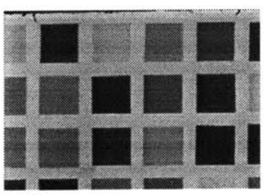


FIG. 36

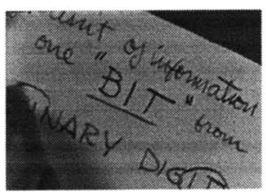


FIG. 37

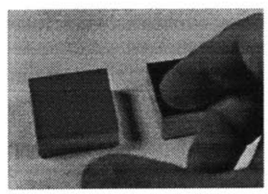


FIG. 38

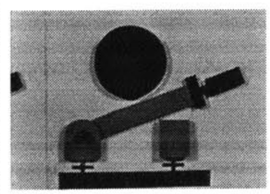


FIG. 39

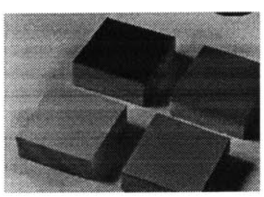


FIG. 40

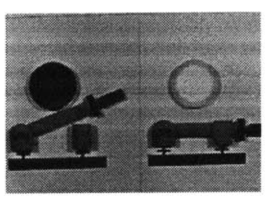


FIG. 41

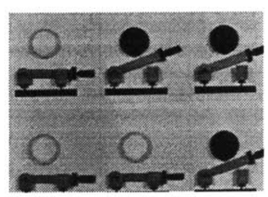


FIG. 35-A

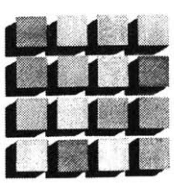
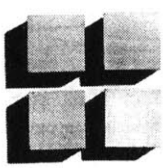


FIG. 39-A



The Bit

Now let's consider amount of information communicated. The message sell contains one bit or unit of information because it was the choice of two possible messages: buy or sell. **A choice of two gives one bit of information. This the amount of information that one "on-off" circuit can handle at one time. It can be "on" or "off". Two bits of information is the amount two circuits can handle. There is a choice of four possible conditions: on-on, on-off, on-on, and off-off. Three circuits can handle three bits or a choice of eight possibilities. Four circuits, four bits, or sixteen possibilities. Five bits, thirty two possibilities. Six bits, sixty four possibilities. Amount of information increases as the logarithm of the number of choices.**
— script of *A Communications Primer,* emphasis mine.

To be somewhat more definite, the amount of information is defined, in the simplest cases, to be measured by the logarithm of the number of available choices. It being convenient to use logarithms to the base 2 ... **This unit of information is called a "bit",** this word, first suggested by John W. Tukey, being **a condensation of "binary digit." When numbers are expressed in the binary system there are only two digits, namely 0 and 1. ... Zero and one may be taken symbolically to represent any two choices, as noted above; so that "binary digit" or "bit" is natural to associate with the two-choice situation which has unit information.**

If one has available say 16 alternative messages among which he is equally free to choose, then $16=2^4$ so that $\log_2 16 = 4$, one says that this situation is characterized by 4 bits of information.
— Weaver, introduction, *The Mathematical Theory of Communication,* 9-10, emphasis mine.

The first example uses Froebel blocks to describe the number of choices. These blocks are of particular importance because the aesthetic nature of these blocks influenced many architects, including Frank Lloyd Wright, the Bauhaus, and ultimately the Eameses. Frederick Froebel designed the blocks as a series of children's toys that would be given to a child starting in the child's second month and ending in the last year of kindergarten at the age of six. Because Froebel had designed these blocks between 1835 and 1850, they would be marketed early enough to have made into the hands of Wright, as well as Bauhaus members. "It is known that Frank Lloyd Wright, Kandinsky, and Le Corbusier were educated according to Froebel methods."

[21] The "sequence was intended to mirror the child's physical and mental development," [22] and were based on the primary shapes: sphere, cube, triangle, and cylinders and bright colors. The colored squares used in the film were most likely from Gift #5 which consisted of 21 whole cubes, six half and twelve quarter cubes. The Milton Bradley toy manufacturer had already begun production of these toys for the American market in 1896 so these blocks were easily available to the Eameses. [23]

The switching analogy is also a very accurate visual explanation of the logarithmic function of measuring information. The example essentially mimics the electronic switches and flow of current which was also to become the working premise of the modern digital computer.

FIG. 42

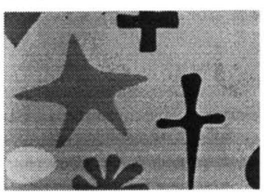


FIG. 43

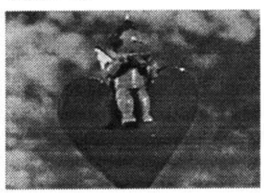


FIG. 44

FIG. 45

FIG. 46

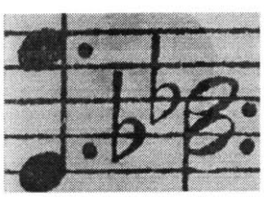
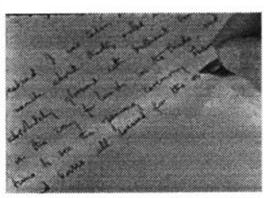


FIG. 47



The Definition of Information

The message "I Love You", to communicate information, must also be a choice of other messages, because if the information source were so loaded with feelings of love as to be incapable of any other thought, then surely by the time the words "I Love You" were spoken, no information was communicated at all. No information, yet previous experiences, could make those three words convey

21. J. Abbott Miller, "Elementary School" in Lupton, Elllen and J. Abbott Miller, eds. The ABC's of [triange, square, circle]: *The Bauhaus and Design Theory from Preschool to Post-Modernism*, editors (Princeton: Princeton Architectural Press, 1993), 18.
22. J. Abbott Miller, "Elementary School," 12.
23. J. Abbott Miller, "Elementary School," 13.

great meaning.

Source. Message. Transmitter. Channel. Message. Destination.

You could imagine the message being music and the transmitted signal being tone. Or it could be applied equally well to writing, or to smoke signals, or to hand signals.
— script of *A Communications Primer,* emphasis mine.

Every system of communication presupposes, of course, that **the sender and the receiver have agreed upon a certain set of possible messages, called "message space".**
— Gilbert King. "What is Information?" 86-7, emphasis mine.

The word *information,* in this theory, is used in a special sense that must not be confused with its ordinary usage. In particular, *information* must not be confused with meaning. ... **To be sure, this word information in communication theory relates not so much to what you *do* say, as to what you *could* say.**
— Weaver, Introduction, *The Mathematical Theory of Communication,* 8, emphasis mine.

This section makes the connection between the "I Love you" example and the quantification of the number of choices in terms of bits. It essentially explains two important points in communication theory: one, in any communication process, there is always a set of messages or "message space" from which the final message is chosen from and two, the concepts of communication can be applied to everything from music to text to the spoken word. The first visual example is an abstract group of symbols, most likely drawn by Ray Eames, which implies the "message space". The remaining images, not all of which are depicted here, attempt to show the wide variety of communication methods that can be be explained via the mathematical theory of communication. Here again the Eameses's attempt to "humanize" these concepts shows through their use of toys, hearts, and flowers. The Eameses's commitment to using a variety of aesthetic was an important technique, as well as political statement, that the Eameses used throughout their entire career.

FIG. 48

FIG. 49

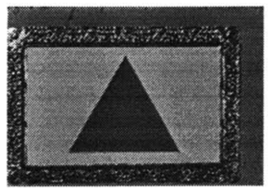


FIG. 50

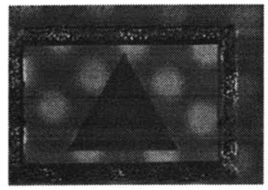


FIG. 51

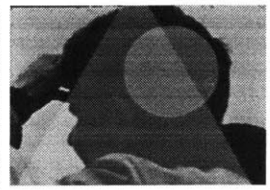


FIG. 52

FIG. 53

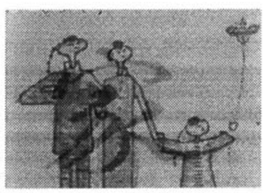


FIG. 54

FIG. 55

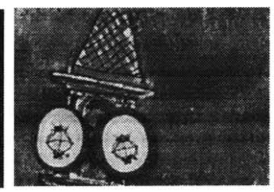


FIG. 56

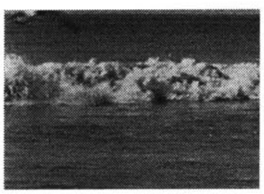


FIG. 53-A

Semantic Noise

But let's take painting as another example of a signal transmitting a coded message.
Information source: mind and experience of painter.
Message: his concept of a particular painting.
Transmitter: his talent and technique.
Signal: the painting itself.
Receiver: all the eyes and nervous systems and previous conditionings of those who see the painting
Destination: their minds, their emotions, their experience.

Now in this case, the noise that tends to disrupt the signal can take many forms. It can be the quality of the light, or the color of the light, or the prejudices of the viewer or the idiosyncrasies of the painter.

But besides noise, there are other factors which can keep the information from reaching its destination intact. The background and conditioning of the receiving apparatus may so differ from that of the transmitter that it may be impossible for the receiver to pick up the signals without distortion.

In any communications system, the receiver must be able to decode something of what the transmitter coded or no information gets to the destination at all. If you speak Chinese to me, I must know Chinese to understand your words. But even without knowing the Chinese language, I can understand much of your feelings through other codes we have in common.

There are systems of communication where there is no redundancy and no duplication of the message. Here knowledge of the code is essential. If planning "one if by land"," two if by sea", the fellow on the opposite shore simply had to know the code. But there are also many examples of times when the message has been conceived and the signals sent long in advance of understanding or acceptance of the code employed. In the case of Galileo or Socrates, it did not in time matter that the receivers of their time were not tuned to receive their signal.

The ultimate transmission of such a message represents communication of a very complex order. Other high level communication occurs in a very different areas – a wave breaking on a beach brings a world of information about events far out at sea – it can tell of winds and storms, the distance and intensity – it can locate reefs and islands and many things – if – you know the code.
— script of *A Communications Primer,* emphasis mine.

One can imagine, as an addition to the diagram, another box labeled "Semantic Receiver" interposed between the engineering receiver (which changes signals into messages) and the destination. **This semantic receiver subjects the message to a second decoding, the demand on this one being that it must match the statistical *semantic* characteristics of the message to the statistical semantic capabilities of the totality of receivers, or of that subset of receivers which constitute the audience one wishes to affect.**

Similarly, one can imagine another box in the diagram which, inserted between the information source and the transmitter would be labeled "semantic noise," the box previously labeled as simply "noise" now being labeled "engineering noise." From this source is imposed into the signal the perturbations or distortions of meaning which are not intended by the source but which inescapably affect the destination.
— Weaver, introduction, *The Mathematical Theory of Communication,* 26, emphasis mine.

Weaver's written modifications to Shannon's diagram are always tempered by the verb "imagine" so as to clearly distinguish the fact that these ideas are not part of Shannon's theories but his own. Because of his status as the author of the introduction and not the book itself, Weaver never gave his modification a visual form and it was the Eameses who would re-draw the diagram according to Weaver's suggestions. (Figures 4 and 4-A) Warren Weaver's ideas actually provide the bridge between the Eameses' interest in Deweyan ideal of strengthening the community through communication as was evident in the City Hall and Jefferson Memorial competition and Shannon's theories that reduced messages to quantities as opposed to qualities. Weaver took the "semantic" into consideration, stating that the whole communicative process "must match the statistical semantic characteristics of the message to the statistical semantic capabilities of the totality of receivers, or of that subset of receivers which constitute the audience one wishes to affect." [24]

The Eameses then translated Weaver's ideas of "semantic noise" visually into four main examples: one, the artist-audience example where "the background and conditioning of the receiving apparatus" may be so different from the transmitter's that distortion is inevitable; two, the translation example between Chinese and English where even if the "code" is not known, other signs, like a smile, help to convey some information; three, the American Revolutionary war example where the "code" is so specific that only the sender and receiver know it; and four, the ocean wave example where many different kinds of information are all carried in one medium ... the "breaking" of the waves on a beach.

The geometric shapes in figures 51 and 52 were meant to signify the mind set of the viewers; the square, heart, the cross and triangle visually confirmed that "the background and conditioning of the receiving apparatus may so differ from that of the transmitter that it may be impossible for the receiver to pick up the signals without distortion." Note that the use of geometric forms to symbolize a person's mind-set is based on the idea that geometric forms can

24. Warren Weaver, Introduction, *The Mathematical Theory of Communication*, 9-10.

inherently stand for or refer to another idea. This technique was also used in the communication diagram (Fig.4) to suggest similarity and difference between sender-destination; transmitter-receiver; message and noise.

The use of Chinese characters in the next example may have been inspired by a passage in *Language of Vision* in which Kepes expressed his aesthetic approval of Chinese calligraphy.

> Chinese and Japanese calligraphy also has a sound respect for the white interval. Characters are written in imaginary squares, the blank areas of which are given as much consideration as the graphic units, the strokes. Written or printed communication is living or dead depending upon the organization of its blank spaces. [25]

The example given in *Language of Vision* is of Chinese calligraphy in the Ts'Ao (running cursive) Style by Su Tung-P'o. (Fig. 53-A.). For Kepes, the appreciation of Chinese calligraphy came from the fact that it was "written in imaginary squares". This technique of proportioning a composition was also advocated by Frederick Froebel who believed that "there is a natural correspondence between the squared surface (Netfläche) of the grid and the way we receive images on the retina (Nethaut)." [26] This belief influenced the Bauhaus, Kepes, and the Eameses as well. For all of them, Chinese calligraphy was considered "alive" because it was organized with "universal" aesthetic principles at its *visual* foundation.

25. Kepes, "Internal Forces," *Language of Vision*, 32.
26. J. Abbott Miller, "Elementary School," 9.

FIG. 57

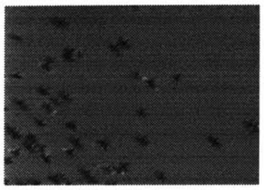


FIG. 58

Birds and a Crowded Crosswalk

> When we watch them turning and wheeling, how often have we wondered what holds such birds together in their flight.
>
> Communication is that which links any organism together. It is communication that keeps a society together – and though these people seem unaware of each others existence, neither looking nor speaking, one group meets and filters through the other ... with hardly two individuals coming into contact ... so constant is the flow of information and so complex the web of communication that keeps them apart and holds them together.
> — script of *A Communications Primer*

The analogy – between a flock of birds and a crowd of people filtering through each other in opposite directions – is a very compelling example of how the word "communication" was beginning to take on a much broader range of meanings. Communication could not only be non-verbal but it could also encompass exchanges of information that did not have "meaning" in the traditional sense of the word. Interestingly, Eames would give non-verbal communication just as much importance in "keeping society together" as verbal communication like the cyberneticians. Even though the Eameses stressed the semantic in the previous examples, the juxtaposition of the birds and people demonstrated their commitment to the other interpretations of the word *communication* and the nuances that each discipline would give to it; the biologist, sociologist, mathematician and engineer all talked about *communication* differently but by the 1940s and 50s, the language used to describe these processes would become unified through the ideas of Claude Shannon and Warren Weaver. The word *communication* would not only "break down the barriers that have grown up between fields of learning" as Eames would state in the *Primer* advertisement, it would itself become an imperative of sorts, inciting people in all disciplines to *communicate* with one another.

FIG. 59

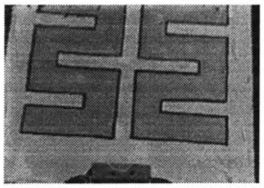


FIG. 60

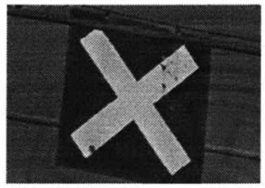


FIG. 61

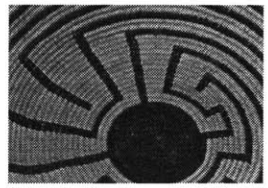


FIG. 62

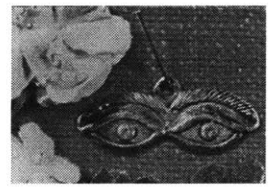


FIG. 63

FIG. 64

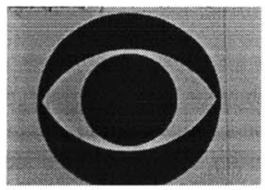


FIG. 65

The Symbol

The symbol, the abstracting of an idea –
Communication – at once anonymous and personal –
Personal because of the countless individuals that created its form – Each one who in his turn who added something good or took something bad away. Anonymous because of the number of individuals involved and because of their consistent attitude. These are examples of communication of an idea through symbols. But there can also be communication through symbols to an idea as in the burnt offering or in the flame of a candle.

The use of flame as a transmitter in the communications channel is probably as old as man's first fire. It stands for all the wonder and mystery of forces beyond man's knowledge.

The storm warning flags are part of a long evolutionary tradition of signals, but their beginnings were probably in basic reactions to color and form; basic enough to make their communications carry beyond the barriers of language and custom...

But symbols also change and evolve. Some methods of transmitting messages rapidly become symbols then pass into obscurity – to become readable only to the anthropologist, while other symbols of communication remain.
— script of *A Communications Primer*

This section elaborates on communication as a human process ... as well as a process that is ultimately responsible for language and culture. In a brief visual overview of symbols, the Eameses convey what they felt was the essential universal and timeless nature of the *language of vision.*

FIG. 66

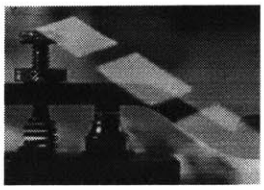


FIG. 67

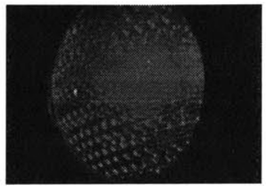


FIG. 68

The Bit Revisited

> The message being transmitted here may be unlimited at the range and subtlety of its ideas, yet the method and signal are such that they must be fed to the transmitter in a series of positive decisions. The system calls for the key to be either up or down. The code calls for a dot or a dash. The current flows – it ceases to flow – it flows. It is black – or white ... It is stop – or go ... On – or off ... One – or none ... Go – or no go ... or black – or white.
> — script of *A Communications Primer*

Unlike the earlier section on the "bit", where the logarithmic nature of choices was explained, the examples here emphasize the duality of the "bit". This duality was essential in the following sections which eventually culminate in an explanation of how a computer operates. Because the computer was not well understood, it was necessary to explain the actual mathematical basis of the computer in very simple terms like the ones here that everyone could apprehend. Symbols that permeate everyday American culture were used to explain the concept of the "bit." This connection gave the mathematical concept a firm grounding in the everyday experiences of people, making the concepts arguably more accessible for the lay person, as well as potentially give the computer a more "human" aura. This approach was an essential part of the Eameses' later educational works, especially in their later work with IBM, in which the goal was more often than not, to "humanize" the computer.

FIG. 69

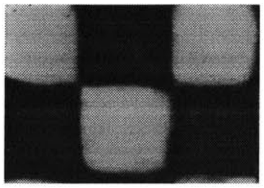


FIG. 70

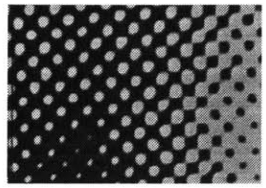


FIG. 71

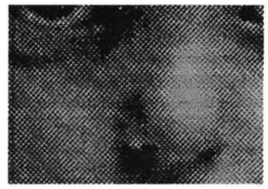


FIG. 72

FIG. 73

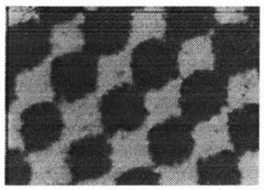


FIG. 74

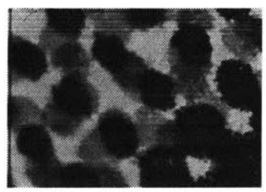


FIG. 75

The Printing Process

> As in this small area from a halftone reproduction in a magazine. The press that printed it is capable of printing but one color of ink at a time. **In this case, black ink on white paper. In order to transmit the image, it had to be broken down into many points of decision: black – or white.**
>
> We know that such a limitation is not at all restricting if enough decisions are made. In this case, half a million decided points give fair rendition. A million would be better. Conventional printing of color is no different except that with the added factor of color, four times the number of decisions had to be made: one set in yellow; one in red; in blue and in black.
> — script of *A Communications Primer,* emphasis mine.

> For the sake of compressing information into as small an area as possible, the ability of emulsions to record degrees of brightness is given up, and **all that is asked of a grain is whether it is black or not. In other words, the technology of this medium is tending to a binary system.**
> — Gilbert King, "What is Information?," 91, emphasis mine.

This section like the previous one, attempts to explain an abstract concept with an example known to almost everyone. The "bit" concept is explained by using half-tones and color processing. The inspiration for this example might well have come from Kepes again. In *Language of Vision*, Kepes makes the point that even a "half-tone" is made up simply of "different sized dots". [27]

27. Kepes, *Language of Vision*, 43.

FIG. 76

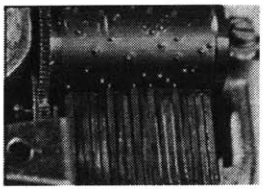


FIG. 77

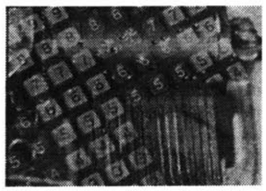


FIG. 78

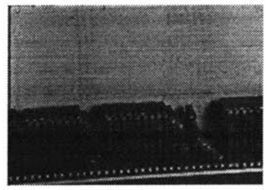


FIG. 79

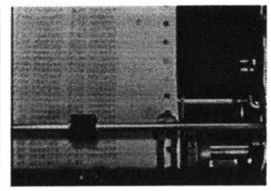


FIG. 80

FIG. 81

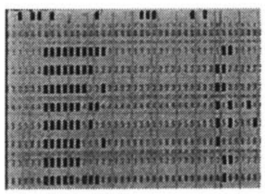
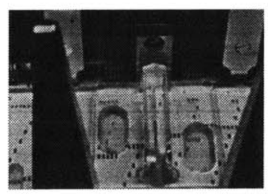


FIG. 82



The Electronic Calculator

> Whenever added factors in a problem are recognized, the number of decisions necessary for the solution grows by large leaps. As theories and equipment and men developed it becomes apparent that one sure way of handling multiple factors is to build a system that can handle each decision in its time.
>
> Men have long known the theory on which complex problems of many factors can be solved but the number of decisions - the calculations necessary, were prodigious. – and not until the recent development of the electronic calculator could these areas be touched.
>
> The problem became one of communication between the man and the machine – between machine and machine – between machine and man. The cards are punched or not punched. Light passes, or stops – and by this binary system, information is fed the machine.
> — script of *A Communications Primer*

This is the first mention of a computer, or rather as it is known here, "an electronic calculator". It will be obvious in Charles Eames' letter to Ian McCallum (See chapter "Promoting Communication"), as well as in his lectures, that this was in fact the real reason for making the film. Eames basically hoped that architects would be inspired by this film to use the computer as a design tool. But the other ideas in the film, of a universal visual language, cybernetic ideas and hopes of interdisciplinary communication, were just as important.

FIG. 83

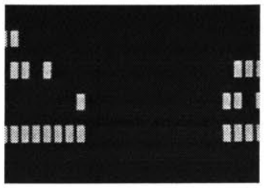
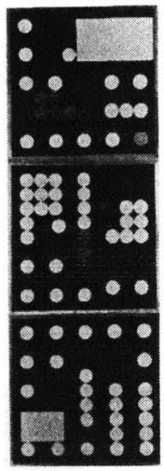


FIG. 83-A



The Pulse

> In a moment we will hear sounds which are an actual product of a huge calculator. The frequencies are made audible to check its functioning and in a way, feel its pulse. Here it is.
> — script of *A Communications Primer*

As the atonal sound progressions of the "electronic calculator" dominate the film's soundtrack, the visual frame is filled with an abstract sequence of vertical rectangles representing the electronic registration of punch cards. The aesthetic progression of abstract forms was an idea presented in a section in Kepes' book *language of vision* entitled "Organization of optical sequence. Rhythm." In this section, Kepes states

> By reducing the picture surface to the basic opposites – pure colors, elementary shapes, and horizontal and vertical directions – by eliminating any resemblance to the familiar object world, as Mondrian writes, art today has succeeded in establishing a plastic expression, "the clear realization of liberated and universal rhythm distorted and hidden in the individual rhythm of the limiting form." [28]

The examples included a "rhythmic sequence" by Sophie Taeuber-Arp called *Composition,* made in 1931 (Fig. 83-A) followed by a praising of the "motion picture which has opened up an undreamt scope and flexibility of rhythmic organization," which quite possibly foreshadowed the Eameses' example here. [29]

28. Kepes, *Language of Vision*, 58.
29. Kepes, *Language of Vision*, 58.

FIG. 84

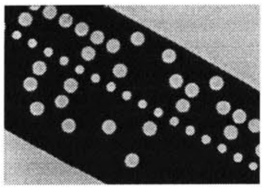
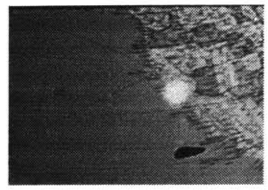


FIG. 85

FIG. 86



Cybernetic Influence

The ability of these machines to store information, manipulate, sort, and deliver it is fantastic. And with their complex feedback systems, their memories, their almost human reactions to situations it is understandable that they are popularly referred to as "brains". The greatest fallacy in the comparison is one of degree. The decisions made by the machines are comparable in number to the half million made in this half tone. But far greater is the number of stops and go's performed by the human nervous system in order to complete the simplest act. So great, that if each decision were represented by a small half-tone dot, the total area of dots would cover several earths. Such is the magnitude we reach when a number like a half million is raised to the fourth power.

As flowing as the human movements may seem they are actually the product of these countless yes-no decisions – communicated with great speed to and from all parts of the body.

The channel is the nervous system. Each nerve is made up of hundreds of fibers. The decision is the impulse of a single nerve fiber – an all-out event – a trigger process – which is set off like an explosion when the stimulus exceeds the ignition point. The dot in the half tone – the hole in the tape – each is a separate fire-no fire signal, but together they add up to a smooth, sometimes incredibly complex action ... that often seems more vague than decisive.
— script of *A Communications Primer*, emphasis mine.

The most efficient known mechanism for the retention of information is the human brain. Recent physiological experiments suggest that the brain operates not with continuous signals but with sampled digital information, probably on a binary system; nerves seem to transmit information by the presence or absence of a pulse. The brain, with its ability to store vast amounts of information in a tiny space and to deliver specified items on demand, is the model which automatic control design strives to imitate.
— Gilbert King, "What is Information?," 90-91, emphasis mine.

The brain-computer analogy is obviously derived from the cybernetic research done by McCulloch and Pitts and Norbert Wiener. The fusion of physiology and logistics in the 1940s linked the function of the brain to Boolean operations and the fact that computers represented an ideal model of the problems arising in the nervous system" [30] linked the functions of the computer with those of the brain. [31] This correlation between the computer and the human brain accounted for the fears that many Americans had of a "computer-driven" society and therefore, the film ends with the assurance that "man will always be in control".

30. Wiener, *Cybernetics*,.22.
31. See chapter "Interdisciplinary Communication."

FIG. 87

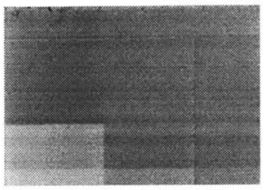


FIG. 88

FIG. 89

FIG. 90

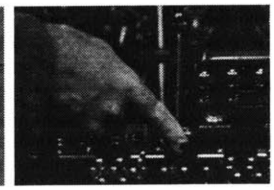
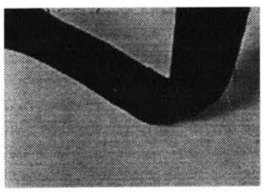


FIG. 91



Man's Responsibility

Yet many things that we except as indecisive vagaries would be, if we could bring our focus in sharp, decisive individual units. It is the responsibility of selecting and relating the parts which makes possible a whole which itself has unity.

The line on which each color breaks, and a point at which each dot that makes up this painting is placed, affects the whole canvas. The communication of the total message contains the responsibility of innumerable decisions made again and again – always checking with the total concept through a complex feedback system.

These elements of a communications system act together as one great tool. And though the tool may perform a most complex task, it can never relieve the man of his responsibility.

No matter where it occurs –
no matter what the technique –
communication means the responsibility of decision all the way down the line.
— script of *A Communications Primer,* emphasis mine.

The examples here once again emphasize the universality of the concepts presented in the film. Using art as an analogy, the communications process is compared to the composition of a painting ... a series of discrete decisions to create a unified message and the final two images juxtapose a human hand controlling an aircraft and a hand controlling a Chinese calligraphy brush. Whether it is act of artistic expression or of technical decision, it is ultimately the choice of the human and it would in fact be the *responsibility* of the human to make the correct decisions. The emphasis on “responsibility” would resurface again in terms of using the computer in the architectural and planning professions. Charles Eames stated in his letter to Ian McCallum that it was not only the choice but the “responsibility” of the architect to use any tool that would help facilitate the design process. In the same way an architect would be acting *irresponsibly* by not putting his/her own agenda before the client’s, the architect would be acting *irresponsibly* by not using a computer.

Promoting | Communication

Introduction

This chapter will examine the letter Charles Eames wrote to Ian McCallum in which Charles Eames explains his interest in game theory and its application to architecture and planning. The letter has been quoted in secondary source material but it has been referenced inaccurately. For example, in *Eames Design: The Work of the Office of Charles and Ray Eames,* the Neuharts and Ray confuse Charles Eames' interest in communication theory, with his hopes for applying game theory to architecture.

> [Charles] sent a print of the film to Ian McCallum, editor of the British journal *Architectural Review*, and in an accompanying letter proposed the application of communications theory to architecture. He went on to explain how such theories have unlimited potential for calculating and managing the multiplicity of factors and relationships involved in architecture and planning. 1

This statement is only partially correct. It is true that Charles Eames was interested in communication theory and its relationship to architecture – architecture was listed in the *Primer* advertisement – and in the interview with Digby Diehl, Charles Eames stated that he and Ray had wanted to "make a statement about communications theory for architects," [2] Communication theory, however, does not account for nor can it be applied to "calculat[ing] and manag[ing] the multiplicity of factors and relationships involved in architecture and planning." The only theory available for this application is game theory. Notably, the mention of game theory as an influence on Charles Eames is missing from all the secondary source material. By looking at the letter in its entirety, this thesis will show why Charles Eames sent the film *A Communications Primer* with a letter to Ian McCallum that explained game theory and linear programming instead of communication theory.

In 1953, the computer and its applications were very much misunderstood, and an audi-

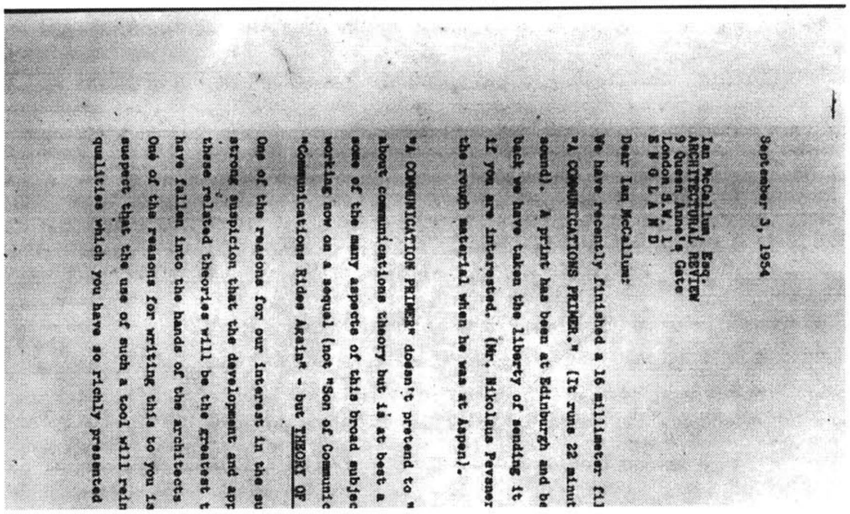
1. Neuhart, Neuhart, Eames. *Eames Design*, 183.
2. Charles Eames, "Q&A Charles Eames," 16-17.

ence of lay architects would have been skeptical of the any speculation about the potential uses of the computer in their profession. Therefore, I would speculate that in *A Communications Primer*, Eames was much more interested in teaching architects about computers in general – as a preparatory step to telling them that they could use the computer in the design process. Charles Eames' interest in computers is accurately summed up by Philip Morrison.

> Philip Morrison believed that it was Charles' interest in theoretical structures and a belief that "you could take apart everything that had meaning and form and could show it as a simple combination of yes-no binary choices" that made him so enthusiastic about this new machine. [3]

The binary choices that a computer makes comes directly from the concept of the "bit" in communications theory and as seen in the previous chapter, the Eameses dedicated much of the film *A Communications Primer* to explaining this concept. The reduction of choices to a binary system was the functional basis of the computer, but it was not the basis for game theory, which is why Eames wrote the lengthy letter describing game theory to Ian McCallum. Eames wanted to make clear the difference between the computer as a functioning machine and the use of game theory and linear programming to analyze data. Taking a contemporary analogy, the computer is the hardware; game theory, the application; and all the factors that must be considered in the architectural and planning design process, the data to be stored and analyzed.

3. From Philip Morrison, 'Eames Celebration,' in *Charles and Ray Eames*, Pat Kirkham, 347.



September 3, 1954

Ian McCallum, Esq.
ARCHITECTURAL REVIEW
9 Queen Anne's Gate
London S.W. 1
E N G L A N D

Dear Ian McCallum:

We have recently finished a 16 millimeter fil
"A COMMUNICATIONS PRIMER." (It runs 22 minut
sound). A print has been at Edinburgh and be
back we have taken the liberty of sending it
if you are interested. (Mr. Nikolaus Pevsner
the rough material when he was at Aspen).

"A COMMUNICATION PRIMER" doesn't pretend to
about communications theory but is at best a
some of the many aspects of this broad subjec
working now on a sequel (not "Son of Communic
"Communications Rides Again" - but THEORY OF

One of the reasons for our interest in the su
strong suspicion that the development and app
these related theories will be the greatest t
have fallen into the hands of the architects
One of the reasons for writing this to you is
suspect that the use of such a tool will rein
qualities which you have so richly presented

A Letter to Ian McCallum – from Charles Eames

This letter was written in 1954 by Charles Eames to Ian McCallum, editor of the *Architectural Review* in London. It clearly describes Eames' interest and enthusiasm for ideas about game theory and how these ideas could be used by architects and planners. It is not known if Ian McCallum ever responded to this letter.

This material is not yet in general circulation, even though it is accessible researchers at the Eames Archives (Box 218, Folder 3, part of the Jehane Burns file) Library of Congress. This chapter will present a close reading of the letter in the same manner as was done for the film *A Communications Primer*. The full text of the letter in its entirety is available in Appendix B.

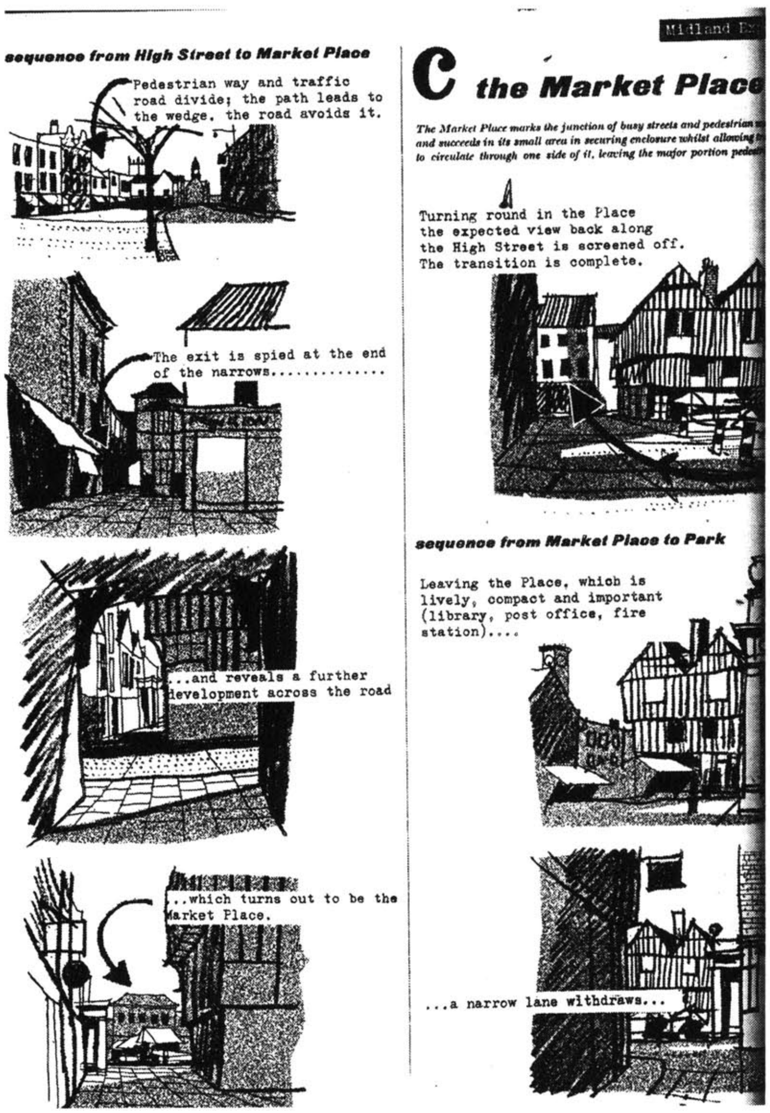
Introduction

> Dear Ian McCallum:
>
> We have recently finished a 16 millimeter film which we call "A COMMUNICATIONS PRIMER." (It runs 22 minutes, is in color-sound). A print has been at Edinburgh [4] and before shipping it back we have taken the liberty of sending it to you to view, if you are interested. (Mr. Nikolaus Pevsner saw some of the rough material when he was in Aspen).
>
> "A COMMUNICATION (sic) PRIMER" doesn't pretend to "teach" anything about communication theory but is at best a door opener to some of the many aspects of this broad subject. We are working now on a sequel (not "Son of Communications" or "Communications Rides Again" – but THEORY OF FEEDBACK).[5]

After a brief introduction, Charles Eames is quick to point out that the film does not teach anything about the mathematical concepts underlying "communication theory," but rather tries to be a "door opener to some of the many aspects of this broad subject." The *Primer* advertisement expresses a similar sentiment stating the film's goal as mainly to "help discourage ever thinking of communication in a limited way." And Charles Eames' statement in his interview with Diehl that he and Ray had simply wanted to make a statement about communications theory for architects also supports this case. Another purpose of the film, although never explicitly stated in the script, was to educate architects about computers in hopes that they would someday use the computer as a design tool. It would seem obvious that the next step would be to try to persuade the editors of architectural journals to at least carry the *Primer* advertisement, if not to carry a review. To my knowledge, this never happened. The writing of this letter is rather an attempt to find a willing partner in promoting the computer as a design tool. In particular, Charles Eames was interested in a series published in *Architectural Review* called "Townscapes" which seemed to hold a lot of potential if transposed into computer data.

4. The film was probably at the Edinburgh film festival. Two later films of the Eameses would win awards at this festival: *Toccata for Toy Trains* and *The Information Machine*.
5. The film "Theory of Feedback" was released entitled *Introduction to Feedback* in 1960. This film will not be discussed in this thesis because I could not locate the film.

FIG. 1- A page from "Townscapes" in *Architectural Review.*



Townscapes

> One of the reasons for our interest in the subject is our strong suspicion that the development and application of these related theories will be the greatest tool ever to have fallen into the hands of the architects or planners. One of the reasons for writing this to you is that I also suspect that the use of such a tool will reinforce those qualities which you have so richly presented in "Townscapes."

"Townscapes" was a regular section in the *Architectural Review,* usually written by Gerold McCullen, that used photographs and perspectival drawings to breakdown the city to its essential relationships.[1] The focus was not predominantly on specific elements, like stores, institutions, and residences even though they were important "data". Rather the essentials were conceived as the *relationships* between these programmatic elements and how a person moved and perceived the city as a series of these relationships. These relationships were also evaluated in terms of success. The criteria was explained to a certain extent in the text, but for the most part, the argument was implicit in the perspective drawings. What constituted a "good" space or "good" transition would be immediately apparent just by looking at the drawing.

Charles Eames was most likely aware of the Townscapes article in Figure 1. The breaking down of the planning process into small manageable elements – "narrow", "busy", "lively", and "compact" – and how a planner would string these together into a discrete sequence of spaces was very compelling to Charles Eames. The reductive nature of the "townscape" argument echoed the "process of communications which, like the composition of a painting, was constituted of a series of discrete decisions to create a unified message. In this case however, the message would be a whole town or in the case of the architect, a whole building. In order to create such a complicated "message" however, a large number of factors would need to be taken into account simultaneously. This is where Eames thought the computer would be able to help the architect; it could organize the different design criteria that go into designing a building or planning a city, and then evaluate it using game theory and/or linear programming.

The Architectural Design Process

If ever an art was based on the handling and relating of an impossible number of factors, this art is architecture. One of the things that makes an architect is the ability to include in a concept the effect of and affect on many simultaneous factors – and a precious tool has been his ability to fall back on his own experiences which have somehow turned into intuitive associations. It is one reason why an architect seldom is, nor can afford to be, bored with anything.

The ability to make keen intuitive associations does not, of course, relieve the architect of the responsibility of calculating and predicting all factors of a problem that can be calculated and predicted. It is perhaps safe to say that in any architectural problem very few of the factors involved have been calculable – the relationships of factors are almost impossible to calculate – and most of the factors remain unknown.

If, however, a tool should be developed which could make possible the inclusion of more factors – and could make calculable the possible results of relationships between combinations of factors – then it would become the responsibility of the architect and planner to use such a tool. The talent for associations would be far from negated – it would be put to a much keener use. The level of creativity would be immediately raised and so would the responsibility. We may have the possibility of such a tool in the "Theory of Games."
— emphasis mine.

Eames understood that the architect's role as being extremely dependent on his (her) ability to organize "simultaneous factors" and that this ability would be facilitated by a "tool" that could both calculate and predict many factors. Here, he states that the "possibility of such a tool" exists in the "Theory of Games." Note that on different occasions, Eames would refer to the computer and the application together and separately as a "tool". Eames was also quick to point out that the use of the electronic calculator would not negate the architect's "talent for association", nor relieve the architect of responsibility. 6

6. Rather, "the level of creativity would be immediately raised and so would the responsibility." This debate is still being waged today in schools of architecture where the relationship with the computer still is a love-hate one. Instead of seeing the computer as a *tool*, like a pencil or spreadsheet, those in architecture schools who resist the computer see it as an "easy way out". Ironically, there are also opponents who are unwilling to use the "tool" because as a "tool" it is not so-called developed or sophisticated enough.

The connection to John von Neumann and Oskar Morgenstern is finally revealed in this letter. Interestingly, none of these ideas were ever explained or even alluded to in the film *A Communications Primer*. This may point to some hesitation on Eames' part to diverge from the main subject of "communication", or it may point to a reservation to not predict or speculate too heavily on such a new technology. In the later film *The Information Machine* [See chapter "Incorporating Communication"] the application of these ideas would become more explicit but the crediting of game theory and linear programming is not mentioned once again. [7]

Game Theory and Linear Programming

> You are no doubt familiar with the main aspects of the "Theory of Games of Strategy" or "Game Theory." (Now some 35 years old, [8] it was of great importance during the war, and in complex organizational and industrial problems today, linear programming is a development of games theory). While the big concept is great and simple, the working vocabulary gets so supermathematical as to unintelligible and the working mechanics would have been impossible had it not been for the simultaneous development of the present day electronic calculator.
>
> Like linear programming, game theory is a pure mathematical system that can be used in relation to very human problems. By it a number of variables can be considered simultaneously and a solution calculated that has the highest probability of filling the desired requirements under the given circumstances.
>
> How human and confidence giving it is to learn that such answers are not given in terms of "a sure thing" but in terms of "high probability."
>
> About 10 years ago John von Neumann, mathematician (and author of the theory of games) and Oskar Morgenstern, economist, coauthored a book "Theory of Games and Economic Behavior." Many of its pages are so filled with mathematical symbolism that they

7. See chapter "Incorporating Communication"
8. Here Eames is referring to the work done by John von Neumann in the 1920s. The seminal text was a paper von Neumann had written in 1928 entitled "Zur Theorie der Gesellschaftsspiele," in *Math. Annalen* 100, .295-320. It is highly unlikely that Eames ever read this original paper.

> look like (and are for many of us) pages of a foreign language. But very real was the method and the concept of treating human actions and needs in such a way that they can be discussed mathematically. In most any economic situation, some of these actions and needs are emotional or psychological. To discuss these aspects of a problem mathematically seems difficult but not unreasonable, when we hear that mathematics did not exist in physics before the 16th century or in chemistry and biology until the 18th century.
>
> Here is a super simple and interesting example of thinking taken from a footnote in the von-Neumann-Morgenstern book:
>
> "Assume that an individual prefers the consumption of a glass of tea to that of a cup of coffee, and the cup of coffee to a glass of milk. If we want to know whether the last preference – i.e., difference in utilities – exceeds the former, it suffices to place him in a situation where he must decide this: Does he prefer a cup of coffee to a glass the contents of which will be determined by a 50% – 50% chance device as tea or milk."
>
> As the authors go step by step through the process of evaluating economic situations in mathematical terms – the very nature of the situations makes it apparent that one can substitute "planning" or "design" for "economics" and since the direction is toward high probabilities and not sure things, the factors are all open to re-evaluation on a highly creative or personal level – including nothing out.

The theory of games and linear programming were used during World War II in logistics, submarine warfare and air defense, but it was the 1944 publication linking game theory to economics and the use of the computer to actually do the calculations that would fascinate Eames the most. In the letter, Eames almost seems to suggest a book entitled "Theory of Games and Planning" or "Theory of Games and Design". His predictions and speculations would come true in the sixties when very concrete research in computers and architecture would begin to surface, but never once did Eames himself enter into the field of computers on a programming level.

In the final part of the letter, Eames addresses two factors that will effect the implementation of these ideas: one, the secrecy surrounding the computer during the early Fifties due to its military funding and uses and two, the reluctance on the part of architects and planners to embrace such a tool.

Predicting the Computer's Impact

> It is unfortunate that in this time much of the really creative thinking in organizing and programming and evaluation should be so shrouded with the panic of secrecy. Here is a useful working tool that comes to us at a time when numbers and complications seem about to obliterate the human scale. **What makes this tool so handy is that it would seem to actually use large numbers and unlimited relationships to help us return to the human scale and the richness of the Townscape in the terms of our times.**
>
> Of course, there will be the hidden fears of loss of individuality and creativity which tend to swamp any concept which gives greater responsibility to the individual and the creator – but of one thing we can be quite sure – the buildings and communities of the near future will be planned with the aid of some development of these theories. Whether or not they are planned by architects may pretty well depend on the way architects today prepare to use such tools.
>
> Anyway, this is the background thinking of the film "A COMMUNICATIONS PRIMER."
>
> Sincerely,
> Charles Eames
> — emphasis mine.

Charles Eames starts off this last section by lamenting the fact that all the work being done in this area is "shrouded with the panic of secrecy." Here, he is referring to the military research organizations, like RAND, which were the "think tanks" of Cold War strategy. But as computers became more wide spread, the technique of using game theory and linear programming to organize and evaluate architectural and planning data became more feasible. [9] It is difficult to trace Charles Eames' impact on the researchers who actually applied game theory and linear programming techniques to architecture and planning but it is certain that Charles Eames' final hope of a "return to the human scale and the richness of the Townscape" by using computer techniques has not yet come to fruition.

9. The first conference will be discussed in the Postscript.

Other references to scientific and technological concepts

Charles Eames continued to promote these ideas in the form of discussions, lectures and letters. (Many of the original source materials have been "untapped" and are available at the Eames Archives.) In 1956, in a Panel Discussion "Converging Forces on Design" at the School of Architecture at the University of Southern California, Eames once again refers to a blend of ideas from Dewey, Shannon, Weaver, von Neumann and Morgenstern. Throughout the discussion, he is very enthusiastic about the new scientific and technological advancements. It is not until the end that he promotes the use of the computer in the design professions.

> This work is developing a set of tools (used mostly so far in relation to war, economy and communications problems) that would seem to be absolute naturals to back up the development of a creative "climate" and uniquely applicable to problems of design and planning. They include the approach to quantitative treatment of factors, as unlikely as human emotions, and methods of handling a number of factors in a single problem. The theories for handling multiple factors and the machinery for putting the theories in action are both tools and as such they can only add to, they can never take away from man's responsibility.
>
> It would not be too impossible to speculate on what influences these forces may have on design and planning. It would be more difficult to say how architects and designers will adjust themselves in order to become a part of this development. [10]

It is difficult to interpret Eames' hesitation in the last sentence. On one hand, it shows that he decidedly positioned his own faith in computer technology against the general distrust of computers felt by the majority of architects. On the other hand, Eames never programmed or even tried to program a computer so in this light, it is hard to judge the sincerity of this statement. He never did become a mathematician, nor a city planner, nor a physicist. I would suggest that Eames' position makes more sense when regarded in respect to the Eameses other educational films and projects; it is highly doubtful if Eames ever understood all the concepts that he and Ray were asked to convey visually and graphically. Instead, Eames' commitment was arguably at

10. Charles Eames, "Converging Forces on Design," panel discussion, School of Architecture at the University of Southern California, May 12, 1956, WCRE, Box 217, Folder 6.

a higher level, which was to promote science and technology and disseminate its values to the greatest number of people possible. The "marketing" of science and technology was not, however, a simple contract job. I would propose that the Eameses interest in education was in fact a continuation of Deweyan concepts ... where communication and education would ultimately bring a more democratic community to maturity.

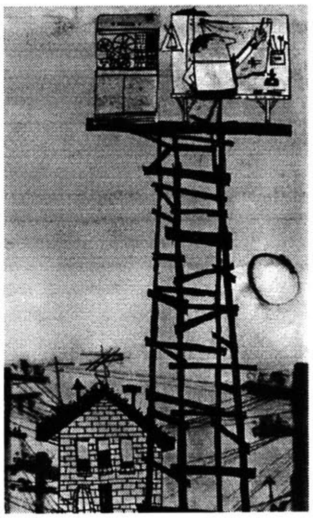
The ideas of game theory and linear programming resurface once again in 1960, when Charles Eames wrote a letter to Reyner Banham, who at this time was an editor at the *Architectural Review*. This letter made very similar points to the letter to Ian McCallum in 1954.

> 1. That we have, in recent years, come upon some first rate planning tools —
> Theory of Games of Strategy
> Operations Research
> Linear Programming
> Many aspects of Information Theory
> (the computer or data processor I think of as something else — a piece of very valuable hardware, the development of which has made such theory workable)
> 2. Much of the nature of these tools would indicate that they belong to the main stream of the architectural tradition.
> 3. We can be reasonably sure that these, or similar tools, will be used to attack some of the architectural problems already upon us.
> 4. We can hope that the architect will be the one to use these tools. [11]

Unfortunately, this letter is an anomaly, just like the letter to McCallum. And once again, there is no evidence that Banham sent any return correspondence. The importance of this letter lies in the fact that even if he Charles Eames did not fully comprehend the subjects he promoted, he fully comprehended their importance. Charles Eames, whether acting alone or as a team with Ray, would do his and their best to facilitate the dissemination of information – or in other words, communicate these ideas to the broadest audience as possible.

11. Charles Eames, "Letter to Reyner Banham, *The Architectural Review,*" WCRE, Box 218.

Incorporating | Communication



Introduction

In the book *Eames Design*, there is an illustration of an architect at his drafting board and a computer next to him. Both are situated on a platform at the top of a truss-like structure. There is not much room at the top except for the architect, a drafting board and a computer. The implication of this illustration is that the architect only needs his drafting board and computer to design. Although the majority of architecture firms today design in this manner, this concept was very radical, if not futuristic, when proposed in 1957. Also, Charles Eames' vision of *how* architects would use the computer is very different from how they are used today. Contemporary architects use the computer primarily for drafting; Charles had proposed to use the computer in the design process as a data processor. Unfortunately, this illustration was never used in the final version of the film but it was obviously important enough for Ray Eames and the Neuharts to give it a whole page in the book *Eames Design.* [1] After a brief explanation of the Eameses's relationship with IBM, the rest of this chapter will be dedicated to the part of the film that highlights the potential uses of the computer in the architectural and planning fields. The full script is found in Appendix C.

1. Neuhart, Neuhart, Eames, *Eames Design*, 222.

The Eameses work for IBM

By the end of their career, the work that the Eameses did for IBM totalled over fifty projects, ranging from educational films and exhibitions to architecture and interiors, as well as toys and graphics. The original marketing concept, inspired by the Italian firm Olivetti, was to use a cohesive design aesthetic in order to define a corporate identity that would be instantly recognizable on an international scale. To implement this strategy, Thomas J. Watson, Jr., the CEO of IBM, asked Eliot Noyes and Paul Rand to come up with a cohesive plan. One of their suggestions was to hire the Eameses as design consultants, due to their skill in explaining scientific and technological concepts with a "human touch." Their decision was in fact based on their viewing of the film *A Communications Primer.* Donald Albrecht in his article "Design is a Method of Action" in the book *The Work of Charles and Ray Eames: A Legacy of Invention,* describes IBM's marketing strategy as per described by correspondence to the Eameses.

> IBM's soft-sell approach addressed "the need for science to be better understood by the American public." Its sponsorship of films, exhibitions, and books was intended to foster a climate in which computers would be perceived as acceptable and benign. In its ongoing film program in the 1970s IBM directed the Eameses to convey three points: IBM as an international company; technology is a basic economic resource — like land or water — for a country; and computer technology is being applied to improve the quality of life for people around the world. [2]

The Eamses' first commission was to create the film *The Information Machine* for the Brussels World Fair of 1958. [3] As a result, the production of the film *Introduction to Feedback,* the sequel to *A Communications Primer* that was mentioned in the letter to Ian McCallum, would be delayed until 1960. It too would be funded by IBM.

2. Albrecht, "Design is a Method of Action," 38, quote from footnote 45: Jane P. Cahill, letter to Charles Eames, June 16, 1972, Folder 4, Box 48, WCRE, Manuscript Division, Library of Congress. quote from footnote 46: Charles G. Francis, letter to Charles Eames, June 16, 1972, Folder 4, Box 48, WCRE, Manuscript Division, Library of Congress.
3. The film received a certificate "In Recognition of Public Service" by the United States State Department. See Hélène Lipstadt's article "Natural Overlap": Charles and Ray Eames and the Federal Government in The Work of Charles and Ray Eames: A Legacy of Invention, published by Harry Abrams 1997, footnote 11, 174.

The relationship proved to be very successful, in no small part due to the fact that Charles himself believed in the computer's power to solve "mankind's problems." The media presented conflicting viewpoints on the computer: whether it could actually perform the things its designers said it could do; whether it would really help mankind; whether IBM was a monopoly; whether the computer would ever take on a purposeful, and inherently evil, consciousness and overtake the world. Donald Albrecht notes that the government brought an antitrust lawsuit against the company in IBM in the late 1960s and that social critics like Ralph Nader claimed "that without government regulation the computer would turn the U.S. into a a 'nation of slaves'". [4]

Before a close reading of the film, a brief explanation of the film's title is in order. The exact terminology used to refer to the computer was a very controversial subject when this technology was first gaining recognition in the late 40s and early 50s. Charles Eames referred to it primarily as an "electronic calculator" while others felt this term was too limited. In the book *Automatic Control*, Louis Ridenour proposed that the new machines be called "information machines," since they did much more than "compute".

> Computer is really an inadequate name for these machines. They are called computers simply because computation is the only significant job that has so far been given to them. The name has somewhat obscured the fact that they are capable of much generality. ...
>
> To describe its potentialities the computer needs a new name. Perhaps as good a name as any is "information machine." This term is intended to distinguish its function from that of a power machine, such as a loom. A loom performs the physical work of weaving a fabric; the information machine controls the pattern being woven. Its purpose is not the performance of work but the ordering and supervision of the way in which the work is done. [5]

The progression from the article "The Mathematical Theory of Information" to an article entitled

4. Albrecht, "Design is a Method of Action," 39 and footnote 47. Charles Eames, even without the influence of or funding aid from IBM, always maintained that he and Ray would have continued to promote the computer through the use of films even without the support of IBM.
5. Louis Ridenour, "Information Machines," *Automatic Control*, 111.

"Information Machines" helped to link the ideas of Claude Shannon and Warren Weaver to the development and inner processes of the computer. Interestingly, even though the word "computer" remained current and "information machines" would not, the discipline of studying and using computer technology is still called "Information Technology" in many schools.

The Information Machine: Creative Man and the Data Processor

The film starts with the phrase "ever since the time when man began to control his environment, he has been plagued by his limited ability to speculate," and continues with an explanation of how certain men were able to speculate and predict what was going to happen by using their memory or what the film would call their "active memory banks". Eames called the men who were able to able speculate and predict particularly well "artists" and he lists the various fields in which these artists were found: "architecture, mechanics, medicine, science, politics, and the art of relating factors." [6] The meaning of the film's title is taken from this analogy; "Creative Man" meant artists in all different fields and data processing was a specific use of the computer that could help man speculate and predict. Donald Albrecht explains the main point of the film was to "promote data processing as the best technique with which to solve contemporary society's most complex problems." [7]

After an explanation of how all of these artists in the various disciplines were able to use numbers "as abstract symbols for states of being," the film explains how computers might be used "in the service of mankind". [8]

> Computers are generally used in any of three ways:
> First – as a control or balance;
> Second – as a function of design;
> Third – as a simulation or model of life, where we can see

6. All quotes from script of *The Information Machine: Creative Man and the Data Processor*. Appendix C.
7. Albrecht, "Design is a Method of Action," 29.
8. Script, *The Information Machine: Creative Man and the Data Processor*. Appendix C.

> the effect before taking action.

The film then continues to explain each of these uses. The first use is one of "self-regulation" and does not affect how the computer might be used by architects and planners. The explanation of the second and third uses however, are extremely important to Eameses's belief that the computers would have a major impact on the design professions. The second function is described as follows:

> As a function of design, the calculator provides creative man a higher platform upon which to stand – and from which to work.
>
> Data processing removes the drudgery but imposes new and broad responsibilities.
>
> The designer must be able to state precisely what it is he needs to know. This is not always so easy.
>
> He must formulate a general plan or procedure; the plan or program takes the greater part of all the time involved.
>
> He must write a concise step by step list of instructions, translate it into a digestible code and feed it to the computer.
>
> Then he must provide the machine with all pertinent background information and related data.
>
> The preparation may have taken months – the actual calculation hours – or even minutes.
>
> But once set up, it can attack the problem with infinite variations and trustworthy memory.

The process of programming is simply and generically outlined. There is no mention of the architect or planner but the possibilities can be seen in the visual counterpart to the last sentence – "But once set up, it can attack the problem with infinite variations and trustworthy memory." – which is accompanied by quick edit cuts of different cartoon-drawn snowflakes. Even though a computer can not design or make a snowflake in accordance to a written set of codes, the suggestion that the computer can create or design beautiful results given the right constraints and/or parameters is significant. If a computer is used in the design process of a building and planning of a city, the design criteria could be stored faithfully in the memory of the computer and analyzed to create "infinite variations". Unfortunately, the illustration of the architect with his drafting board and computer would have made the direct connection between the computer "design" process and the architectural "design" process an indisputably direct one. (The reason for not putting the illustration in the final film is unknown.)

The third use of the computer was "the simulation or model of life, where we can see the effect before taking action."

> Perhaps the most challenging use of the computer is the simulation of real situations.
>
> If, for example, a machine is properly programmed, and is provided with sufficient numerical data concerning a chemical plant - - - -
>
> Then the computer begins to take on the functions of a working mathematical model of that chemical plant - in which it is possible to determine the probable effects of many possible courses of action.
>
> Today there are working mathematical models of railroad systems, rocket engines, complete reactors, and whole living communities.

The last line which states that there are already mathematical models of "whole living communities" was possibly a reference to the government contracts given to aero-astro corporations and non-profit spin-offs like the RAND Corporation which gave expertise to local governments on transportation and regional planning problems.

The Information Machine represents an interesting turning point in the Eameses careers because it signals a change in the financial structure of the production of films and other multi-media presentations in the Office. No longer would the films be made in the Office after hours with their own money, but rather for their client IBM. In one way, the opportunities IBM was to give the Eameses, in terms of amount of individual commissions would have been hard to pass up. And the quality of work that resulted from these commissions could have never been accomplished on such a scale without the financial support of IBM. The *Mathematica* exhibit, which introduced mathematical concepts through the use three-dimensional demonstrations and a time-line wall would not have been undertaken by the Eameses alone. Another example is *A Computer Perspective,* an exhibit and book that recorded the history of the computer. On the other hand, one wonders if any objective autonomy that the Eameses might have had in terms of content and presentation was sacrificed in the process. If the object in question had been a building, the evaluation of the final structure would have most likely been a question of how well the architect met the client's needs or how well the building was designed in relation to other structures. But in this case, because the "object" designed inherently included marketing schemes, historical evidence, and didactic, and maybe even ideological purposes, the autonomy of the Eameses have to be called into question.

Therefore, the title of this chapter, "incorporating communication", attempts to express the ambiguity that surrounds the critique or the position of the Eameses' marketing commissions. How much of the original Deweyan-inspired ideas about communication and community were sacrificed or incorporated into the marketing schemes of the IBM Corporation? Or, to the contrary, how much were the Eameses actually using IBM to further their ideas on communication and community rather than vice-versa? These questions are beyond the scope of this thesis but hopefully this thesis has been able to demonstrate that the word "communication" in all its forms and nuances was more than a passing interest for Charles Eames, and as a concept would effect many of the projects that the Eames Office would produce.

Conclusion

> While the central results [of information theory] are chiefly of interest to communications engineers, some of the concepts have been adopted and found useful in such fields as psychology and linguistics.
>
> Information is interpreted in its broadest sense to include the messages occurring in any of the standard communication mediums such as telegraphy, radio or television, the signals involved in electronic computing machines, servomechanisms systems and other dataprocessing devices, and even the signals appearing in the nerve networks of animals and man. [1]

By 1968, the influence of the computer and information technology could not be ignored. Even Claude Shannon, in his *Encyclopaedia Britannica* entry for "Information Theory" discusses the breadth of the field and its interdisciplinary uses. From psychology to television to computers, information theory and its terminology would basically become ubiquitous. But the enthusiasm for these ideas were not ubiquitous and the negative consequences of the computer and its uses in the architectural and city planning professions were also being voiced. In 1967, Edmund N. Bacon, who was at Cranbrook at the same time as Charles and Ray Eames in the late Thirties, had become an influential city planner and expressed his skepticism as follows.

> With the enormous improvement in the techniques of mathematical manipulations of electronic computers applied to the problem of projecting past trends, we are in danger of surrendering to a mathematically extrapolated future which at best can be nothing more than an extension of what existed before. Thus we are in danger of losing one of the most important concepts of mankind, that the future is what we make it. [2]

Christopher Alexander, three years before at the 1964 Boston Architectural Center conference "Architecture and the Computer", also had expressed similar reservations about the ability of the computer to predict and project into the future. Alexander framed his critique around the fact that he himself used the computer "to solve both practical and theoretical problems in design". [3] But

1. Claude Shannon, "Information Theory," *Encyclopaedia Britannica 14th edition* (Chicago: Encyclopaedia Britannica, 1968.)
2. Edmund Bacon, *Design of Cities* (New York: Viking Press, 1967), 13.
3. Christopher Alexander, "A Much Asked Question about Computers and Design," in *Architecture and the Computer*, proceedings, First Boston Architecture Center Conference, December 5, 1964, Boston, MA, 52–54.

unlike the computer advocates who wanted to use the computer in the design *process*, Alexander made it clear that he only used the computer for its computational abilities, not its predictive or probabilistic capabilities – which was the very reason why Eames believed the computer to be important.

> Although we speak a great deal about the complexity of problems, the complexity of architecture, and the complexity of the environment, this talk, so far, is rarely more than hand waving. In the present state of architectural and environmental design, almost no problem has yet been made to exhibit complexity in such a well defined way, that it actually *requires* the use of a computer. [3]

Even though there were and still are opponents to the use of computers in architecture, the trend to use computers in the architectural design profession puts a premium on studying the history of this relationship. So far, the history of computers has been for the most part, a history of hardware and software development and the people who were instrumental in making these advancements happen but the origins of the current philosophical and theoretical debates that surround the computer today are just as important. This thesis hoped to prove that there is another history that can be written that does not depend on any discipline in and of itself, but on words, the evolution of words and how words are adopted and adapted in cross-disciplinary exchange. The progression of the Eameses work in relation to the changing definition of the word "communication" is, I would argue, not a semantic coincidence but a phenomenon that is historically and contextually grounded.

For this reason, a well thought out history of a word, can shed light on the "logic" of that word. This thesis showed how at one moment, the word "communication" could be seen as an active human process having positive social, educational and political ramifications – and at another moment, simply be a process reduced to mathematical equations. It is important to note

3. Christopher Alexander, "A Much Asked Question about Computers and Design," 52.

that due to time constraints, I was unable to write the counter-history of the word "communication" which does exist.

There were many people who were skeptical of Dewey's socialist tendencies; who hated Kepes' Gestalt influenced *language of vision;* who had severe reservations of the quantification of communication for philosophical reasons; who felt that interdisciplinary exchange diluted the autonomy and integrity of the various disciplines; who criticized game theory and its military uses; and who resented the computer and essentially all its attributes. This thesis, in the end, is only half a thesis because it lays out the positive influences of the word on the thinking of Charles Eames and how these ideas were translated into the Eameses work. The negative influences, and how they might have either strengthened or destabilized Eames' faith in the word "communication" have not yet been recorded. Instead, this thesis lays the groundwork for a larger investigation.

Charles Eames' interest in communication and nuances of the word are as varied as the work of the Eames Office. In many ways the Eames Office practiced the very ideas presented in the word "communication". Not only was the work in the Office interdisciplinary in nature, it was dependent on a *fusion* of art, science, technology, education, and community. Whether it was an exciting new mathematical concept or a political philosophy, the word "communication" would permeate both the content of projects as well as the *justification* for the projects. Whether explicitly or implicity, the ideas of John Dewey, Gyorgy Kepes, Claude Shannon and Warren Weaver, John von Neumann, Oskar Morgenstern, and Norbert Wiener would form the basis for the film *A Communications Primer*, and hopefully, this thesis succeeded to bring these relationships to light.

Postscript: Architecture and Computers

In Eugene Ayres' article "An Automatic Chemical Plant." in the book *Automatic Control*, he makes an interesting point about the relationship between computers and the creative process. In the last paragraph, he abruptly stops talking about the chemical plant and turns to more general issues surround the computer and even speculates on the future of the computer as a design tool, although in a way markedly different from that of the Eameses.

> Men have regarded the machine as a mixed blessing. Machine-made goods are a synonym for inferior goods. Will automatization remove the last drops of human creativeness and variety from man's products? Such fear is ill-founded. To be sure, textiles made by the machine loom have lacked the traditional charm of those woven by hand. But the shortcomings of the machine are not inevitable. With modern automatic controls, machine-made textiles can approach the beauty and quality and individuality of the "hand-made." Machines can now be designed not only to surpass the regularities of careful hand manipulation but also to duplicate faithfully the irregularities of the artist's inspiration. ... [1]

When Eames talked about the relationship of computers to the design process, he was not interested in the "irregularities of the artist's inspiration" but rather the creativity involved in developing "theories by which the many factors in a problem could be numerically related." [2] Only in hindsight is it possible to see the importance of Ayres ideas. These ideas impacted artificial intelligence in their hope to develop a "more human" intelligent computer and they impact current efforts to bring Genetic Algorithms into the design process. The premise, or promise, of G.A.'s is the possibility to program the "the irregularities of the artist's inspiration" in to the application. It is important to make this distinction because in the past four decades of architectural computer research, these two different mentalities have influenced each other and played off one another in very interesting ways.

1. Eugene Ayres, "An Automatic Chemical Plant," *Automatic Control*, 52.
2. Eames, *The Information Machine*, Appendix C.

On one hand, there are researchers like George Stiny and his theory of Shape Grammars where the desired algorithm, the one that Shape Grammar researchers strive for, is always the *one and only right* one. From within that one algorithm, infinite variation will be possible. In other words, for each stylistic movement – whether it be the patterns on a Greek vase or the structure of a Chinese Hall structure – there is a corresponding grammar. On the other hand, there are the researchers who are inspired by the current work in Artificial Life and Genetic Algorithms where the "right" algorithm is constantly being re-evaluated through a process of evolution and "natural" selection. In other words, the variety of shapes that result from the creative, or heuristic, design process is not dependent on one "right" algorithm like in the shape grammar method, but rather, on the continual evolution of the algorithm.

In different ways, both of these movements can be traced back to ideas that Charles Eames also held. The interest in optimization, which is fundamental part of GA's, is indebted to people like John von Neumann and Danzig for their work in game theory and linear programming. Interestingly, both the Genetic Algorithm movement and Game Theoreticians explicitly credit Charles Darwin. But there is also a fundamental difference between Eames and contemporary GA researchers. Both view the design process as a problem with many complex factors where optimization techniques are used in order to find the best solution but *how* they find that solution is the difference. The essential goal of GA's is to infuse creativity into the computer program in a very heuristic manner. Optimization techniques are used, not to optimize the accuracy of a "final" algorithm like how most GA researchers in the sciences use them, but to optimize "creativity". In many of these programs, the ultimate design decisions are made by the architect who plays the role of "Mother Nature" in the selection process. (In a way, this defeats the purpose of "optimization" but considering the long tradition of architectural researchers and theoreticians liberally and inaccurately borrowing from science and math, it comes as no surprise.) Charles Eames, on the other hand, believed that optimization in the more traditional sense could be achieved through game theory and linear programming techniques developed by von Neumann and Danzig.

On this point, Eames seems to be more aligned with George Stiny where the creativity of man is placed in his ability to relate a variety of factors in order to find a solution. In one of his more famous research projects, Stiny was able to take a catalogue of Chinese Lattice designs, quantify the proportional relationships and ultimately derive an algorithm that would generate a potentially infinite number of Chinese lattice patterns. [3] In a strange way, creativity is de-mystified, its inspirational qualities, forever quantified. Going back to the explanation of the second function of the computer, expressed in the *The Information Machine*, it is clear that these ideas are apparent even in the 1950s.

> The designer must be able to state precisely what it is he needs to know. This is not always so easy.
>
> He must formulate a general plan or procedure; the plan or program takes the greater part of all the time involved.
>
> He must write a concise step by step list of instructions, translate it into a digestible code and feed it to the computer.
>
> <u>Then</u> he must provide the machine with all pertinent background information and related data.
>
> The preparation may have taken months – the actual calculation hours – or even minutes.
>
> But once set up, it can attack the problem with infinite variations and trustworthy memory. [4]

Game Theory and Systems theory in the Architectural Design Process

The influence of game theory on research in architecture is significant as well and Charles Eames probably knew of these developments, although there is no evidence to support this claim. Two examples of game theory and systems analysis are a 1966 article by R.L. Meier and R.D. Duke in the *American Institute of Planners Journal* called “Gaming Simulation for

3. George Stiny, “Ice-Ray: a Note on the Generation of Chinese Lattice Designs,” 1977.
4. Eames, *The Information Machine*, 8.

Urban Planning" and C. Steiniz and P. Rogers' 1968 article "A Systems Analysis Model of Urbanization and Change" in *An Experiment in Interdisciplinary Education.* Many of the National Science Foundation grants for this type of research were in fact allocated to the Civil Engineering and Architecture departments at MIT, and by 1975, Nicholas Negreponte had edited a book called *Reflections on Computer Aids to Design and Architecture.* [5]

Charles Eames' influence on these developments was most likely minimal, but he was unquestionably one the first to grasp the potential of computers. In terms of current research, it is important to understand how current research is shaped by its history, how its rationale is derived from not just one source but many, and ultimately, how current research will impact future manifestations of these concepts.

5. Negreponte, Nicholas. *Reflections on Computer Aids to Design and Architecture*. (New York: Petrocelli/ Charter. 1975.)

Timeline

1943
– *Architecture Forum* Magazine City Plan, "New Buildings for 194(X)"

1944
– *Language of Vision* by Gyorgy Kepes
– *Theory of Games and Economic Behavior* by John von Neumann and Oskar Morgenstern

1947
– "Jefferson National Expansion Memorial" Competition (1947)

1948
– *Cybernetics: or Control and Communication in the Animal and the Machine* by Norbert Wiener
– *Automatic Control* by Scientific American

1949
– T*he Mathematical Theory of Communication* by Claude Shannon

1950
– *The Human Use of Human Beings: Cybernetics and Society* by Norbert Wiener

1953
– A Rough Sketch for a Sample Lesson for a Hypothetical Course
– *A Communications Primer*

1954
– Letter to Ian McCallum, editor of *Architecture Review*

1955
– *A Communications Primer* is shown at the ICA and influences the Independent Group

1956
– Independent Group exhibit *This is Tomorrow* inspired by ideas in *A Communications Primer*
– Charles Eames participates in the conference "Converging Forces on Design"
– *The New Landscape in Art and Science* by Gyorgy Kepes

1957
– *The Information Machine* made for the IBM Pavilion at the Brussels World's Fair

1960
– *An Introduction to Feedback* made for IBM
– Letter to Reyner Banham (1960)
– *The Image of the City* by Kevin Lynch
– *The Visual Arts Today* by Gyorgy Kepes

1964
– Christopher Alexander. "A Much Asked Question of Computers in Design" *Architecture and the Computer,* conference at the Boston Architectural Center

1969 – 1970
– MIT Arts Commission Report

Appendix A | Script to *A Communications Primer* (1953)

WCRE, Motion Picture, Broadcasting, and Recorded Sound Division
Note: Everything in {} is not in the script but is spoken in the film.

> Communication – from the Latin "Communication".
>
> One – act or fact of communicating: as communication of smallpox, of the secrets of power.
>
> Two – Intercourse by words, letters, or messages; {interchange of thoughts or opinions, by conference ...}

In the broadest aspects of communication, much work has recently been done to clarify theories and make them workable. The era we are entering might well be characterized as an era of communication. This film will touch in the most elementary way some aspects of the subject that are of daily concern to all of us.

Here is Claude Shannon's diagram by which almost any communication process can be schematically represented. The information source selects the desired message out of a set of possible messages. The transmitter changes the message into the signal which is sent over the communications channel to the receiver where it is decoded back into the message and delivered to the destination.

Every such system contains noise. Noise is the term used in the communications field to designate any outside force which acts on the transmitted signal to vary it from the original. In this usage, noise does not necessarily mean sound.
Reading is a form of communication where the word is the signal, the printed page the transmitter, light the channel, the eye the receiver.
Here sound can act as noise and interfere with the message.
But in some situations, like reading on a train where the sound level is normally high, it is not the sound that interferes with the communication process, as much as the motion and the unpredictable quality of the light source.
Quality of light and motion then become noise.
In radio, noise could be static.
In television, noise is often the distortion of the picture through transmitting or receiving.
In a type written passage, the noise source could be in the quality of the ribbon or the keys. And we are all familiar with the carbon copy that keeps getting progressively worse.
If anything acts on the signal, so as to vary it in an unpredictable and undesirable way in the communications system, it is noise.

We can consider telegraphy in terms of this same diagram. We will use a New York stock broker's office as the information source and a Los Angeles stock broker's office as the destination.
There may exist at the information source just two possible messages: buy or sell.
From these two, the message sell is selected, then coded by the telegraphic key, which is the transmitter, and sent over the channel as electrical impulse signals, decoded by the receiver back into the message sell and delivered to the destination.

Noise of course is there. This time acting electrically. It could distort the signal in such a way as to change sell into self. But as there are only two possible messages buy and sell, there is sufficient redundancy in the spelling of the words that even if it did read self, the information would still be clear.

Naturally, this example has nothing to do with the stock broker's office of today, because of all organized communication, market information is perhaps the most efficiently handled. The New York information enters the signal channel in this form and is automatically decoded in Los Angeles in this form. Here We find redundancy counteracting noise.

The English language is about one-half redundant. This extra framework helps prevent distortion of the message in the written language, or in the spoken language.

In speech, the brain is usually the information source. From it, the message is selected. The message is the thought, not the words. The vocal mechanism codes the words into vibrations and transmits them as sound across the communications channel which is of course the air. The sound of the word is the signal. The ear picks up the signal and with the associated eighth nerve, decodes the signal and delivers the message to the destination.

This time noise could originate in the transmitter, or in sound vibrations that disturb the channel – Or it could be a nervous condition on the part of the receiver, and it could change the message from I Love You to I Hate You.

How do you combat it? One way is through redundancy. "I love You" "I love You" "I love You". Another is increasing the power of the transmitter. This combats noise as does the careful beaming of the signal or duplicating of the message via other signals.

Now let's consider amount of information communicated. The message sell contains one bit or unit of information because it was the choice of two possible messages: buy or sell. A choice of two gives one bit of information. This the amount of information that one "on-off" circuit can handle at one time. It can be "on" or "off". Two bits of information is the amount two circuits can handle. There is a choice of four possible conditions: on-on, on-off, on-on, and off-off. Three circuits can handle three bits or a choice of eight possibilities. Four circuits, four bits, or sixteen possibilities. Five bits, thirty two possibilities. Six bits, sixty four possibilities. Amount of information increases as the logarithm of the number of choices.

The message I Love You, to communicate information, must also be a choice of other messages, because if the information source were so loaded with feelings of love as to be incapable of any other thought, then surely by the time the words I Love You were spoken, no information was communicated at all. No information, yet previous experiences, could make those three words convey great meaning.

Source
Message
Transmitter
Channel
Message
Destination.

You could imagine the message being music and the transmitted signal being tone. Or it could be applied equally well to writing, or to smoke signals, or to hand signals.

But let's take painting as another example of a signal transmitting a coded message.
Information source: mind and experience of painter.
Message: his concept of a particular painting.
Transmitter: his talent and technique.
Signal: the painting itself.
Receiver: all the eyes and nervous systems and previous conditionings of those who see the painting
Destination: their minds, their emotions, their experience.

Now in this case, the noise that tends to disrupt the signal can take many forms. It can be the quality of the light, or the color of the light, or the prejudices of the viewer or the idiosyncrasies of the painter.

But besides noise, there are other factors which can keep the information from reaching its destination intact. The background and conditioning of the receiving apparatus may so differ from that of the transmitter that it may be impossible for the receiver to pick up the signals without distortion.

In any communications system, the receiver must be able to decode something of what the transmitter coded or no information gets to the destination at all. If you speak Chinese to me, I must know Chinese to understand your words. But even without knowing the Chinese language, I can understand much of your feelings through other codes we have in common.
There are systems of communication where there is no redundancy and no duplication of the message. Here knowledge of the code is essential. If planning "one if by land"," two if by sea", the fellow on the opposite shore simply had to know the code. But there are also many examples of times when the message has been conceived and the signals sent long in advance of understanding or acceptance of the code employed. In the case of Galileo or Socrates, it did not in time matter that the receivers of their time were not tuned to receive their signal.

The ultimate transmission of such a message represents communication of a very complex order. Other high level communication occurs in a very different areas – a wave breaking on a beach brings a world of information about events far out at sea – it can tell of winds and storms, the distance and intensity – it can locate reefs and islands and many things – if – you know the code.

When we watch them turning and wheeling, how often have we wondered what holds such birds together in their flight.

Communication is that which links any organism together. It is communication that keeps a society together – and though these people seem unaware of each others existence, neither looking nor speaking, one group meets and filters through the other ... with hardly two individuals coming into contact ... so constant is the flow of information and so complex the web of communication that keeps them apart and holds them together.

The symbol, the abstracting of an idea –
Communication – at once anonymous and personal –
Personal because of the countless individuals that created its form –
Each one who in his turn who added something good or took something bad away. Anonymous because of the number of individuals involved and because of their consistent attitude. These are examples of communication of an idea through symbols. But there can also be communication through symbols to an idea as in the burnt offering or in the flame of a candle.

The use of flame as a transmitter in the communications channel is probably as old as man's first fire. It stands for all the wonder and mystery of forces beyond man's knowledge.

The storm warning flags are part of a long evolutionary tradition of signals, but their beginnings were probably in basic reactions to color and form; basic enough to make their communications carry beyond the barriers of language and custom...

But symbols also change and evolve. Some methods of transmitting messages rapidly become symbols then pass into obscurity – to become readable only to the anthropologist, while other symbols of communication remain.

The message being transmitted here may be unlimited at the range and subtlety of its ideas, yet the method and signal are such that they must be fed to the transmitter in a series of positive decisions. The system calls for the key to be either up or down. The code calls for a dot or a dash. The current flows – it ceases to flow – it flows. It is black – or white ... It is stop – or go ... On – or off ... One – or none ... Go – or no go ... or black – or white.

As in this small area from a halftone reproduction in a magazine. The press that printed it is capable of printing but one color of ink at a time. In this case, black ink on white paper. In order to transmit the image, it had to be broken down into many points of decision: black – or white.

We know that such a limitation is not at all restricting if enough decisions are made. In this case, half a million decided points give fair rendition. A million would be better. Conventional printing of color is no different except that with the added factor of color, four times the number of decisions had to be made: one set in yellow; one in red; in blue and in black.

Whenever added factors in a problem are recognized, the number of decisions necessary for the solution grows by large leaps. As theories and equipment and men developed it becomes apparent that one sure way of handling multiple factors is to build a system that can handle each decision in its time.

Men have long known the theory on which complex problems of many factors can be solved but the number of decisions - the calculations necessary, were prodigious. – and not until the recent development of the electronic calculator could these areas be touched.

The problem became one of communication between the man and the machine – between machine and machine – between machine and man. The cards are punched or not punched. Light passes, or stops – and by this binary system, information is fed the machine.

In a moment we will hear sounds which are an actual product of a huge calculator. The frequencies are made audible to check its functioning and in a way, feel its pulse. Here it is.

The ability of these machines to store information, manipulate, sort, and deliver it is fantastic. And with their complex feedback systems, their memories, their almost human reactions to situations it is understandable that they are popularly referred to as "brains". The greatest fallacy in the comparison is one of degree. The decisions made by the machines are comparable in number to the half million made in this half tone. But far greater is the number of stops and go's performed by the human nervous system in order to complete the simplest act. So great, that if each decision were represented by a small half-tone dot, the total area of dots would cover several earths. Such is the magnitude we reach when a number like a half million is raised to the fourth power.

As flowing as the human movements may seem they are actually the product of these countless yes-no decisions – communicated with great speed to and from all parts of the body.

The channel is the nervous system. Each nerve is made up of hundreds of fibers. The decision is the impulse of a single nerve fiber – an all-out event – a trigger process – which is set off like an explosion when the stimulus exceeds the ignition point. The dot in the half tone – the hole in the tape – each is a separate fire-no fire signal, but together they add up to a smooth, sometimes incredibly complex action ... that often seems more vague than decisive.

Yet many things that we except as indecisive vagaries would be, if we could bring our focus in sharp, decisive individual units. It is the responsibility of selecting and relating the parts which makes possible a whole which itself has unity.

The line on which each color breaks, and a point at which each dot that makes up this painting is placed, affects the whole canvas. The communication of the total message contains the responsibility of innumerable decisions made again and again – always checking with the total concept through a complex feedback system.

These elements of a communications system act together as one great tool. And though the tool may perform a most complex task, it can never relieve the man of his responsibility.

No matter where it occurs –
no matter what the technique –
communication means the responsibility of decision all the way down the line.

Music composed and conducted by Elmer Bernstein.
Woodwind quintet; Martin Ruderman flute; Arnold Koblentz oboe; Mitchell Lurie clarinet; Jack Marsh bassoon; Sinclair Lott french horn.
Sound by Barry Eddy, western electric magnetic recording.
Acknowledgment for ideas, direction, and material

Claude Shannon; Warren Weaver; Norbert Wiener; Oskar Morgenstern; John von Neumann; Edgar Kaufmann, jr.; John Campbell, jr.; Hamilton Wright; L.M.K. Boelter; and many others.
THE END

Appendix B | Letter to Ian McCallum (1954)

WCRE, Folder 3, Box 218

Letter to Ian McCallum
(1954)

Ian McCallum, Esquire
ARCHITECTURAL REVIEW
9 Queen Anne's Gate
E N G L A N D

Dear Ian McCallum:

We have recently finished a 16 millimeter film which we call "A COMMUNICATIONS PRIMER." (It runs 22 minutes, is in color-sound). A print has been at Edinburgh and before shipping it back we have taken the liberty of sending it to you to view, if you are interested. (Mr. Nikolaus Pevsner saw some of the rough material when he was in Aspen).

"A COMMUNICATION (sic) PRIMER" doesn't pretend to "teach" anything about communication theory but is at best a door opener to some of the many aspects of this broad subject. We are working now on a sequel (not "Son of Communications" or "Communications Rides Again" – but THEORY OF FEEDBACK).

One of the reasons for our interest in the subject is our strong suspicion that the development and application of these related theories will be the greatest tool ever to have fallen into the hands of the architects or planners. One of the reasons for writing this to you is that I also suspect that the use of such a tool will reinforce those qualities which you have so richly presented in "Townscapes."

If ever an art was based on the handling and relating of an impossible number of factors, this art is architecture. One of the things that makes an architect is the ability to include in a concept the effect of and affect on many simultaneous factors – and a precious tool has been his ability to fall back on his own experiences which have somehow turned into intuitive associations. It is one reason why an architect seldom is, nor can afford to be, bored with anything.

The ability to make keen intuitive associations does not, of course, relieve the architect of the responsibility of calculating and predicting all factors of a problem that can be calculated and predicted. It is perhaps to safe to say that in any architectural problem very few of the factors involved have been calculable – the relationships of factors are almost impossible to calculate – and most of the factors remain unknown.

If, however, a tool should be developed which could make possible the inclusion of more factors – and could make calculable the possible results of relationships between combinations of factors – then it would become the responsibility of the architect and planner to use such a tool. The talent for associations would be far from negated – it would be put to a much keener use. The level of creativity would be immediately raised and so would the responsibility. We may have the possibility of such a tool in the "Theory of Games."

You are no doubt familiar with the main aspects of the "Theory of Games of Strategy" or "Game

Theory." (Now some 35 years old, it was of great importance during the war, and in complex organizational and industrial problems today, linear programming is a development of games theory). While the big concept is great and simple, the working vocabulary gets so supermathematical as to unintelligible and the working mechanics would have been impossible had it not been for the simultaneous development of the present day electronic calculator.

Like linear programming, game theory is a pure mathematical system that can be used in relation to very human problems. By it a number of variables can be considered simultaneously and a solution calculated that has the highest probability of filling the desired requirements under the given circumstances.

How human and confidence giving it is to learn that such answers are not given in terms of "a sure thing" but in terms of "high probability."

About 10 years ago John von Neumann, mathematician (and author of the theory of games) and Oskar Morgenstern, economist, co-authored a book "Theory of Games and Economic Behavior." Many of its pages are so filled with mathematical symbolism that they look like (and are for many of us) pages of a foreign language. But very real was the method and the concept of treating human actions and needs in such a way that they can be discussed mathematically. In most any economic situation, some of these actions and needs are emotional or psychological. To discuss these aspects of a problem mathematically seems difficult but not unreasonable, when we hear that mathematics did not exist in physics before the 16th century or in chemistry and biology until the 18th century.

Here is a super simple and interesting example of thinking taken from a footnote in the von-Neumann-Morgenstern book:

"Assume that an individual prefers the consumption of a glass of tea to that of a cup of coffee, and the cup of coffee to a glass of milk. If we want to know whether the last preference – i.e., difference in utilities – exceeds the former, it suffices to place him in a situation where he must decide this: Does he prefer a cup of coffee to a glass the contents of which will be determined by a 50% – 50% chance device as tea or milk."

As the authors go step by step through the process of evaluating economic situations in mathematical terms – the very nature of the situations makes it apparent that one can substitute "planning" or "design" for "economics" and since the direction is toward high probabilities and not sure things, the factors are all open to re-evaluation on a highly creative or personal level – including nothing out.

It is unfortunate that in this time much of the really creative thinking is organizing and programming and evaluation should be so shrouded with the panic of secrecy. Here is a useful working tool that comes to us at a time when numbers and complications seem about to obliterate the human scale. What makes this tool so handy is that it would seem to actually use large numbers and
unlimited relationships to help us return to the human scale and the richness of the Townscape in the terms of our times.

Of course, there will be the hidden fears of loss of individuality and creativity which tend to swamp any concept which gives greater responsibility to the individual and the creator – but of one thing we can be quite sure – the buildings and communities of the near future will be planned with the aid of some development of these theories. Whether or not they are planned by architects may pretty well depend on the way architects today prepare to use such tools.

Anyway, this is the background thinking of the film "A COMMUNICATIONS PRIMER."

Sincerely,

Charles Eames

Appendix C | Script to "The Information Machine" (1957)

[WCRE, Motion Picture, Broadcasting, and Recorded Sound Division]

Script of The Information Machine: Creative Man and the Data Processor
(1957)

Ever since the time when man began to control his environment, he has been plagued by his limited ability to speculate.

His failure to accurately predict the effect and the consequences of his proposed action.

This is the result of his not being able to consider and relate all the factors in a problem.

Evidence of this inability can be seen in the persistence of a certain kind of myth involving three wishes –

In a frantic effort to reap immediate rewards, the first wish is often not too wise; the second usually tends to overcorrect; our hero can consider himself lucky if, after the last wish, he ends up just where he started.

But there were men whose wishes were not only prudent, but had a habit of coming true.

These men - and women - were artists, and had certain characteristics in common.

They were seldom bored with anything; they were constantly building up stores of information in active memory banks.

When confronted with a special need, they would call on these memory banks for information – which they would run through, sort out, and relate to the problem at hand.

These men could speculate – and could predict.

They were artists – artists in many fields – architecture, mechanics, medicine, science, politics, and the art of relating factors.

It is often not a conscious art, and the degree to which it is operative can tend to make one normal, bright, super-bright, or genius.

Numbers were used to count – but soon they were also being used as abstract symbols for states of being.

Values were given to mass, speed, inertia, and the forces of gravity.
Such measurement was an enormous help to creative thinking.

Man was learning to numerically relate and to predict.

Theories were developed by which the many factors in a problem could be numerically related. But the magnitude of the calculations necessary made many such theories impractical.

In the last century, the complications of our society have been compounding themselves, and it began to look as though the science of numerical relationships could never catch up.

For a long time, in the world of numbers, man has been developing tools to help him handle increasing amounts of data.

Something has now emerged that might make even our most elegant theories workable.

The recent acceleration has been fantastic. The electronic calculator has already become a tool upon which much of our daily activities depend.

A tool which has broadened the range of man's concepts and intuitions; much the way other tools have broadened man's range of communications, or man's range of travel or the phenomenal range of his control over the environment.

With the computer, as with any tool, the concept and direction must come from the man.

The task that is set, and the data that is given, must be man's decision and his responsibility.

This is information –

The proper use of it can bring a new dignity to mankind.

Properly related, it can maintain a balance between man's needs and his resources.

In many aspects, these are information machines, capable of storing, processing, and relating a vast quantity of information.

They process information so that it can be made meaningful at the human scale.

Computers are generally used in any of three ways –

First – as a control, or balance;
Second – as a function of design;
Third – as a simulation or model of life, where we can see the effect before taking the action.

As a control or balance, the calculator keeps our complicated systems functioning.

It determines the logistics of raw material, its inventory and flow; history and performance of tools, and of personnel –

Production rate and quality; public utilities rates and flow – cost accounting – pay rolls – billing – and all the ramifications of insurance; and in addition, presents the broadest possible basis for making decision.

As a function of design, the calculator provides creative man a higher platform upon which to stand – and from which to work.

Data processing removes the drudgery but imposes new and broad responsibilities.

The designer must be able to state precisely what it is he needs to know. This is not always so easy.

He must formulate a general plan or procedure; the plan or program takes the greater part of all the time involved.

He must write a concise step by step list of instructions, translate it into a digestible code and feed it to the computer.

Then he must provide the machine with all pertinent background information and related data.

The preparation may have taken months – the actual calculation hours – or even minutes.

But once set up, it can attack the problem with infinite variations and trustworthy memory.

Perhaps the most challenging use of the computer is the simulation of real situations.

If, for example, a machine is properly programmed, and is provided with sufficient numerical data concerning a chemical plant ......

Then the computer begins to take on the functions of a working mathematical model of that chemical plant – in which it is possible to determine the probable effects of many possible courses of action.

Today there are working mathematical models of railroad systems, rocket engines, complete reactors, and whole living communities.

The calculator is helping to define society's most complicated problems.

It is a tool for turning inspiration into fruitful prediction.

As an information machine it has done much to broaden the base of our growing concepts.

But the real miracle is the promise that there will also be room for those smallest details that have been the basis for man's most rewarding wishes.

This is the story of a technique in the service of mankind.

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