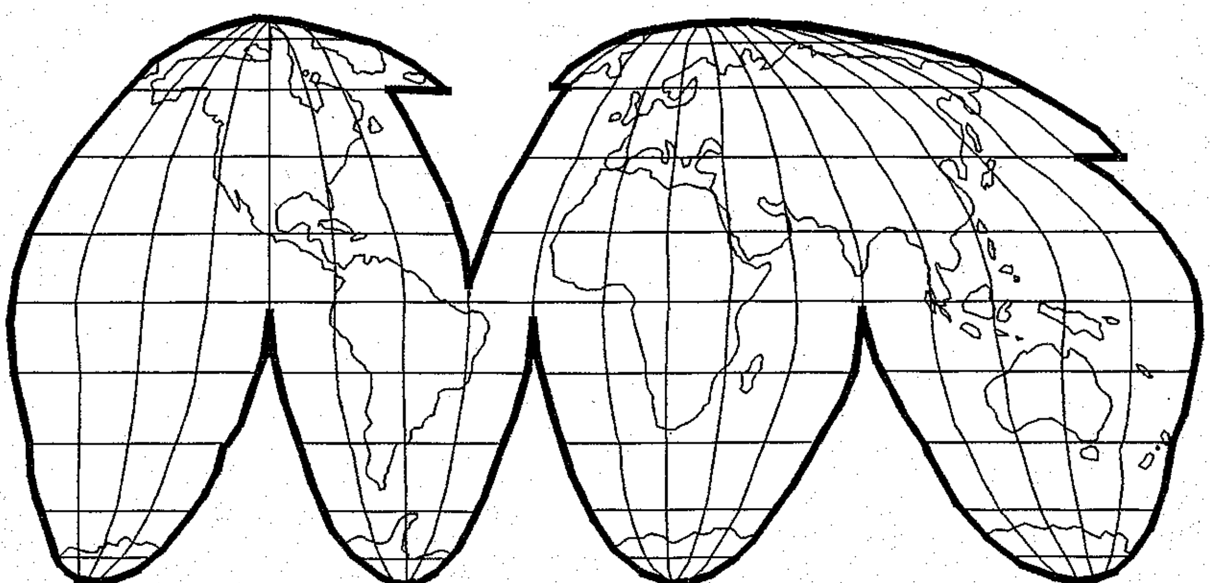
PRINCIPLES OF COMMUNICATION



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Principles of Communication

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Preface

Communication pervades every aspect of human experience, and, indeed, human experience itself is a form of communication between people and their environment. There is virtually no limit to the number of aspects of communication that may interest scholars from time to time, nor to the approaches to understanding communication that may be employed.

Among the major approaches to the study of communication is the scientific approach. This volume brings together examples of some of the more important aspects of communication that are studied by scientists, and illustrates some of the techniques on which those investigations are founded. In the first chapter, George Barnett describes the important concept of communication networks. His chapter describes the elements of the theory of communication networks and the way they process information, with an emphasis on the role of mathematics and empirical research. Frank Tutzauer introduces the concept of bargaining and negotiation, and shows how game theory and mathematical models interact with empirical research to develop understandings of how people reach agreements in situations of conflict. Woelfel discusses recent developments in neural networks, and shows how artificial neural networks, patterned after some fundamental biological odels, help measure and understand communication processes. Woelfel and Richards describe these theories of cognitive processes drawn from neuroscience, psychology and computer science in greater depth, and show how they relate to human perception and cognition.

Tom Jacobson examines the explosive development of information systems in modern society. In all of these essays, the central role of communication provides a common thread. While by no means exhausting the vast range of topics and techniques communication scientists consider and employ, these essays provide useful illustrations of how scientists approach the study of communication. Most importantly, all three essays show the role of fundamental communication theory, the roles of information flowing through networks, the role of mathematics in symbolizing the essential features of communication, and the role of observation and empirical research in the formation and revision of communication theory.

jw
Amherst, NY
June 4, 1992

Chapter I

Communication and the Diffusion of Information

George A. Barnett

What is communication?

Communication may be defined as the process by which information is exchanged among two or more systems that exist within a common environment. When the system is composed of people, one goal or purpose of the information exchange is to reduce the uncertainty of the future states of the interacting systems. To help you understand this definition, each of its terms will be described in more detail.

Process is simply change over time. Variables, such as an attitude, behavior or individual's knowledge, change during a given period of time. Communication scientists typically measure one or more of these variables at a number of points in time and then plot them on the Y-axis and time on the X-axis. Such a plot is presented as Figure 1. Then, they determine the function which describes the relationship between the variable (attitude, behavior or knowledge) and time. In mathematical terms, $Y = f(X)$. The function in Figure 1 is simply $Y = bX$, where Y is the attitude, behavior or knowledge, X is time, and b is the slope of the resulting equation.

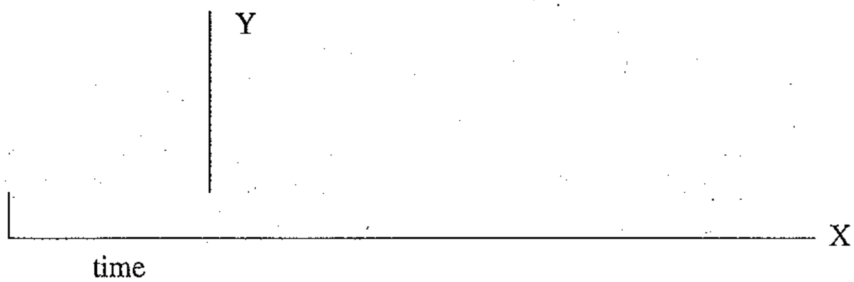


Figure 1
Variable Plotted Against Time

Because communication is a process, we must examine how variables such as attitudes, behaviors or knowledge change as a function of time. Changes in attitudes, behavior and knowledge are the result of the information that systems receive. The slope of the function described above, b, may be determined through a statistical technique known as regression analysis. Because the slope describes the rate of change in variable X, once the function (relationship) is known, precise predictions can be made about the state of variable Y at any point in time. When the intervals of time between the measurements are infinitely small, slope is also known as a derivative. It is often presented as dy/dt. The derivative tells us the velocity or rate of change in the variable. The change in the slope (derivative) for a given period of time (the second derivative ($[d^2 y / dt^2]$) tells us the acceleration in the variable.

Information may be described as patterns in matter or the flow of energy which reduces uncertainty in the future state of the interacting systems. For example, a memo is made up of black dots of ink on white paper. Together, these dots form a pattern, which we recognize as words. The pattern of words compose a message which may inform us about the future and thus reduce our uncertainty. Likewise, we could have received the message via the telephone. In that case, the patterns would have emerged from the sounds produced by patterns of electrical energy rather than on the material-paper.

When the systems include people, meaning may be attributed to the information. Communication scientists examine the code system or language used to communicate the information. Traditionally, the concept of **meaning** or **symbolic meaning** has often substituted for the term information. In that case an alternative definition of communication may be, "a process by which symbolic meaning is exchanged among people."

Communication scientists typically use **Information Theory** when discussing this information. Information Theory deals with the principle that systems are measured in terms of the probability distribution of a state of occurrence, such as an individual holding a certain attitude. Basic to information theory is the concept of **entropy**, which refers to the lack of order. A system with low entropy is one with a great deal of order, predictability and certainty. It has a lower potential for an individual to reduce his/her uncertainty through additional information.

Mathematically, entropy is defined as:

$$H_n = -\sum p_i \log_n p_i$$

where, H_n is the amount of information provided by n bits, p_i is the probability of that a system will be in state i and R the sum of the information of the individual bits.

Information is simply negative entropy, -H, or the mean predictability in a system. H is an informational quantity describing how much uncertainty there is in the state of a system. When entropy increases, the system has departed further from a defined state of order or perfect predictability.

In order to determine the amount of information in a message, we must know the total number of different messages that are possible for the source. For simplicity, assume that the message source is a computer and that all messages are in a binary code consisting of only two signals, "1" and "0". How many different messages can be sent? If the length of the message is unlimited, the number of potential messages is infinite. However, if we consider messages of only a certain length, say n signals, we can say that there are 2^n unique messages, n signals long.

For example, there are 16 possible messages if we allow the message to be 4 signals long ($2^4 = 16$). We could, therefore, take the number 2^n as a measure of the amount of information such a message contains. But, communication scientists have decided to take another number derived from 2^n because it is more convenient (The numbers are smaller and the function is linear.). That number is the logarithm of 2^n.

A message n units long is composed of n_1 "1's" and n_2 "0's", so that $n_1 + n_2 = n$. Suppose that the message n signals long is composed of 75% "1's" and 25% "0's". That is, the probability of an individual message will be .75 "1" and .25 "0". The probability that the n_1 "1's" and the n_2 "0's" arranged in a particular way (an unique message) will be $(.75)^* n_1 * (.25) * n_2$. The logarithm of the reciprocal of this number to the base 2 is the measure of the amount of information in the message. The logarithm is equal to $-n_1 \log_2 (.75) - n_2 \log_2 (.25)$.

This represents the amount of information for a particular message. To determine the amount of information of an average message n signals long coming from the source we substitute n_1 and n_2 for their average values, averaged over a great many messages. Thus,

$$H = (-p_1 \log p_1)(-p_2 \log p_2) \ldots (-p_n \log p_n)$$

or

$$H_n = -\sum p_i \log_n p_i$$

The concept of **exchange** means that there is a symmetrical two-way flow of information between the interacting systems. Either system may initiate the interaction with a message, and the volume and rate of flow originating from the components are relatively equivalent.

The concept, exchange, may be replaced by the term **transfer**. Transfer implies that the flow of information is primarily one-way, from a particular **source** to a **receiver**, i.e., communication is asymmetrical. This may be more appropriate when analyzing mass communication systems which typically **encode** (send) more messages than they **decode** (receive). In this case, communication may be considered as the information transferred from a source (the television or radio station) to a receiver (the audience); and **feedback**, the information sent back from the receiver to the source in response to the initial message. As will become obvious later when we discuss models of communication, I prefer the term exchange because it suggests that the interactants can simultaneously act as both a source and a receiver.

A **system** is a set of interdependent components or parts. These components may be individuals, groups or machines, such as computers. They could even be any interrelated set of objects, such as the words that make up a language. Together, the sum of the parts produce a set of emergent properties that could not result if the components behaved independently. An example of an emergent property is culture. Culture is a property of a group. Individuals do not have culture, they only manifest the influence of the group on their thoughts and behaviors.

Social organizations are generally considered goal-seeking systems. The components' interdependent behaviors make it possible for the organization to achieve its goals, such as manufacturing a product or performing a service. These products or services are some of the emergent properties of organizations. Communication makes the interdependency and achievement of system goals possible. It facilitates the coordination of the components' activities.

The **environment** is the context in which the systems exist. It is everything that is external to the interactants, which has an influence over their cognitive states and behaviors. Thus, the environment affects the process of communication. It determines the code system the systems use to communicate, the subject matter that they communicate, and the meanings they attribute to the information they receive.

There is little agreement about whether communication purposeful or not. In certain situations, the person who initiates the interaction may have a purpose or goal in mind. At other times, he/she might not.

The concept of purpose is a philosophical issue beyond the scope of this chapter. It arises in communication because the discipline's early history begins with the ancient Greek philosophers. One of the greatest of the Greeks was Aristotle, who attributed purpose or goal-seeking behavior to <u>all</u> animate and inanimate objects. More recently, one of the central foci of communication research has been the area of persuasion. In this case, the source communicates with the goal of changing receivers' attitudes or behaviors. Also, one of the contexts in which communication is examined is the formal organization, which exist for a specific purpose, e.g., to make a profit or to provide social services. In this context, communication typically serves two functions: to facilitate the completion of tasks, or to display emotions.

In spite of the number of cases that we have discussed in which communication serves a purpose, we can identify others in which it may not have a goal. For example, communication among the members of a family or between a boy and his dog. In the Information Age, a great deal of communication occurs among computers. Are they exchanging information with a purpose in mind?

Models of Communication

This section of the chapter discusses a number of models of communication. A **model** is an abstract representation of some aspect of a theory. Further, models may serve as classification systems that enable one to abstract and to categorize the potentially relevant parts of a process. In this case, they help establish boundaries to the question, "What does communication entail?" and to organize the components of the process. They simplify the process of communication by facilitating the identification of the variables and the relationships to consider when analyzing the phenomenon. When presented graphically, they visually represent the relationships among the factors involved in the communication process.

As a field of inquiry, communication has evolved from a variety of academic disciplines in both the humanities and sciences, both natural and social. They range from rhetoric, speech, English, journalism, law, and linguistics at the humanistic end of the spectrum; through the social sciences (anthropology, political science, sociology, economics, and psychology) and management; to electrical engineering and cognitive, computer and systems science, and mathematics at the scientific end. Traditionally, Communication cut across all these fields. While its focus is the process and effects of information exchange, all these orientations have provided different perspectives from which to analyze the process of communication. As a result, a number of different models of communication will be presented here.

There is no best model of communication. They all should serve as different vantage points for identifying those concepts, variables, and relationships that affect the process of communication. Each model describes the process in a different context. As a result, they provide unique insights in the communication process. The models presented here should be considered together when asking questions and interpreting observations about communication.

Lasswell's Model

One of the earliest models of communication was developed by Harold Lasswell (1948).

Who

Says What

In Which Channel

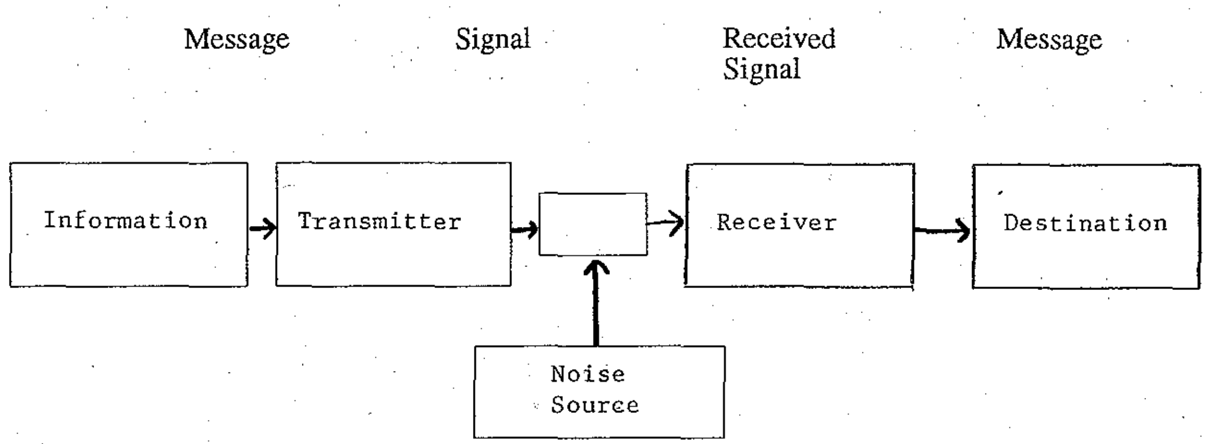
To Whom and

With What Effect?

Lasswell's model may be applied to a formal organization. For example, a research analyst (who) presents business information for internal and external users (says what), generally in written reports (which channel), to decision-makers (to whom), with the goal of providing reliable, relevant and timely data for making informed business decisions (the effect). This model is simple and graphic but lacks a number of elements necessary for an understanding of the communication process.

The Shannon-Weaver Model

Claude Shannon and Warren Weaver (1949) developed the mathematical model of communication presented in Figure 2. The model was developed to describe communication over a mediated device, such as a telephone. It represents a conceptual advance because it differentiates between the information source, the transmitter, the receiver, and the destination. In telephony, an individual is the source and the telephone is the transmitter. Likewise, the telephone is also the receiver and an individual is the ultimate destination. In the case of the formal organization, the source may be a bookkeeper or a clerk; the transmitter, a comptroller; the receiver, the person who obtains the documents, such as an accountant; and the destination, the ultimate user -- a client.



Shannon and Weaver also add noise into the communication process. **Noise** is any stimuli which contributes to the distortion of the information transfer. It may lead to a breakdown in communication. Static in a telephone line is noise. The Shannon-Weaver model as presented, lacks the critical notion of feedback (the exchange of information, rather than the one-way transfer of information), and the context or environment in which the process takes place. But these shortcomings may be easily rectified by adding the mirror image to the model.

Gerbner's Model

George Gerbner's (1956) model graphically depicts the role of perception and representation in the process of communication. An event E is perceived by person M. The event as perceived (E^1) is the product of perceptual activity. Thus, the mediation and transformations of particular selective and contextual factors introduce differences between E and E^1.

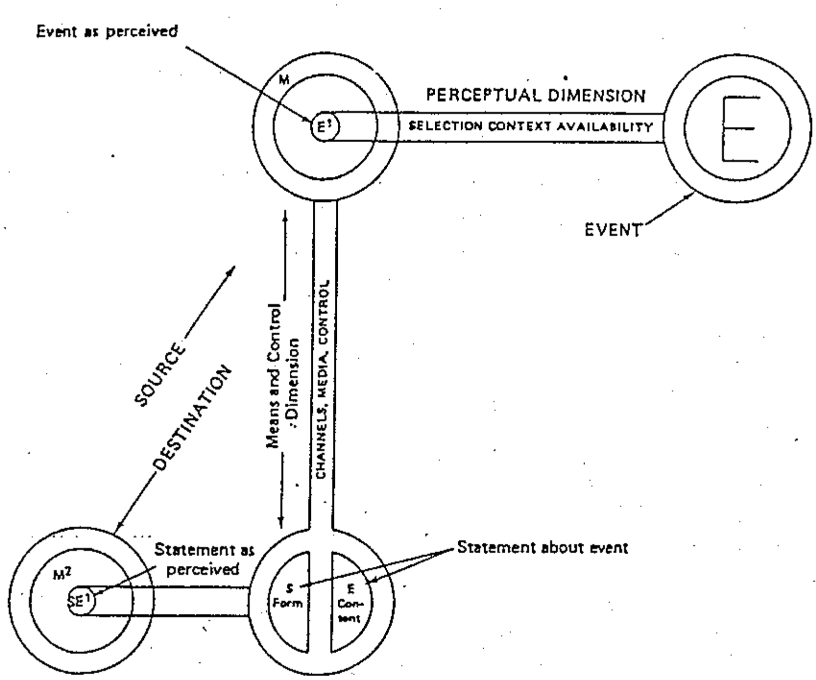
The vertical arm of the model shows the representation of the event (statements about the event) by the perceiver to be a product of the available media (print, speech, radio, television or film) and of the particular conventions of use of these systems. The way in which the media is used is determined by social and historical contingencies. These elements of form (S) combine with event-related elements (E).

Finally, the lower horizontal arm shows this representation, the statement about the event (SE), being perceived by a second person (M^2). This perceptual activity involves a transformation such that the differences between SE and SE^1 occur.

Gerbner's model is significant because it makes explicit the role of perception in the communication process. Also, the model shows the relationship of language to reality and thought, the nature of different forms of representation, and the problems which follow from considering form as separate from content. The model has implications for the study of mass communication because it suggests that it is difficult, if not the impossible to achieve objectivity in reporting events through the media.

The Westley-MacLean Model

Bruce Wesley and Malcolm MacLean's Model for communication research (1957), presented in Figure 4, has a number of important implications. It was developed to describe the journalistic process of reporting and presenting a new item to the public. The model describes the ways in which individuals and organizations decide which messages are communicated, and how they are modified or deleted in the process.

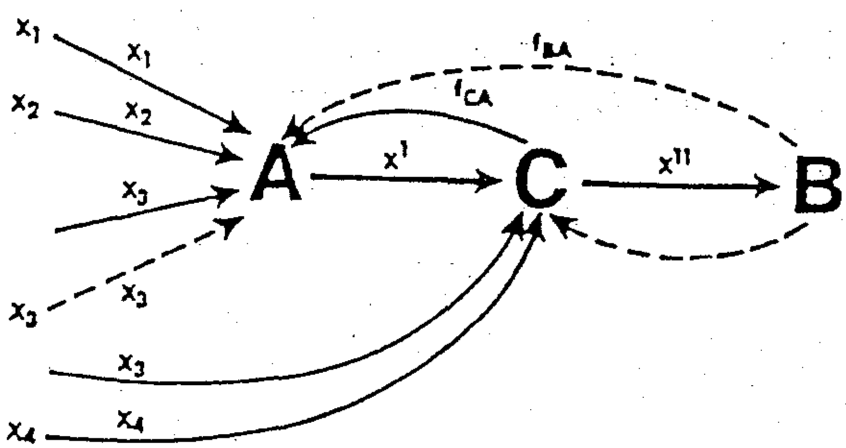


Person(s) A receive(s) stimuli X_i, from the environment. The process of reporting these events is imperfect. There are omissions and additions caused by selective perception and distortion resulting from A's bias due to his/her relative position as an observer. A then produces a message, X^1, and communicates it to C. C is an editor or **gatekeeper**. In formal organizations, secretaries typical act as gatekeepers between their boss and the rest of the organization and the environment. They select the message X^1 to communicate to the eventual audience, B (readers or the boss). The gatekeeper, C, modifies the message as he sees fit based upon the stimuli, he/she receives from the environment.

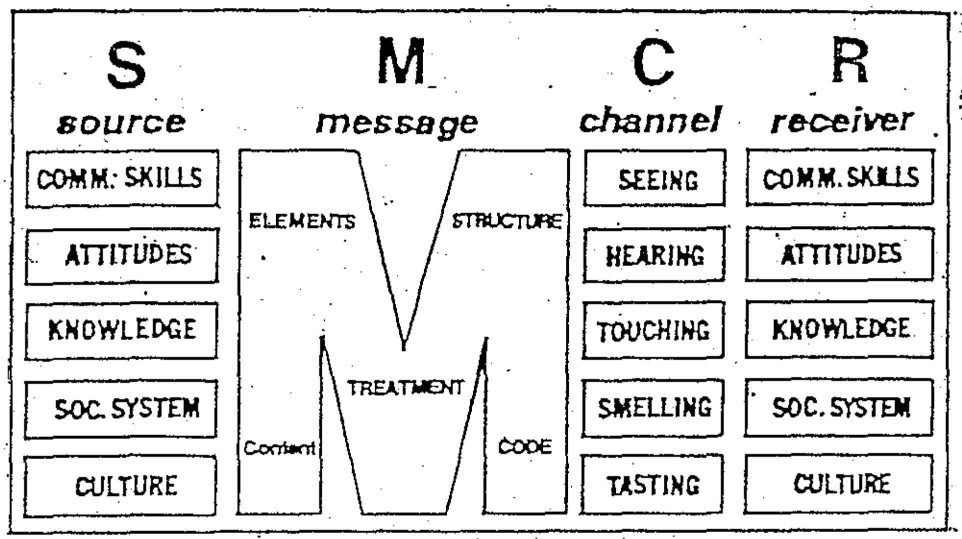
Due to his/her unique position as an observer some environmental stimuli may be unique such as X_4, and some of these may be the same as A received, such as X_3. C receives additional information in the form of feedback, f_{bc}, from the eventual audience. Likewise, A may receive feedback from C (f_{ca}), which may impact on their future communication.

<u>Berlo's SMCR Model</u>

The SMCR (source, message, channel, receiver) model of communication proposed by David Berlo (1960) has many of the same faults as the earlier models. It is shown as Figure 3. It suggests a one-way flow of information from a source to a receiver without feedback, and it excludes the concept of noise. However, Berlo specifies the factors which influence the fidelity (accuracy) of communication and at which stage in the process these factors operate.



For example, when considering the MESSAGE, he suggests that the elements of the message--its content, structure, code, and treatment--will influence its understanding by the receiver. While Berlo describes CHANNEL in terms of the some combination of the senses, channel could also be thought of as the medium of communication. Television, radio, print, computers and interpersonal communication use a somewhat different combination of senses. Further, while not explicitly discussing the context in which the process occurs, the model indicates that the source's and receiver's social systems and cultures, as well as the code system in which the message is constructed, do affect the fidelity of the communication process. These notions are especially important for intercultural communication which must take into account the different cultures and the social systems of the interactants.



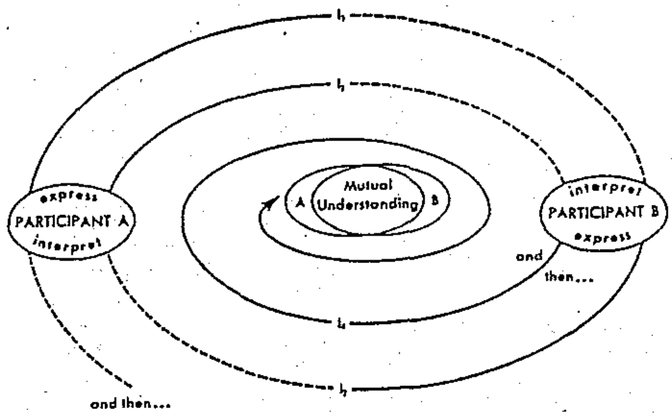
The Convergence Model of Communication

Everett Rogers and Larry Kincaid (1981) have criticized the aforementioned models because they lead to seven biases. They are:

1) A view of communication as a linear, one-way act, rather than a cyclical, two-way process in which information is exchanged over time.
2) A source bias. The model stresses the receiver's dependency, rather than focusing on the relationship of those who communicate and their fundamental interdependency. Typically, in traditional models the receiver is dependent upon the information the source transfers to him/her. There need not be interaction.
3) A tendency to focus on the objects of communication as simple, isolated physical objects, at the expense of the context in which they exist.
4) A tendency to focus on the messages per se at the expense of silence, and timing of messages.
5) A tendency to consider the primary function of communication to be persuasion, rather than mutual understanding, consensus and collective action.
6) A tendency to concentrate on the psychological effects of communication on separate individuals, rather than on the social effects and the relationships among individuals within networks. Networks will be explained later in the chapter.
7) A belief in one-way mechanistic causation, rather than the mutual causation that characterizes human information systems, which are fundamentally cybernetic.

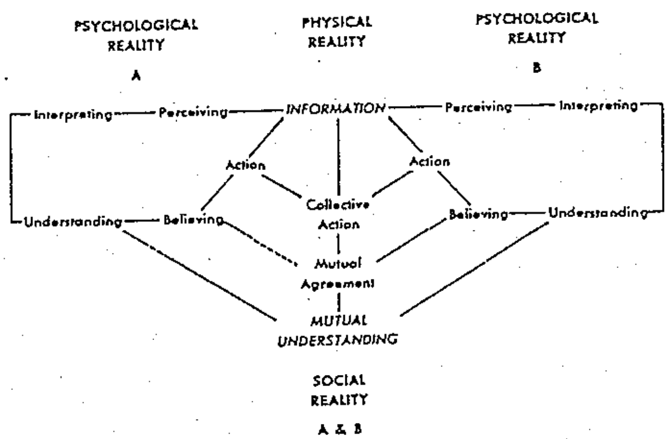
As an alternative to the biased models Larry Kincaid and associates (Everett Rogers, June Yum, Joseph Woelfel and George Barnett) propose the Convergence Model of Communication. Two graphic representations of the model are presented as Figures 5 and 6. The model stresses the unity of information and action. All information is a consequence of action; through information processing, action may result in additional information. The model has no beginning or end. Only the mutually defining relationship among the parts gives meaning to the whole. When information is shared by two or more participants, information processing may lead to mutual understanding, agreement and collective action, such as solving group problems.

Figure 2–5. A Convergence Model of Communication.



Note: Communication is a process in which participants create and share information with one another in order to reach a mutual understanding. This cyclical process involves giving meaning to information that is exchanged between two or more individuals as they move toward convergence. Convergence is the tendency for two or more individuals to move toward one point, or for one individual to move toward another, and to unite in a common interest or focus.

Figure 2–3. Basic Components of the Convergence Model of Communication.



Note: Information and mutual understanding are the dominant components of the convergence model of communication. Information shared by two or more participants in the communication process may lead to collective action, mutual agreement, and mutual understanding.

One consequence of this model is that communication always implies a relationship, a mutual process of information sharing among two or more people. Consequently, the analysis of communication must take into account the interactant's differences and similarities, and for our purposes, changes in the relations among the interactants over time. Thus, the notion of the environment in which communication takes place becomes increasingly important because it includes the interpersonal context.

How Information Diffuses Through Social Systems

One phenomenon that communication scientists study is the process by which new ideas, products and practices diffuse or spread through social systems. Generally, the **diffusion** process involves a combination of the mass media and interpersonal communication. Once, it was thought that new ideas were spread directly via mass communication--both electronic--radio, television and film, and print--books, magazines and newspapers. **The hypodermic needle or direct effects model** proposed that the mass media had a direct, immediate and powerful effect on its audience. It was a one-step flow model. The message went from the media source directly to all members of society, without being mediate by other people. The direct effects model is presented below as Figure 7.

Mass Media -----------> Audience

Figure 7

The Direct Effects Model

Research by Paul Lazarsfeld and associates in the 1940s found that the Direct Effects Model was incorrect. The results of their research on how people in Elmira, New York make up their minds for whom to vote, revealed that ideas flow from the mass media (at that time radio and print) to **opinion leaders** and from these individuals to others who were less active in the information retrieval process.

This has become known as the **Two-step Flow Model**. The first step is from the media source to opinion leaders. This is primarily a transfer of information. The second step, from the opinion leaders to the general public, involves the communication of influence. The opinion leaders act as gatekeepers and add their interpretations to the information they gained from the media before passing it along to the public. **Gatekeepers** are people or institutions who restrict the flow of information. They may act consciously, such as censors, or unconsciously, through selective perception.. The Two-step Flow Model is displayed below as Figure 8.

Mass Media ----> Opinion Leaders -------> Audience

Figure 8

The Two-step Flow Model

Today, communication scientists use the **Multi-Step Flow Model** to describe the process of information diffusion. It indicates that some people receive information directly from the mass media while others receive information from other individuals in their social network. The later individuals may be many steps removed from the original source of the information, depending on their location in the social structure and their position in the communication network, as well as the availability of the media, the nature of the message, and the differential salience of the message to the individual members of the social system.

Communication Networks

Now that the role of the mass media in the diffusion process has been described, we can turn our attention to the role of the communication network. The term **communication network** describes the relationship among the members of a social system based upon the communication among the members. When discussing communication networks, the members are generally called **nodes** and the relationships, **links**. It should be noted, however, that the examination of the information flows of a system may involve components other than people. The components may be individuals. Or, they may be the mass media, small groups, computers, entire organizations or even cities or countries, when examining the flow of information among cities or countries.

Recent research has generalized the study of networks to include any type of relationship among any members of a system. Examples include semantic networks, where communication scientists study the relations among a system of symbols; and cognitive or neural networks, where they study the time-ordered relationships among stimuli, an information processing device, such as a computer or the human brain, and a behavioral outcome.

The relationships among the members of a social system define the **communication structure** and may be identified through network analysis. **Network analysis** is a set of research methods for identifying emergent patterns in social systems based upon the transfer (or exchange) of information among the parts of a social system. Formal mathematical procedures exist to calculate descriptive indices which may be used to predict a number of social implications. Some network methods provide a graphic description or **sociogram** of the communication structure, and others define network roles, such as, isolate, group member, liaison and tree node. These roles are described in the sociogram is presented in Figure 9. It shows the pattern of communication within the system and various network roles.

Bill Richard's NEGOPY computer program, the most widely used software to describe communication networks identifies seven different communication roles. They are defined as follows:

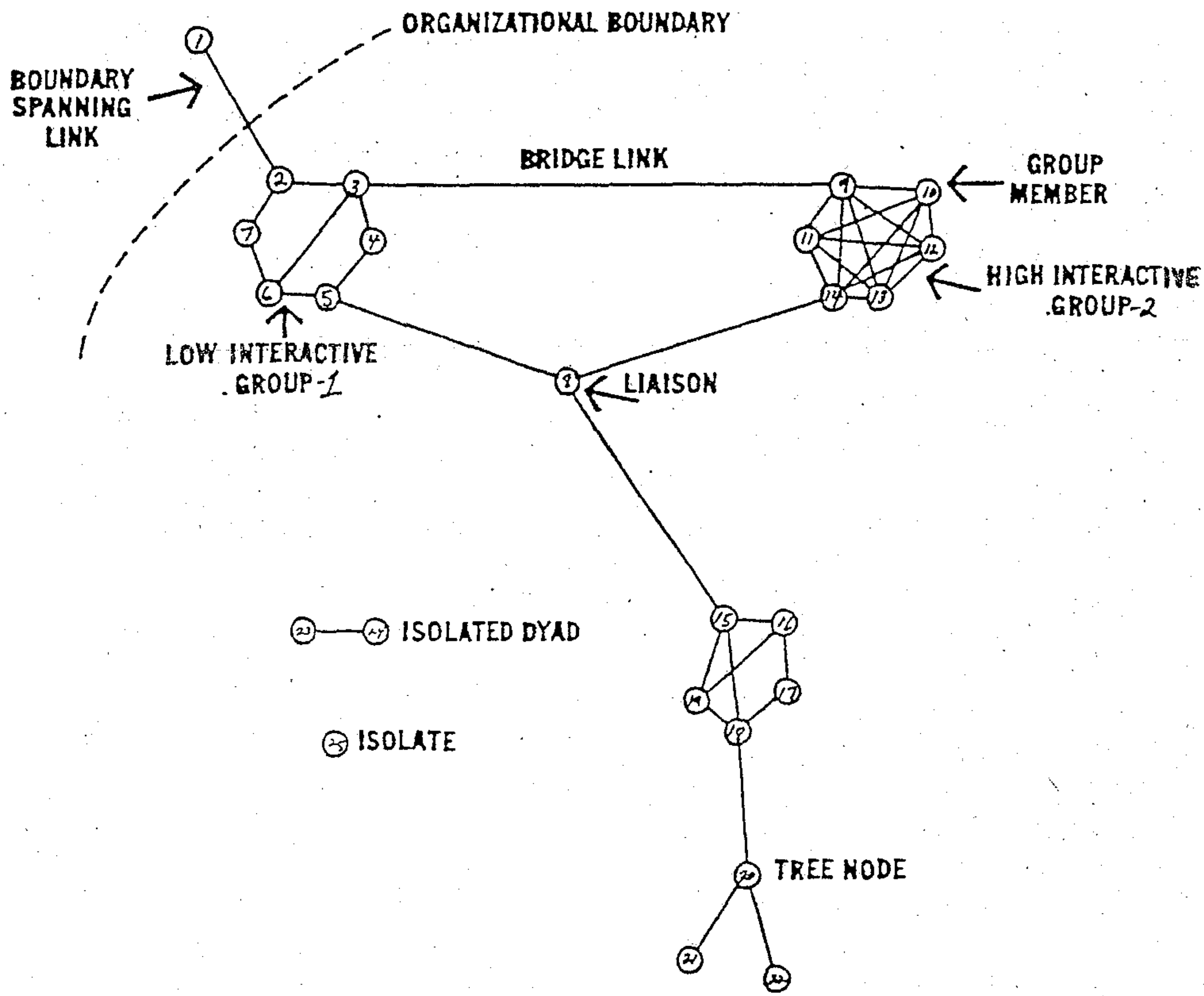
1. **Isolate Type 1**--This individual has no links (#25).

2. **Isolate Type 2**--This individual has only one link (#21 and #22).

3. **Isolated Dyad**--A pair of people who communicate only to each other (#23 and #24).

4. **Tree Structure**--An isolate type 2 has only one link. If one or more of these isolates is attached to the first one, this first one is called a tree node, and the whole structure (tree nodes [#20] and isolates [#21 and #22]) a tree structure.

5. **Liaison Type 1**--(**Direct Liaison**) A person who has more than 50% of his communication with members of groups, but not with members of any single group. They link groups directly (#8).


ORGANIZATIONAL BOUNDARY
BOUNDARY SPANNING LINK
BRIDGE LINK
GROUP MEMBER
HIGH INTERACTIVE GROUP-2
LOW INTERACTIVE GROUP-1
LIAISON
ISOLATED DYAD
ISOLATE
TREE NODE

6. **Liaison Type 2**--(**Indirect Liaison**) A person who has less than 50% of his communication with members of groups. Most links will be with other liaisons. They connect groups indirectly. There is no indirect liaison shown in Figure 9.

7. **Group Member**-- A person who has more than 50% of his communication with other members of the same group. A **group** is a set of at least three people all of which are connected by a link entirely within the group. There must be no node which, if removed, causes any of the conditions not to be met. He must have at least two links with other members (#2-7, #9-18).

So, why do communication scientists study networks? First, a precise description of the communication network makes it possible to determine the pattern by which information flows through society. For example, consider node #1 as the mass media. Node #2 receives a news item and then passes it on to #3 and #7. They may pass it on to #4 and #6 who in turn communicate the story to node #5. The message may spread to another group through #3's bridge link to #9 or from #5 through liaison #8 to the other groups which compose the social system. Given this sociogram, nodes #21 and #22 would be the last to learn the information, and isolated nodes #23, #24 and #25 may never learn the information. It should be noted that people can learn about novel ideas in ways other than direct interpersonal communication or from the mass media. For example, people may learn about them through observing the behavior of individuals with whom they don't communicate.

Second, it has been determined that one's position in the communication network makes a difference in their attitudes, behaviors and knowledge. For example, isolates are typically the last to find out about a new product because they are not in contact with the other members of the system. Liaisons usually serve the function of opinion leader. That is, they are influential with the other members of the social system because they possess information about a number of topics. The reason they possess the information is due to their position in the information flow among the members.

Group members generally have uniform opinions. This is due to the fact that, as a group, they are interconnected. The majority of their communication is with other group members. Thus, there is only limited contact with non-group members. The convergence model of communication would suggest that, over time, the members of the group would converge on a common set of attitudes, values, beliefs and knowledge.

In addition to defining the members' communication roles, network analysis provides indicators which describe a social system's structure. These indicators may be for the system as a whole, for the groups which are identified from the network analysis, or for individuals which compose the social system. One of these indicators is **connectedness**, or **density**. System density is the degree to which the members of a system communicate with one another. Mathematically, it is the number of actual contacts divided by the number of possible contacts.

$$\text{System Density} = \frac{\text{contacts}}{N * (N-1)/2}$$

where, N is equal to the number of members in the system. Connectedness has important implications for how quickly information flows in the social system. The greater the density, the faster the diffusion of information.

Another descriptive indicator of an social system's communication structure is **system integration.** It is the average of the degree to which units linked to a focal unit are linked to each other. Integration describes the likelihood of the members receiving information that they have already received. In Figure 9, Group #1 is less integrated than Group #2. Integration also indicates how open the system is to new information. Communication patterns of highly-interconnected personal networks discourage the exchange of new information because they lack openness. Integrated networks (Group #2) simply facilitate the sharing of ignorance among individuals. The degree of integration is negatively related to the potential for the exchange of novel information and therefore, impedes the diffusion of new ideas in society.

Related to system integration is **openness**. Openness is the degree to which the members of a system are linked to nodes external to the system. In Figure 9, node #1 is external to the system. Mathematically, openness is the number of links that cross the system's boundary into the environment, divided by the total number of possible links. The more open a system, the greater its likelihood of receiving novel ideas. For the system in figure 9, the openness is 1/38, or .026.

As indicated form the examples above, network analysis can provide descriptive indices of the communication of the groups it identifies. These indicators are useful when examining the flow of information between groups. One such indicator is **group connectedness**, the degree to which a group in the system is connected to others. For example, work groups with gatekeepers (bridges) who communicate a great deal with their colleagues-- both internal and external to the group-- perform better than those where they have few communication links.

Another index is **average group connectedness.** This is the number of links of the members of the group to other group members divided by the number of possible links [N(N-1)/2]. For example, in Group #1 there are 7 links and 15 possible links [6(5)/2]. Therefore, the group connectedness is 7/15 or .467. For Group #2 , average group connectedess is 15/15 or 1.0.

Additionally, one can examine **group integration**, i.e., the degree to which the groups linked to a focal group are linked to one another. Similar to analyzes at the system level, one can determine **group openness**. It is the degree to which group members are linked to others outside the group.

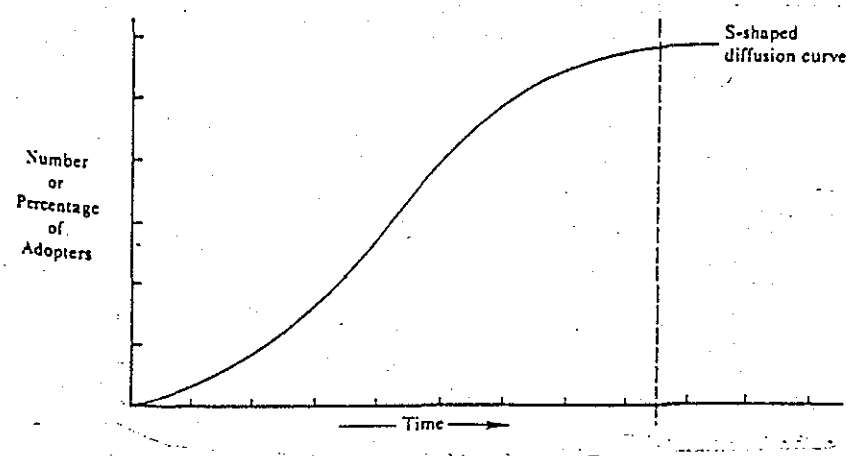
Centrality is the average distance from a focal group to all of others in a network, such that the smaller the distance relative to the other members, the more central the unit. Distance may be taken to be the number of links that must be crossed in order for the group to communicate with all other groups in the system. Among other variables, centrality has been found to be related to member satisfaction, such that, the more central a node the greater his/her satisfaction with the group process. Without going into the mathematics, #8 is the most central node in Figure 9.

At the individual level, the network analyst may examine the connectedness, integration and centrality of individuals. These indices make it possible to answer the following questions: Does the individual have contacts with those people with new information? Is an individual's level of integration too great, thus restricting his/her ability to receive novel information? And, how central is the individual in the information flows of society?

The Diffusion of Information Over Time

The process by which a society's members learning about and adopt novel new products, practices or ideas, may be described in the same manner the other processes discussed at the beginning of this chapter. The total number of individuals who know the new information may be plotted as variable Y on a graph with respect to time. Again, time is represented by the X-axis. This results in an S-shaped curve. It is known as the diffusion curve.

At first, only a few individuals know the information or adopt an innovation. The rate of knowledge gain or adoption is very slow and is represented by a small positive slope. Then, the rate increases at an increasing rate until about half the members of society know about the new information (adopt the innovation). After this point, additional non-knowers become knowers (potential adopters become adopters), but at a decreasing rate. Although still positive, the slope becomes smaller approaches zero as fewer and fewer new people learn the information (adopt), until all the members of the social system learn about the new product, practice or idea (or adopt it). The S-shaped diffusion curve is present in Figure 10.



While an S-shaped pattern of learning or adoption may be used to describe most information (innovations), there is variation in the slope among specific innovations. Some new ideas spread very rapidly, producing a steep curve. Others may diffuse very slowly, resulting in an adoption curve having a gradual grade. By examining the slope of the diffusion curve, communication scientists can predict the rate of adoption for various innovations. Once this is known, they can then determine why some information or innovations diffuse rapidly and others very slowly. Past research indicates that attributes of an innovation, along with characteristics of the adopting social system determine how quickly innovations diffuse. Some of the attributes of an innovation affecting adoption are its compatibility, triability, complexity, observability, perceive relative advantages, and relative costs.

The External-Influence Model

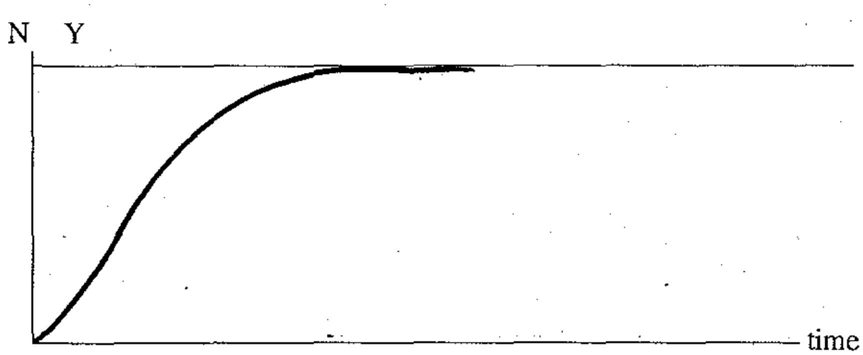
There have been a number of attempts to identify the function which describe the diffusion curve but they involve advanced mathematics and are beyond the scope of this discussion. However, three theoretically significant models will be discussed as simply as possible. For those how are interested, the models are discussed in detail by Mahajan and Peterson (1987).

The first model is known as the external-influence model. It is mathematically described by the formula below.

$$Y_{(t)} = N\,(1 - e^{-at})$$

$Y_{(t)}$ is the cumulative number of adopters (or knowers) at time t. N is the total number of potential adopters (or knowers) in the social system at time t. And, a represents the influence of an external source on the diffusion process. e is the natural log, approximately 2.718. While a is generally taken to be the influence of the mass media, it may also be the influence of government, change agents, or salespeople.

Over time, the cumulative number of adopters increases, but at a decreasing rate. This is because information comes only from a source external to the social system. Notice the similarities between this model and the direct effects model. The external-influence model does not produce an S-shaped curve, but rather a decaying exponential as displayed in Figure 11.



The external-influence model does not attribute any diffusion to the interaction among those who have adopted and those who have not. It is appropriate only in those instances where the social network is very sparse, when the information is taboo, or when information is available only from external sources. Because the model does not result in an S-shaped curve and because it is appropriate only under certain conditions, communication scientists have founds its value limited and generally rely on other models.

Internal-Influence Model

One model considered stronger than the external-influence model is the internal-influence model. The internal-influence model based on the assumption that diffusion occurs only through interpersonal communication, such as the social network described above.

$$Y_{(t)} = N/(1 + (N\text{-}N_{t0})/N_{t0})e^{-bNt}$$

$\underline{N}_{t0}$ is the number of knowers or adopters at time zero. Interpersonal interaction is represented by $\underline{N}_t$ ($\underline{N}$-$\underline{N}_t$). That is, the number of prior adopters times potential adopters. $\underline{b}$ is the degree of internal influence. This model results in the S-shaped curved described above. It is most appropriate to describe the diffusion process in those instances where the innovation is complex and observable, and the adopting social system is highly interconnected.

The Mixed-Influence Model

Realistically, the diffusion process takes place through a combination of external influences and interpersonal interactions. As a result, communication scientists have proposed the mixed-influence model. Conceptually, it is similar to the Multi-Step Flow Model discussed above.

$$Y_{(t)} = \frac{N - (a(N\text{-}N_{t0}))/(a+b\,N_{t0})\,e^{-(a+bN)(t-t0)}}{1 + b(N\text{-}N_{t0})/\,a+b\,N_{t0})\,e^{-(a+bN)(t-t0)}}$$

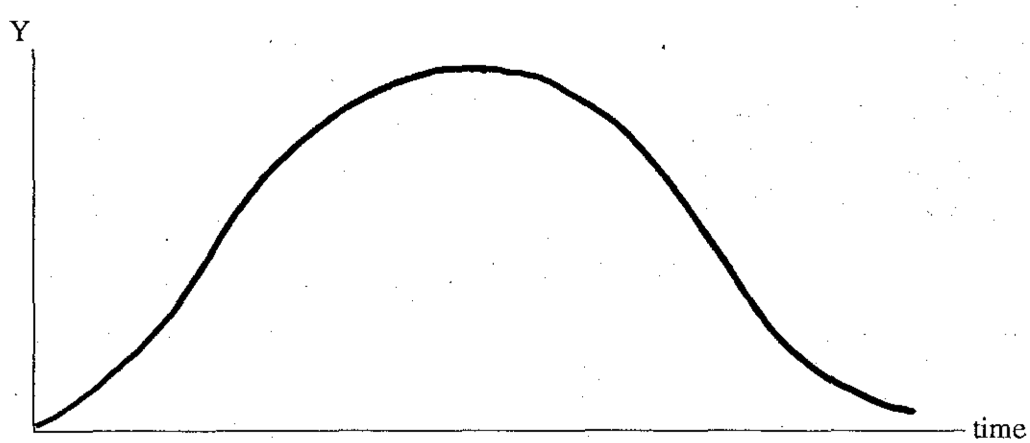
While these models are widely accepted by communication scientists, they are not without criticism. Foremost, they suffer from a pro-innovation bias. This implies that any innovation should be diffused and adopted by all members of society. The innovation should neither be reinvented (made appropriate for the individual or the setting), or rejected because it is inappropriate or simply a bad idea. Further, communication research is typically used to facilitate the process of diffusing innovations more rapidly.

One manifestation of this bias has been the focus of diffusion research on adoption to the neglect of disadoption. As a result, little is known about the disadoption process or what may be called social forgetting. There are two types of disadoption (discontinuance): replacement and disenchantment. A **replacement** discontinuance is a decision to cease using an innovation in order to adopt a better one. For example, vinyl records are in the process of being replaced by digital disks.

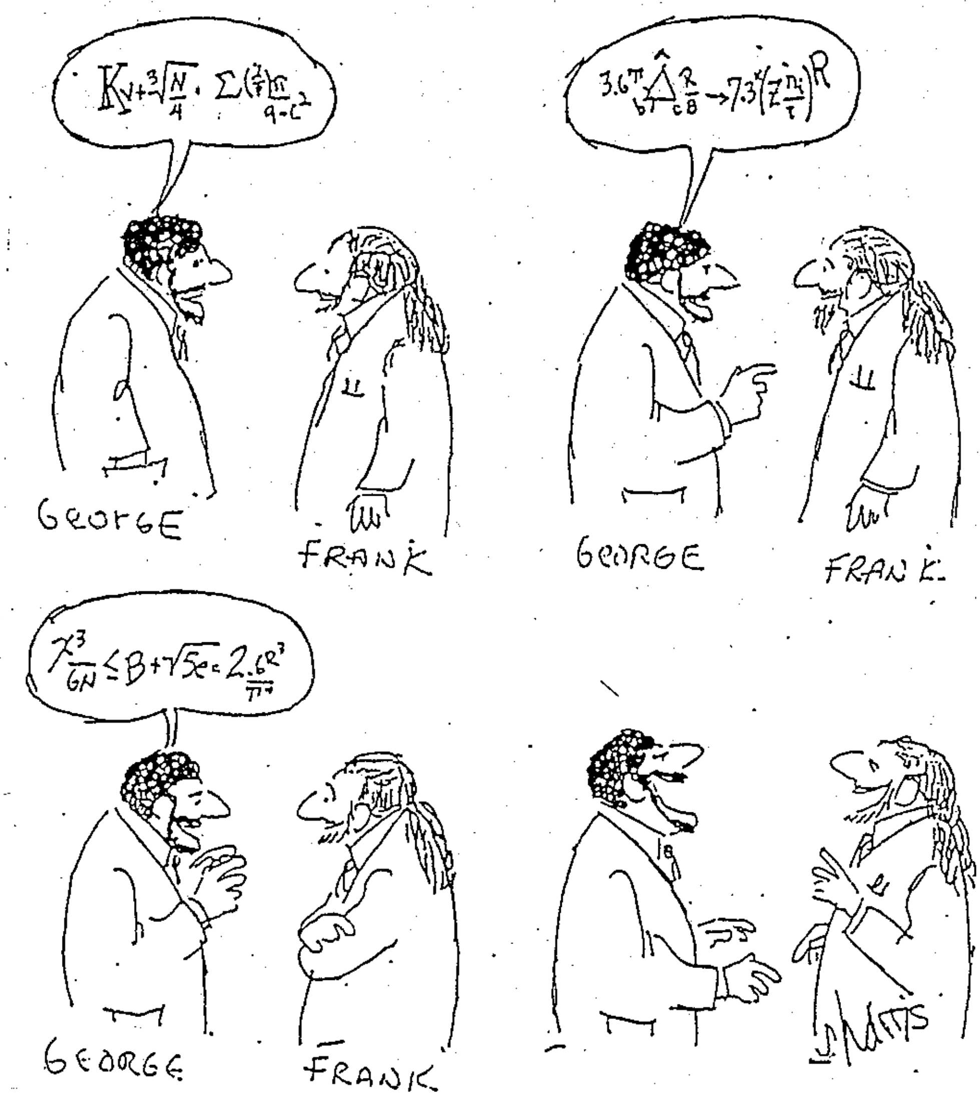
A **disenchantment** discontinuance is a decision to cease using an innovation as a result of dissatisfaction with its performance. The dissatisfaction may come about because the innovation is inappropriate for the individual, or society, and does not result in a perceived advantage over an alternative. For example, chemical fertilizers, pesticides and herbicides are being disadopted because people are becoming aware of their negative impact on the environment.

Another result of the pro-innovation bias has been the lack of mathematical models to describe the process by which a society adopts and disadopts a product, practice or idea. Recent research is being carried out to develop a general model to account for this process. Such a model would describe the curve presented in Figure 12.

This concludes the discussion on how novel information and innovations spreads through a society. When this chapter was written, I wanted to leave the impression that the process of communication can be studied in much the same way as scientists study other processes, that is through mathematical functions. Through the use of even quite simple mathematical models we can precisely describe the process of communication. These models make it possible for us to make accurate **predictions** about social behavior and



cognitive processes, and to evaluate the quality of our **explanations** about these phenomenon. Finally, they make it possible for us to intervene and **control** the diffusion of information and innovations in society.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Suggested Readings

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Chapter I: Exercises

1. Define the following terms in your own words.

   A. communication

   B. process

   C. system

   D. gatekeeper

   E. entropy

   F. feedback

2. What is information? (Give a verbal definition and the mathematical definition.)

3. In the space below, develop a model of communication with which you feel comfortable. discuss its strengths and weaknesses.

4. Differentiate between the Direct Effects, the Two-Step Flow, and the Multi-Step Flow Models of the Influence in explaining the influence of Mass Communication.

5. Choose one indicator that describes a communication network. What does it tell you? Discuss why you think that statistic is important in the study of the dissemination of information in society.

6. On the next page is a table which provides data on the average number of hours the average American household watched television per day. These data come from the A.C. Nielsen Company and are provided in monthly intervals from 1950 to 1989. Use these data to perform the following tasks:

   A. Plot the diffusion curve. Take the average (mean) for each year, 1950 to 1989. Graph the annual averages on the Y-axis against the year on the X-axis. Describe in your own words the diffusion of television.

   B. Take any two adjacent years, for example, 1968 and 1969. Graph the number of hours of household television viewing on the Y-axis against the month on the X-axis. The months should be scaled 1 to 24, with January (year 1) as 1, February (year 1) as 2 and so on. December (year 2) should be 24. Describe, in your own words, the pattern that you see in the graph.

39 YEARS OF NTI AVERAGE HOURS OF TV USAGE PER TV HOUSEHOLD PER DAY BY MONTH, SEASON, QUARTERS, QUADS & HALF YEARS*

SEASON	BY MONTH SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	ANNUAL AVERAGE	BY QUARTER SON	DJF	MAM	JJA	BY QUAD SOND	JFMA	MJJA	BY 1/2-YRS NOV APR	OTHER 6 MOS	NOV-APR % OF TOTAL
1950-51	4.34	5.10	5.31	4.99	5.49	5.39	5.58	5.12	4.30	3.96	3.52	3.57	4.72	4.92	5.29	5.00	3.68	4.94	5.40	3.84	5.31	4.13	56.3%
51-52	4.08	4.97	5.29	5.32	5.76	5.64	5.61	5.02	4.32	3.96	3.88	3.74	4.80	4.78	5.57	4.98	3.86	4.92	5.51	3.98	5.44	4.16	56.7
52-53	4.31	4.90	5.28	5.38	5.76	5.44	5.33	4.88	4.22	3.77	3.67	3.82	4.73	4.83	5.53	4.81	3.75	4.96	5.35	3.87	5.34	4.12	56.5
53-54	4.20	4.72	5.03	5.19	5.77	5.35	5.20	4.71	4.67	3.98	3.68	3.90	4.70	4.65	5.44	4.86	3.85	4.78	5.26	4.06	5.21	4.19	55.4
54-55	4.38	4.61	5.40	5.46	5.81	5.89	5.25	4.93	4.17	4.30	3.72	3.88	4.82	4.80	5.72	4.78	3.97	4.96	5.47	4.02	5.46	4.18	56.6
55-56	4.28	4.81	5.61	5.54	6.02	6.03	5.57	5.21	4.35	4.28	3.90	4.03	4.97	4.90	5.86	5.04	4.07	5.06	5.71	4.14	5.66	4.28	57.0
56-57	4.43	5.07	5.61	5.65	6.07	5.91	5.43	5.60	4.54	4.40	3.91	4.14	5.06	5.04	5.88	5.19	4.15	5.19	5.75	4.25	5.71	4.42	56.4
57-58	4.57	5.45	5.85	6.00	6.10	6.11	5.86	5.60	4.24	4.28	4.17	4.05	5.19	5.29	6.07	5.23	4.17	5.47	5.92	4.18	5.92	4.46	57.0
58-59	4.38	4.96	5.39	5.78	5.91	5.87	5.67	5.39	4.52	4.19	4.07	4.17	5.02	4.91	5.85	5.19	4.14	5.13	5.71	4.24	5.67	4.38	56.4
59-60	4.58	5.05	5.42	5.51	5.99	5.87	5.78	5.39	4.60	4.32	4.09	4.07	5.06	5.02	5.79	5.26	4.16	5.14	5.76	4.27	5.66	4.45	56.0
1960-61	4.45	5.22	5.78	5.68	6.00	6.14	5.54	5.41	4.63	4.48	4.17	4.20	5.14	5.15	5.94	5.19	4.28	5.28	5.77	4.37	5.76	4.52	56.0
61-62	4.52	5.12	5.42	5.78	5.95	6.00	5.64	5.24	4.30	4.54	4.25	4.19	5.08	5.02	5.91	5.06	4.33	5.21	5.71	4.32	5.67	4.49	55.8
62-63	4.62	5.19	5.53	5.49	6.15	6.02	5.58	5.09	4.67	4.49	4.21	4.36	5.12	5.11	5.89	5.11	4.35	5.21	5.71	4.43	5.64	4.59	55.1
63-64	4.79	5.07	5.74	6.04	6.25	6.04	5.88	5.59	4.70	4.64	4.49	4.74	5.33	5.20	6.11	5.39	4.62	5.41	5.94	4.64	5.92	4.74	55.6
64-65	5.17	5.67	5.84	6.02	6.35	6.39	6.35	5.82	4.85	4.70	4.41	4.70	5.52	5.56	6.25	5.67	4.60	5.68	6.23	4.66	6.13	4.92	55.5
65-66	5.14	5.39	5.80	5.92	6.25	6.46	6.20	5.81	5.21	4.71	4.39	4.74	5.50	5.44	6.21	5.74	4.61	5.56	6.18	4.76	6.07	4.93	55.2
66-67	5.21	5.49	5.82	6.03	6.35	6.39	6.28	5.77	5.47	4.96	4.83	4.90	5.62	5.51	6.26	5.84	4.90	5.64	6.20	5.04	6.11	5.14	54.3
67-68	5.37	5.70	6.05	6.25	6.75	6.55	6.30	5.89	5.37	5.03	4.68	4.95	5.74	5.71	6.52	5.85	4.89	5.84	6.37	5.01	6.30	5.18	54.9
68-69	5.43	5.77	6.21	6.35	6.59	6.46	6.32	5.89	5.25	5.06	5.12	5.09	5.80	5.80	6.47	5.82	5.09	5.94	6.32	5.13	6.30	5.29	54.4
69-70	5.54	5.88	6.34	6.41	6.97	6.60	6.43	6.10	5.33	5.25	4.95	5.03	5.90	5.92	6.66	5.95	5.08	6.04	6.52	5.14	6.48	5.33	54.8
1970-71	5.59	6.04	6.53	6.50	6.93	6.88	6.60	6.06	5.52	5.22	5.13	5.15	6.01	6.05	6.77	6.06	5.17	6.16	6.62	5.26	6.58	5.44	54.7
71-72	5.77	6.12	6.43	6.69	7.02	6.86	6.52	6.20	5.58	5.46	5.23	5.44	6.11	6.11	6.86	6.10	5.38	6.25	6.65	5.43	6.62	5.60	54.2
72-73	6.03	6.46	6.84	6.80	6.97	6.87	6.50	6.22	5.84	5.49	5.49	5.59	6.26	6.44	6.88	6.19	5.52	6.53	6.64	5.60	6.70	5.82	53.5
73-74	6.13	6.52	6.76	6.64	6.94	6.81	6.62	6.26	5.81	5.54	5.32	5.52	6.24	6.47	6.80	6.23	5.46	6.51	6.66	5.55	6.67	5.81	53.5
74-75	6.14	6.40	6.65	6.77	7.06	6.92	6.52	6.33	5.65	5.52	5.20	5.27	6.20	6.40	6.92	6.17	5.33	6.49	6.71	5.41	6.71	5.70	54.1
75-76	5.92	6.07	6.44	6.60	6.99	6.82	6.58	6.19	5.87	5.60	5.55	5.73	6.20	6.14	6.80	6.21	5.63	6.26	6.64	5.69	6.60	5.79	53.3
76-77	6.05	6.48	6.82	6.86	7.27	6.91	6.54	6.08	5.54	5.40	5.21	5.58	6.23	6.45	7.01	60.5	5.40	6.55	6.70	5.43	6.75	5.71	54.2
77-78	5.91	6.20	6.50	6.77	7.13	7.00	6.60	6.08	5.77	5.46	5.53	5.70	6.22	6.20	6.97	6.15	5.56	6.34	6.70	5.62	6.68	5.76	53.7
78-79	6.15	6.41	6.74	6.85	7.34	7.19	6.68	6.44	5.88	5.83	5.76	5.91	6.43	6.43	7.13	6.33	5.83	6.54	6.91	5.84	6.87	5.99	53.4
79-80	6.26	6.54	6.94	6.89	7.30	7.37	7.08	6.63	6.11	5.92	5.80	6.00	6.57	6.58	7.19	6.61	5.91	6.66	7.10	5.96	7.04	6.10	53.5
1980-81	6.26	6.66	7.03	7.09	7.58	7.38	7.11	6.73	6.31	6.09	6.00	6.27	6.73	6.65	7.35	6.72	6.12	6.76	7.20	6.17	7.15	6.26	53.3
81-82	6.35	6.86	7.09	7.26	7.79	7.37	7.13	6.89	6.27	6.22	6.15	6.29	6.81	6.77	7.47	6.76	6.22	6.89	7.30	6.23	7.26	6.36	53.3
82-83	6.47	6.72	7.02	7.26	7.64	7.55	7.27	7.31	6.65	6.38	6.39	6.41	6.91	6.74	7.48	7.08	6.39	6.87	7.44	6.46	7.34	6.50	53.0
83-84	6.69	6.99	7.50	7.62	7.89	7.63	7.51	7.28	6.75	6.50	6.43	6.76	7.13	7.06	7.71	7.18	6.56	7.20	7.58	6.61	7.57	6.69	53.1
84-85	6.75	7.12	7.43	7.45	7.97	7.81	7.33	7.06	6.60	6.69	6.56	6.69	7.12	7.10	7.74	7.00	6.65	7.19	7.54	6.64	7.51	6.74	52.7
85-86	6.90	7.19	7.61	7.57	7.86	7.80	7.44	7.12	6.74	6.52	6.61	6.58	7.16	7.23	7.74	7.10	6.57	7.32	7.56	6.61	7.57	6.76	52.8
86-87	6.82	7.14	7.45	7.46	7.84	7.58	7.43	7.09	6.67	6.59	6.53	6.51	7.09	7.14	7.63	7.06	6.54	7.22	7.48	6.58	7.48	6.71	52.7
87-88+	6.64	6.88	7.17	7.25	7.74	7.64	7.33	6.91	6.70	6.46	6.51	6.54	6.98	6.90	7.54	6.98	6.50	6.98	7.40	6.55	7.34	6.62	52.6
88-89	6.87	7.02	7.31	7.34	7.61	7.53	7.41	7.03	6.72	6.51	6.45	6.57	7.03	7.07	7.49	7.05	6.51	7.14	7.40	6.56	7.37	6.69	52.4
89-90																							

* Months are NTI Report Months (4 week intervals); Quarters, Quads, Half-Years & Annual Averages are combinations of those months.

The November thru April half-year includes the 6 months typically having the highest hours per day of usage, while the other 6 months are those with lower TV usage.

Beginning with the 1962-63 Season, "Unusual Days" are excluded from the per-day average TV usage figures.

+ Beginning with the 1987-88 Season, HUTs are based on New York time in eastern time zone and, in other time zones, on the principal telecast time of the typical network program airing during each time period. Prior to this, HUTs were based on New York time except New York time plus 3 hours in the Pacific territory.

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39YTABLE

Chapter II
Communication and The Study of Bargaining

Frank Tutzauer

Conflict is a ubiquitous facet of life. It occurs at all levels of analysis: between individuals, within and among groups and organizations, between nations, and even between cultures. Conflict can be both beneficial and deleterious; it can revitalize and destroy. It can be abstract and highly symbolic, and it can degenerate into violence.

And in all cases, it is inextricably intertwined with communication.

This chapter focuses on one form of conflict in which communication plays an especially prominent role: bargaining. It begins by outlining the important terms and ideas used by bargaining researchers. Then, it concludes with a discussion of the major theoretical approaches to the study of this important domain of social behavior.

Key Concepts

Basic Terminology

As a working definition, let us take bargaining to mean a situation in which two or more interdependent parties to a dispute attempt to arrange the terms of agreement between them. Some authors (e.g., Rubin & Brown, 1975) distinguish between bargaining and negotiation, using the former term for individuals--for example, a shopkeeper and a customer--and reserving the latter term for formal talks between groups--for example, between management and a labor union;

or between the United States and the Soviet Union. In this chapter, however, I will use the two terms interchangeably.

Most bargaining sessions consist of a series of offers or demands--that is, proposals put forth as possible settlements. If an offer represents a lowering of a bargainer's previous offer, it is called a concession. If all bargainers agree to a particular proposal, then that proposal is called the settlement; otherwise we say that the bargainers have deadlocked. The state of affairs that obtains upon a deadlock is called the disagreement point. The disagreement point, along with any possible settlement are called outcomes. The resistance point or limit is that point below which the bargainer will concede no further--the point below which the bargainer would just as soon disagree as accept the offer. A bargainer's level of aspiration, on the other hand, is the bargainer's target point, the current goal he or she is trying to obtain.

It should be clear from the foregoing discussion that each of the bargainers prefers some settlements to others. Accordingly, it is important to index (i.e., assign a measurement to) the value or worth of all possible settlements to each of the bargainers. Sometimes a convenient measure--such as money, or points--is available to index the worth of the agreements to the bargainers. More generally, however, it is necessary to define a utility function to assess the worth of each outcome. A bargainer's utility function is a mathematical function that assigns a numerical value to each possible outcome. Utility functions have the property that the more the bargainer prefers an outcome, the higher the value assigned to it. They also have the property that if an outcome consists of a gamble (e.g., a 40% chance of obtaining A and a 60% chance of obtaining B), then the utility of this compound outcome is the same as the weighted average (i.e., an average where the components are given differential weights) of the individual utilities, where the weights are given by the appropriate probabilities. In our example here, the utility of the gamble would be equal to .4 times the utility of A plus .6 times the utility of B.

Under certain reasonable assumptions about the outcomes and the bargainers' preferences, it can be shown that each bargainer possesses a utility function, and that this function is unique up to a change in scale and zero point, (for example, Fahrenheit and Celsius thermometers have different units and zero points, even though they measure the same thing), although the bargainers will not, in general, have the same utility functions. It should be remembered, however, that the utility functions derive from the preferences, not the other way around. For example, it would be incorrect to say that a bargainer preferred outcome A to B because it had a higher utility. Rather, we should say that A had the higher utility because the bargainer preferred it to B.

Distributive and Integrative Bargaining

There are two important kinds of bargaining sessions that researchers find important. The first, distributive bargaining, is the hard-nosed, win-lose stereotype that most lay people think of as the typical negotiation style. The second, perhaps theoretically more interesting, is integrative bargaining, sometimes called win-win bargaining, a branch of research popularized by Dean Pruitt and his colleagues (see Pruitt, 1981, for a review). This section will cover both.

One can think of distributive bargaining in three distinct, but related, ways: as a structural feature of the outcomes, as a bargaining style, and as a cognitive framework. Structurally, we say a bargaining situation is distributive if its outcomes are such that whatever one negotiator gains, the other loses. For example, if we are trying to divide ten dollars, every dollar I get is one that you can't have. Such negotiation situations lead to intensely competitive behavior because the bargainers' interests are diametrically opposed. So, it is natural to also consider distributive bargaining as a style of negotiation behavior. When a bargainer engages in tough negotiation tactics, withholding information, using threats and other coercive measures, we say that he or she is behaving distributively. Finally, distributive bargaining can be thought of as a cognitive framework--that is, the mind set that occurs when negotiators believe that the structure of the situation is distributive, independent of whether or not it actually is. Bazerman and Neale (1983) call this phenomenon the bias of the mythical fixed pie.

Integrative bargaining, like distributive bargaining, can be thought of as a structure, as a style, and as a cognitive framework. If there exist outcomes high in mutual benefit--that is, outcomes where both bargainers do well--then the situation is structurally integrative, and such outcomes high in joint benefit are called integrative outcomes. For example, if we are bargaining over two issues, and if one is very important to me while the other is very important to you, we might be able to construct a trade off in which we both get what we most desire. Just as in distributive bargaining, integrative bargaining can also be considered a negotiation style. When the bargainers exchange information, and approach the bargaining task with a problem-solving orientation and with mutual concern, then we say they are engaging in integrative bargaining. Finally, integrative bargaining can be thought of as a cognitive framework: when the bargainers treat the mythical fixed pie as what it is--mythical--and seek to expand the pie by considering integrative outcomes.

Outcome and Process Models

This section discusses two important approaches for studying bargaining and the communication that takes place during negotiation.

Game Theory

The seminal work in game theory is von Neumann and Morgenstern's 1944 Theory of Games and Economic Behavior. As a branch of knowledge, game theory is perhaps ill-named; the term conjures up images of Parcheesi and hopscotch. In fact, game theory is the mathematical study of the strategic dimensions of conflict. As such, it is broader than the study of bargaining, but bargaining certainly has strategic elements that can be modeled using the terminology and theorems of game theory.

There are two important classes of games having relevance to bargaining researchers: matrix games and bargaining games. Each is discussed in turn below.

Matrix games. In its simplest form, a matrix game is defined by a pair of bargainers (game theorists call them players), each having available to them a finite number of strategies, along with the consequences of each strategy pair. Such a conceptualization has a natural representation as a matrix, with strategies represented by the rows and columns of the matrix, and with the entries of the matrix giving the outcomes of the strategies. In other words, the ij-th cell of the matrix tells what happens if Player 1 chooses his or her i-th strategy and Player 2 chooses his or her j-th strategy.

Consider Figure 1. Here, the row player (Player 1) has three strategies available (maybe strike, slowdown, or continue working), and the column player (Player 2) has two (maybe accept union demands, or lockout the workers). The entries in the matrix are called payoffs and the numbers should be taken as utilities or some other measure of the worth of the outcomes resulting from the intersection of two strategies. For example, if both players choose their first strategy, then Player 1 receives a payoff of 3 whereas Player 2 loses 3. This matrix is an example of a zero-sum game, so called because the payoffs in each of the cells adds up to zero. Zero-sum games are the natural model of bargaining situations that are structurally distributive.

	2	
	(3, -3)	(-2, 2)
1	(-1, 1)	(4, -4)
	(0, 0)	(8, -8)

Figure 1. A Two-Person Zero-Sum Game.

To model integrative situations, one must use variable-sum games. An example can be seen in Figure 2. Each player has a choice of two strategies, which are called cooperation and defection. If the players both cooperate, they each get a payoff of 3, and if they both defect a payoff of 1 results. However, if one defects and the other cooperates, the defector receives 5 while the cooperative player receives nothing. This matrix is the famous Prisoner's Dilemma. The dilemma is this: Player 1 reasons, "I have a choice of cooperating or defecting. If my opponent cooperates, then defecting is better since 5 is greater than 3. Similarly, if my opponent defects, defecting is still better since 1 is greater than 0. So no matter what my opponent does, I should defect." Player 2, of course, reasons the same way, since the game is symmetric. Therefore, they both defect and receive a payoff of 1. Clearly, however, it would have been better for both players if they had cooperated, receiving 3 each. Thus, the Prisoner's Dilemma highlights the tension between individual and group rationality. If each individual acts in his or her own best interests, the result hurts everyone.

Bargaining games. An alternative game-theoretic approach to the study of bargaining is the line of research begun by John Nash (1950). Nash modeled the bargaining situation by using compact, convex subsets of the Cartesian coordinate system (see Figure 3). A two-person bargaining game is such a set, which we call the feasible outcome set, along with a distinguished point of the set, called the disagreement point, labeled d in the figure. The interpretation to be given to the feasible outcome set is that it represents the utilities of all possible outcomes to which the players might agree. If the bargainers agree to some outcome, then there is a point in the set corresponding to the outcome such that the utility of the outcome to Bargainer 1 is given by the x-coordinate of the point and the utility to Bargainer 2 is given by the y-coordinate. If they bargainers fail to agree, then they receive the utilities associated with the disagreement point.

To model the process of reaching an outcome, we use a solution function, which is simply a mathematical function that takes as its input a bargaining game and produces as its output the point of the feasible outcome set to which the bargainers agree. We define such a function by postulating certain assumptions that we think the bargainers will agree to as fair. Nash's assumptions were as follows:

1. Pareto-optimality. The bargainers will not agree to a point x if there is another point y that improves both players utilities. In other words, if Player 1 prefers y to x, and if Player 2 also prefers y to x, then they won't choose x.

	2	
1	(3, 3)	(0, 5)
	(5, 0)	(1, 1)

Figure 2. The Prisoner's Dilemma.

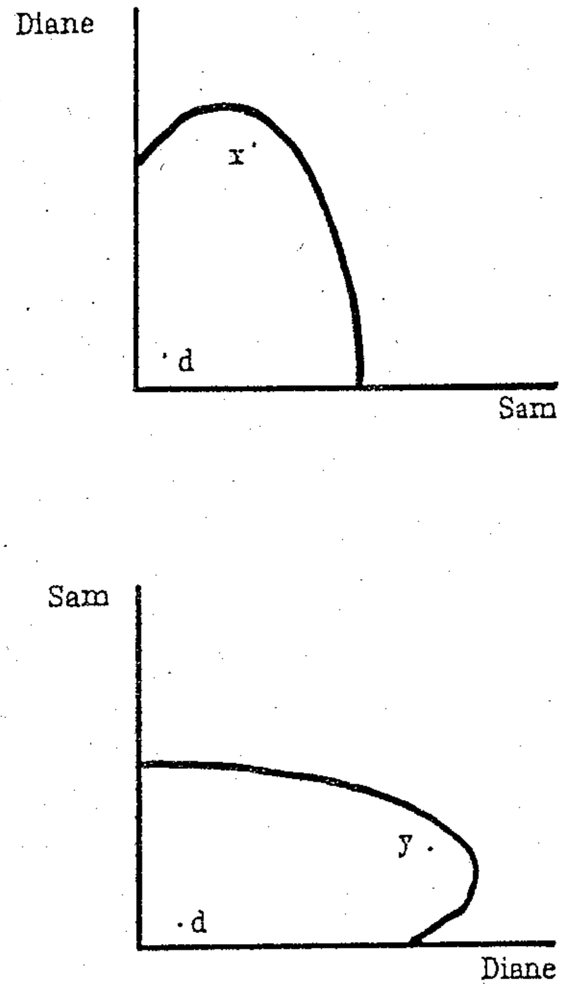

Figure 3. Two–Person Bargaining Games.

2. Symmetry. If the game treats the players equally, then so should the solution. This assumption amounts to saying that it doesn't matter who we put on the horizontal axis and who on the vertical axis provided we make the natural change in the solution. For example, assume Sam is Player 1 and Diane is Player 2, and their outcome set is as in the top half of Figure 3. Suppose further that the solution function chooses x as the bargaining settlement. Suppose now, that we decided to reverse the roles of Sam and Diane, putting Sam on the vertical and Diane on the horizontal. Then their feasible outcome set would be as in the bottom half of Figure 3, and we would expect the solution to choose y as the settlement.

3. Independence of irrelevant alternatives. Suppose the bargainers have feasible outcome set F and agree to x as the solution. Suppose now they bargain over a subset of F, but one still containing x. Then they should agree to x again. In other words, eliminating irrelevant alternatives (irrelevant in the sense that the bargainers don't agree to them) should not affect the solution. An example will make this more clear. Suppose I walk into my favorite Creole restaurant, and the waiter tells me that they have three selections today: jambalaya, crawfish pie, and filé gumbo. Being Cajun-hungry, I tell the waiter, "I'll have the filé gumbo." Suppose the waiter returns after a short while and says, "I'm sorry. We're out of jambalaya." What should I say? I should say, "So what. I wanted the gumbo." In this example, jambalaya is the irrelevant alternative, and eliminating it shouldn't change what I wanted. Similarly, if irrelevant alternatives are eliminated from the feasible outcome set, then the solution should remain unchanged.

4. Invariance with respect to positive linear transformations. If we change the feasible outcome set by changing the origin or the scale, then the solution remains unchanged (except for making the same scale and origin changes). This assumption, of course, derives from the fact that utilities are unique only up to a change in scale and origin. As an example of this assumption, assume that Sam and Diane have agreed to x in the top half of Figure 3. Suppose further that x gives Sam a utility of 2 and Diane a utility of 4. If we change the origin of the feasible outcome set by adding 6 to all utilities, then, in this new set, Sam and Diane should agree to a point giving them utilities of 8 and 10, respectively. If we now make a further change, a change in scale, by multiplying the scale by, say, 1/2, then Sam and Diane would obtain utilities of 4 and 5.

Nash was able to prove that if the above four assumptions were met, then the solution would be the one that maximized the product of the players utilities. This is really quite a remarkable theorem. It says that if the above four assumptions are true--and they certainly seem reasonable at face value--then we know what the bargainers will agree to: We simply choose that outcome producing the highest number when its x- and y-utilities are multiplied together.

Many other solution functions besides Nash's exist, each obeying a different set of assumptions. Which solution function the researcher uses depends on what he or she is willing to assume about bargaining behavior.

As can be seen from the examples in this section, matrix games are very good at capturing the interdependent nature of the bargaining relationship. What happens depends not only on what one does, but also on what one's opponent does. Similarly, bargaining games allow us to formalize what constitutes a fair allocation. Unfortunately, neither matrix games nor bargaining games capture the action-reaction dynamic that characterizes most bargaining. To do so, we must use different theoretical tools. This subject is taken up next.

Richardson Processes

Game theory, by and large, provides good models of bargaining outcome. To model the bargaining process, however, we need slightly different tools. Because the bargaining process is dynamic--that is, it changes over time--the most appropriate machinery is, of course, the differential calculus. Richardson processes take full advantage of calculus.

Richardson processes were originally used to study arms races (Richardson, 1960). The action-reaction dynamic of an arms race is modeled by a pair of linked differential equations

$$\frac{dx}{dt} = m_1 y - n_1 x + g_1$$

$$\frac{dy}{dt} = m_2 x - n_2 y + g_2$$

where x and y are the armaments levels of the two nations, and dx/dt and dy/dt are the instantaneous rates at which these armament levels are changing. The m coefficients measure how much each nation reacts to the arms of the other nation, the n coefficients capture the burden of amassing arms, and the g parameters are constant grievances. If, instead of armaments, we let x and y represent bargainers' demands, then the m coefficients measure reciprocity, the n coefficients index how sensitive a bargainer is to his or her own previous demands, and the g's capture the bargainers' tendencies to concede independent of the current session. By estimating and examining the various parameters of the models, the researcher is able to predict whether or not bargainers will agree, and, if so, what the agreement will be. Unlike game theory, however, these predictions derive from the process--the differential equations--rather than from assumptions about the nature of behavior.

Conclusion

Bargaining and negotiation are forms of dispute resolution that can avoid violent confrontations. Despite the importance of this method of conflict management, there is much to learn about the nature, causes, and consequences of successful bargaining. This chapter has reviewed some important concepts and theories, and should serve as a stepping stone for the student seeking to learn more about the bargaining process.

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Chapter III

NEURAL NETWORKS: Applications of the Cognitive Revolution To Advertising, Marketing and Political Research

Joseph Woelfel

The Cognitive Revolution

The last three decades have seen change in our understanding of mental processes so fundamental and sweeping it is called "The Cognitive Revolution." The academic community refers to all "mental" processes as "cognitive processes", from the Latin word cogere, to think. (Rene DesCartes made this word famous with his dictum "Cogito ergo Sum", which means "I think, therefore I am.")

Cognitive processes include such processes as thinking, feeling, attitude change and the like, but computers and modern communication systems have broadened our understanding to include not only collective cognitive processes, like changes in the beliefs and attitudes of groups and cultures, markets and market segments, but even symbolic processes in computers. Some scientists and philosophers consider cognitive processes to be any manipulation of symbolic information whatever.

To gauge the depth of the cognitive revolution, it helps to understand that, only a few years ago, many if not most scientists believed that cognitive processes where inherently unobservable, and either couldn't or shouldn't be a studied at all. Behaviorism was the predominant philosophy, and its adherents treated humans as "black boxes", observing inputs to the box and the outputs that resulted without speculating about what was going on inside. Now, however, cognitive science is one of the fastest growing areas in the academic community, and includes workers from anthropology, communication, computer science, geography, linguistics, philosophy, physics, psychology and other disciplines. These thousands of scientists and scholars focus explicitly on what was thought to be unobservable only a few years ago -- cognitive processes.

Although the cognitive revolution has been wide ranging, there are three areas of development which seem particularly interesting. The first of these is a change in the way thinking and reasoning is described, from a categorical to a "fuzzy" model. The second is a deepening understanding of the fundamental processes by which the brain operates -- an understanding of the physical principles underlying neural networks. Third, explosive developments in computing have made it possible to simulate cognitive processes in computer software. This has made it possible to test theories that would otherwise have been purely speculation. And it has also given rise to whole new technologies which are now revolutionizing many aspects of human endeavor.

Fuzzy Logic

Since the time of Aristotle, scholars have thought of reasoning as a categorical process. As Bruner said,

> The most self evident aspect of our experience is that we place things into categories. That is a man and he is boarding a bus with the intention of getting some relaxation.

Each and every man is a member of the category man, and no individual man is more or less a member of the category than any other. The boundaries of the category are crisp and distinct, and each member of the category is assigned into that category because he, she or it possess the defining characteristics or essential features of that category. (For the category man, Aristotle required two such characteristics, rational animal.)

Reasoning or thinking within the Aristotelian categorical model was by syllogism, a method of nesting or including categories within categories, as in the familiar classic syllogism

All men are mortal
Socrates is a man
Socrates is mortal.

This is a very powerful model, and it has lived a useful life for over two thousand years. But there are real problems with the categorical model, all flowing from the assumption that categories have sharp, distinct boundaries, and that all members of any category are to be considered identical as far as their membership in the category is concerned. First of all, category boundaries are seldom very sharp, and honest observers disagree about whether objects belong to one category or another. (Aristotle did not believe women, slaves, and most non-Greeks belonged to the category rational, and thus were not actually "men.")

One major step in the Cognitive Revolution was to reconsider categories not as sharply bounded "bins" into which objects could be classified as belonging or not belonging, but rather as "fuzzy sets" with no real boundaries, which faded continuously into neighboring categories. One well known fuzzy set model, instead of classifying objects as members or nonmembers of any given category, instead assigns them a membership score ranging from zero to one, with 1.0 being a complete, perfect member, and 0.0 not being a member at all. The "best" members of a category -- that is, those that best typify or exemplify the category -- are called "prototype members." Collies and German Shepherds are prototypical dogs, while Schnauzers and Pekingese are less "doglike." Members are assigned values based on their similarity to the prototype members; dogs that are very similar to Shepherds and Collies get a high number, while those that are more dissimilar get lower numbers.

Reasoning within this kind of fuzzy logic consists not of classical syllogisms like the Aristotelian model, but rather with a calculus of probabilities. Fuzzy logics have had wide application in traditional expert systems, and have been very well received particularly in Asia, where industrial designers have incorporated fuzzy logic reasoning even into household appliances like vacuum cleaners.

An even fuzzier model familiar to advertising, marketing and political researchers is the Galileo^{tm} model. Galileo does away with categories completely, and simply assigns scores to pairs of "objects" based on their similarity or dissimilarity. Objects that are very similar are placed close to each other, while objects that are different are placed far apart.

Figure 2 shows the way Galileo would represent the "Dog" category. Collies and Shepherds are close to one another, since they are seen as similar. Pomeranians and Chihuahua's are far from Collies and Shepherds, but close to each other. Terriers and Spaniels lie between these extremes, since they are more similar to Collies and Shepherds than are Pomeranians and Chihuahuas, and they are more similar to Pomeranians and Chihuahua's than are Collies and Shepherds. In a Galileo, objects are not defined by being placed in categories, but rather by their pattern of similarities and dissimilarities with other objects. In spite of their name, fuzzy logics are actually more precise than category logics, because they can recognize degrees of similarity rather than lumping all similar objects together as if they were identical.

Neural Networks

The human brain is perhaps the most complicated device we know, and it is folly to believe we understand it fully. Deep questions of consciousness, coordination and control remain unsolved. But it is fair to say that fundamental understandings of how the networks of interconnected neurons in the brain store and retrieve patterns of information in principle are beginning to emerge. A natural neural network (like the brain) consists of neurons, each of which may be connected to many other neurons. (In a human brain, there are about 100 billion neurons, each of which is connected, on the average, to about a thousand other neurons.) When a neuron is stimulated, it becomes "active", and sends signals to all the other neurons to which it is connected.

Neural networks store information as patterns in the same way that a TV screen or theater marquee or electronic scoreboard does: By activating some of the dots or light bulbs and leaving others off, any pattern can be displayed. (Researchers have actually identified more than a dozen maps of the visual field in the human brain.) But because the neurons in a neural network are connected to each other, the neural network can do more than simply display patterns of information: it can store and retrieve those patterns, and recognize patterns it has stored even if they are distorted or incomplete.

Although the actual functioning of a neural network like the human brain can be so complicated as to be beyond comprehension, in principle the way a neural network works is very simple and easy to understand. A neural network learns by connecting together the neurons which represent any particular pattern. Since they are connected together, when some of them are activated, they spread their activation to the others connected to them, which turns on the rest of the pattern. Thus, when a network sees part of a pattern, it can recall the rest of the pattern, even in spite of incomplete or erroneous information, as long as enough of the pattern is there to activate the rest.

Figure 3 shows a hypothetical network consisting of six nodes representing the words "Cat", "Dog", "Barks", "Howls", "Meows", and "Purrs".

Each of the nodes may take on the value "0" (off), or "1" (on). The nodes are connected to each other by weights which represent their relative "closeness" in the network. They communicate with each other by a simple threshold rule: the signal sent from any node i to any node j equals the product of the activation value of i and strength of the connection between i and j. Thus the total signal received by any node j will be the sum of the signals received from all the other nodes, or

The way a node responds to the set of signals it receives is determined by its activation function; in this case we adopt the rule that the node will be activated if the sum of its input signals is positive; otherwise it will be turned off, or

$$a_i = \begin{cases} +1 \text{ if } x > 0 \\ \text{unchanged if } x = 0 \\ -1 \text{ if } x < 0 \end{cases}$$

Following this rule, we assume the network receives the input "Meows" from its environment (i.e., the node which represents "Meows" has been activated.) This sets the activation value of "Meows" at +1, and the activation values of the other nodes at 0. Multiplying the weights in each column by the activation values of the corresponding rows, then summing within each column shows that the activation of the node "Meows" will "spread" to the nodes "Cat" and "Purrs", setting their activations to 1, but will leave the nodes "Dog", "Barks" and "Howls" off.

Figure 4 shows that activating the node "Howls", will also activate the nodes "Cat", "Dog" and "Barks"; Figure 5 shows that activating both the nodes "Barks" and "Howls" will also activate "Dog", but will leave "Cat", "Meows" and "Purrs" off.

This example shows clearly that communication among the nodes of the network produces an apparently qualitative change in the pattern recognition and storage capabilities of the network. When the nodes do not communicate, the network can represent a pattern of virtually any complexity when activated directly by the environment, but the complete input is required to produce the complete pattern. When the nodes communicate, however, the complete pattern can be produced with only a partial input. When a sufficient subset of the nodes in a stored pattern is activated, the activation of those nodes will "spread" through the links and in turn activate the rest of the nodes in the pattern.

It is worth emphasizing the fundamental role communication as it has been defined here plays in this process. A pattern is stored by "connecting" its elements together. Things that "go together" are "close". Nodes or elements in turn communicate their activation values to other nodes in proportion to their closeness in the communication network. If a node is "on", it will tend to transmit that "on-ness" to other nodes through the links between them, so that the "on-ness" will spread to other nodes which represent the other elements in the pattern. Similarly, if a node is "off", it will tend to communicate its "off-ness" to other nodes through the links between them. The entire pattern is encoded in the pattern of communication among the nodes as connections or weights, and can be recovered by the activation of any suitable subset of nodes.

Artificial Neural Networks

The explosive development of computer hardware and software technology, along with rapidly increasing interest in cognitive processes on the part of Computer Scientists has provided a powerful stimulus to the development of neural network technology. While modern silicon hardware is no match for the technology of the human brain, it is sufficiently potent to provide convincing simulations of natural neural networks. Moreover, these artificial neural networks (ANN's) have developed new and original network designs which are not simulations of naturally occurring networks. Several of these artificial neural networks are already well-developed practical technologies which can provide effective and ingenious solutions to real world problems.

Types of Artificial Neural Networks

Neural networks, real or artificial, have three essential variables: how many neurons they contain, how each neuron responds to inputs (the activation function), and how the neurons are connected to each other. As neural networks learn new patterns, the connections among neurons change, since a network's "memory" consists entirely in the pattern of connections or "weights" among the neurons. Networks may be classified according to the way in which their weights change during learning. Although dozens and perhaps hundreds of different kinds of artificial neural networks have already been developed and run, all are variations of two basic types, self-organizing networks and supervised neural networks.

Self-Organizing Neural Networks

Self-organizing neural networks (often called "unsupervised" networks) learn patterns by a simple Pavlovian conditioning rule: When two or more neurons are simultaneously active, the connection among them is strengthened. This means, quite simply, that neurons that have behaved similarly in the past are likely to behave similarly in the future. Self-organizing networks receive information in the form of patterns, which they learn to recognize, and which they can recall later. Self-organizing networks develop an internal representation of the information to which they have been exposed. They are useful because one can enter fragments of a pattern the network has learned, even in somewhat distorted form, and the network can recover the original pattern.

Supervised Neural Networks

Supervised neural networks are usually designed in layers typically including one input layer, one output layer, and one middle or "hidden" layer. Initially these layers are randomly connected from input to hidden and from hidden to output. When a pattern of information is input to the input layer, the activation pattern of the input layer is fed forward to the hidden layer, which in turn feeds its activation pattern forward to the output layer. (These networks are frequently called feedforward networks.) Because the layers are randomly connected, the output will be a random pattern.

In a supervised network, however, a trainer or supervisor presents the network with a "correct" output pattern. By comparing the actual output to the correct output, the network calculates a set of errors, and adjusts its connection weights bit by bit until the network produces the correct output to within a specified tolerance. This kind of network can be trained to produce the correct outputs for a series of inputs, and is very useful in situations where a number of previous cases or examples are available to train the network.

Although there are many variations, the most common method supervised networks use to adjust their weights is a mathematical procedure which expresses the errors as a function of the weights, calculates the derivatives of this function and adjusts these weights by a steepest-descent algorithm. Because this method involves tracing the errors as functions of the connections of hidden to output layers, then backwards to the activations of the hidden neurons, then backward again to the connections from input to hidden layers, this method is called backpropagation.

Applications of Artificial Neural Networks

The unique characteristics of artificial neural networks have led to a wide range of applications. Self organizing networks, like human beings, have the capacity to observe their environment and learn about it without supervision. Supervised neural networks, like human beings, can be trained to associate input information with appropriate outputs. Neural networks are well suited for tasks a human being might do, but, for one reason or another, can't or won't do. And, because they have some distinctly human characteristics, neural networks are particularly useful for simulating human cognitive processes such as attitude formation and change.

SWITCH

SWITCH is just about the simplest neural network there is: each neuron simply takes in signals from all the other neurons to which it is connected, sums them up and passes them along to all the others to which it is connected. Even such a simple network can have real uses, though.

The accompanying figure shows the results of entering loyalty data from the 1989 new car buyer study into SWITCH. SWITCH is easily able to calculate how many cars of each type will remain in service for each of the following ten years, and to calculate what percent of the market each will sell for each of these years. assuming, of course, that nothing changes during that period. Of course, many things will change, but nonetheless, SWITCH can provide a fixed baseline for planning.

CATPAC

CATPAC is a self-organizing neural network that is optimized for reading text. It can read any ASCII text and learn the underlying concepts conveyed by the text. CATPAC provides both a complete neural network of the interrelationships among the chief words in the text, along with a diameter-method cluster analysis of the main meanings.

CATPAC can be useful for reading textual information from any source, including books, newspapers, magazines, electronic full-text data bases, transcripts of focus groups, in-depth interviews and open-ended questions. Among the important applications of CATPAC are the identification of important product attributes and market segmentation studies. CATPAC also provides outputs which can serve as input to other neural networks for further analysis.

GALILEO

Galileo is an artificial neural network in which products, attributes and people are represented as neurons. Each of these products, attributes and people may be more or less tightly connected to each other. Products that are similar may be tightly connected, so that activating "Coke" in the network will probably activate "Pepsi" as well. Products will be tightly connected to their attributes as well, so that activating "sweet", "brown", "carbonated" will probably activate Pepsi and Coke. Attributes can also be connected to each other, so that activating attributes like "sweet", "satisfying", "filling" and the like may well also activate other attributes like "delicious" or "fattening."

Galileo also represents people as neurons. People can be connected to both attributes and products; they are tightly connected to attributes that make a difference to them, and they are more tightly connected to products and services that they buy and use than to those that they don't buy or use. All product development, advertising and marketing strategies can be seen as efforts to connect a product or service more tightly to people.

Galileo doesn't represent neurons as simply "connected" or "not connected" to each other, but instead measures the precise degree of each connection. This means that Galileo includes not only information about whether a car, for example, is smooth riding, but also represents precisely how smooth riding it is. Galileo does not simply say a product, service or object belongs to a category, but instead says to what degree it belongs to that category. A system which quantifies the degree to which objects belong to categories is called a "fuzzy logic."

In a natural neural network, neurons that are tightly connected are typically located close to one another. Galileo provides diagrams based on this principle in the form of "maps," which can help give an intuitive picture of the structure of the network. Figure 1 shows a map of Desert Preferences for Tom and Becky. It shows that "Ice Cream" is closer to cold than "Cherry Pie", which is closer to "Hot." Both are about the same distance from "Sweet."

Tom prefers a hot desert, and the map shows him closer to "Hot" than "Cold." Becky prefers a cold desert, and is closer to "Cold" in the map. She's also closer to "Ice Cream" than Tom, who is closer to "Cherry Pie" than Becky. We should expect Tom to choose Cherry Pie more often than Becky, while Becky would be expected to choose Ice Cream more often than Tom. We'd also expect Tom to choose Cherry Pie more often than Ice Cream, and Becky to choose Ice Cream more often than Cherry Pie.

While the map is useful for getting an intuitive feel for the structure of the network, more precise information is always available. Galileo can write out any distances desired in a simple format, as Table One shows.

One of the major reasons Galileo has been so widely used in advertising and market research is its ability to calculate optimum strategies for strengthening and weakening connections between the neurons. Using Galileo's strategic planning abilities, it's possible to find strategies which will strengthen the connection of a product or service with its potential customers.

In order to design an effective strategy for repositioning a product or service in the customers' minds, it is only necessary to specify what position in the market the product or service is meant to fill. Galileo software will automatically calculate what connections need to be strengthened and which weakened to achieve the desired positioning.

Table Two gives several examples of strategies developed by Galileo to reposition Ice Cream closer to Tom. The first strategy Galileo suggests tightens the connection between Ice Cream and both "Hot" and "Cherry Pie", while weakening the connection between Ice Cream and "Sweet." The second strategy suggests tightening the connections between Ice Cream and "Hot," "Cherry Pie", and Becky. The third suggests weakening the connection between Ice Cream and "Sweet", while tightening the connections to "Cherry Pie" and Becky.

There are as many ways of strengthening and weakening connections as human imagination can devise, but the most common are advertising and actually changing the product or service. However one proceeds to implement the strategies, Galileo provides a convenient way to track the progress of the repositioning.

Galileo can take data from directly from text using CATPAC, or from industry standard quantitative measurements, including complete paired comparison ratio scales for extremely precise results.

ORESEME

ORESEME is a self-organizing neural network which simulates the cognitive processes of individuals or groups of people, such as markets or market segments. ORESEME represents objects, products, attributes, people or any other concept as neurons in a network. Mentioning one or more of these objects (as one would in an advertisement) activates the neurons which represent those objects. These activated neurons in turn activate those other neurons to which they are closely connected, while turning off those neurons to which they are negatively connected. This interactive activation and competition network thus simulates the process by which one or more ideas stimulates still other ideas.

ORESEME can be helpful in alerting advertisers to the potential problems which might arise from unexpected connotations of otherwise useful message strategies. ORESEME can accept inputs from CATPAC or GALILEO, or can develop its own network interactively.

SUPERVISED NETWORKS

By far the most commonly used neural networks are supervised networks, usually back propagation models. These models are of great generality, but for the most part are most useful when your goal is to make predictions, when you have a poor or inaccurate theory on which to base your guesses, when the information you do have is in the form of cases, and that information is incomplete or poorly measured.

A prototypical case is bank loan applications. Here the bank can provide records of many previous cases from files of applicants and their attributes, along with an indication of whether they defaulted their loan or not. The supervised network then "learns" to predict the outcome of these cases, and can be tested for its predictive ability by being asked to predict the outcome of other cases from the bank's files. Once trained, the network becomes an expert loan risk appraiser.

Other common tasks for supervised networks include the prediction of the outcome of football games or horse races, stock market fluctuations, classification of disease from symptoms, equipment failure diagnoses and similar problems.

In the present example, the weights are essentially the correlations between frequencies of occurrence of the various words. Thus "Meows" and "Cat" tend to "go together", with a weight of .8, while "Meow" and "Dog" have a negative coefficient of -.8.

Chapter IV

SPOT and ROVER: Conversational Self Referencing Neural Networks

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ABSTRACT

Most theories of Human Communication tend to be special cases of two general theories. The first is a rational model, in which individuals are thought to follow rules in the pursuit of goals. The second is a pattern matching model, in which individuals are thought to apply behaviors to contexts on the basis of their learned appropriateness to the situational context. This second model seems quite consistent with the behavior of massively parallel systems, which are particularly adept pattern matching machines.

Several FORTRAN implementations of back-propagation neural networks with and without simple feedback loops, and constructed to read and write the ASCII character set, are presented. These networks seem able to learn to associate meaningful linguistic outputs with arbitrary linguistic inputs. They can also produce meaningful output patterns even when the input patterns are incomplete or degraded. With simple feedback loops added, the networks can take account of their own past behavior in interpreting new input, and can also monitor their own

internal cognitive states and take them into account prior to output of a response. The networks are also capable of interpreting novel (not previously encountered) input patterns which are lawful combinations of previously learned patterns, and responding to these with novel (not previously uttered) output patterns which are themselves meaningful.

Although the limitations of the networks discussed are very severe, it appears possible to understand what features of parallel architecture are essential for developing even more complex communication abilities, and a list of such essential features is proposed.

Intelligence as an Emergent Property of Networks

Approaches to the study of "intelligence" have been diverse, ranging from those which consider intelligence a mysterious quality which belongs to the soul, fundamentally free and not governed by scientific laws and thus not analyzable by scientific means, to rationalistic rules based "artificial intelligence" or "expert systems". Within this diversity, however, one may identify two major theoretical models which underlie at least most Western theories of intelligent action.

The first of these, and by far the most widely accepted, is a model based on Aristotle's dualistic concepts of intellect and will. The intellect represents the calculating part of intelligence. It is the part which is aware of its surroundings, identifies and names the objects of experience, and projects future states of the organism. The will, on the other hand, "attaches" itself to some of these possible outcomes and "desires" them. It provides a motive force toward achieving the end state. It is the task, then, of the intellect to plan and carry out a course of action which can result in achieving the desired goal state.

The Aristotelian model is not deterministic. Aristotle was aware of the fact that no valid syllogism which could be constructed from a combination of "intellectual" and "willful" premisses could yield an action as a formal logical conclusion. He concluded that human behavior did not have the "certainty" of physical systems, and cautioned his followers to seek only the level of precision and certainty from this class of phenomena which was appropriate to them. Later Christian philosophers, particularly Aquinas, elevated the uncertainty of the Aristotelian dualistic model to the principle of Free Will. By far the largest part of contemporary theorists in this tradition accept this notion of freedom as an inherent characteristic of human behavior.

This rational quest for desired end states or goals is assumed to take place within a system of constraints which includes the actions of natural laws and the goal oriented activities of other intelligences. Thus some of the plans the intellect might derive are impossible and others prohibited or proscribed by potential conflicts with others. These constraints, over time, tend to be more or less loosely codified into explicit and implicit rules which specify what kinds of actions are available, permissible and effective for achieving desired goals, and these rules provide a framework within which an intelligent agent must act.

Rules theories take on many forms. Some theorists focus particularly on human activities in social situations, and recommend careful, sensitive and holistic observations of the behaviors of actors in social situations as a basis for uncovering the latent set of rules which governs those behaviors (Cushman & Pearce, 1977). Chomsky's theory of language behavior can be seen as a specific example of a non-deterministic rules-based model: Within Chomsky's model, freedom is central and distinguishes human language from all other species and automata, since the "...normal use of language is not only innovative and potentially infinite in scope, but also free from the control of detectable stimuli, either external or internal" (Chomsky, 1972, p.12). Moreover, any speaker's grammar "...must, then, contain a finite system of rules that generates infinitely many deep and surface structures, appropriately related. It must also contain rules that relate these abstract structures to certain representations of sound and meaning..." (ibid., p. 17).

Perhaps the most rigorous and ambitious use of the rationalistic rules based models occurs in computer based expert systems, which consist of databases of facts, examples and rules relating the facts and examples, and "inference engines" or algorithms which apply explicitly formulated rules for achieving specific goals, such as configuring or repairing a complex system, diagnosing and treating a disease, determining the location of subterranean mineral deposits, or parsing and understanding natural language.

Whatever the specific form of such Aristotelian models, however, most typically adopt Aristotle's judgment about all rational, rule following systems: rational systems are not typically assumed to be deterministic, and even computer based expert systems often include substantial stochastic components. Unlike a "natural law", any rule may be violated, albeit by risking some penalty associated with its violation.

More recently, an alternative model of intelligent behavior has developed from two unrelated research traditions. The first of these is the "symbolic interaction" model. Interactionists particularly, following Mead, have emphasized the "symbolic" nature of human intelligence, and suggest that, through symbolic interaction with other members of a community, people are able to develop an internal representation of the objects of their experience, themselves, and their interrelationships. This symbolic representation system constitutes the "self concept", which is believed to be the foundation of human intelligent action. (Mead, 1934).

Many, perhaps most, interactionists are themselves Aristotelian rules based theorists who incorporate the interactionist concepts of symbolic communication, self concept and particularly situational relativism into the basic rationalistic model. Some, however, advocate a different approach. Within this second model, behaviors are considered to be components of the self which, through direct ("self reflexive") experience or through communication with others, have been defined as the appropriate activity for them under specific circumstances. Thus, if one has learned to define oneself as brave, brave actions will be appropriate under dangerous circumstances, but if one has learned one is a coward, cowardly actions will be seen as appropriate. In any situation one must define the nature of the situation, define oneself, and define a set of potential behaviors which might occur in that situation. The behavior actually enacted will be the one most consistent with the self as it has been defined in that situation.In this model, behaviors are chosen because they are appropriate and not because they lead to a desired end state (Mills, 1940; Foote, 1951; Lemert, 1951; Woelfel and Fink, 1980).

This second model, rather than assuming behavior to be rational and goal oriented, assumes that behavior selection is a "pattern matching" algorithm. Specifically, within this model an individual in a social situation is confronted by a set of "objects" which vary from situation to situation. Among the objects in the situation are a set of potential behaviors or actions which, through previous experience and communications from others, the individual has learned are possible behaviors within that situation. The definition of self within that situation is determined by the individual's perception of his/her relationship to the objects in that situation; the pattern of action or "behavior" the individual will exhibit will be that which best matches the pattern of relationships to objects which defines the self in that situation.

Critics of the "pattern matching" model usually indict it specifically for its denial of the role of freedom of action, which they usually associate with the ability to interpret and generate novel patterns. Chomsky, for example, says:

> "...(T)he normal use of language is innovative, in the sense that much of what we say in the course of normal language is entirely new, not a repetition of anything that we have heard before and not even similar in pattern -- in any useful sense of the terms "similar" and "pattern" -- to sentences or discourse that we have heard in the past. (Chomsky, 1972, pp. 11-12).

Although these two views have coexisted for a very long time, research findings from neither group have had much impact on the views of the other. Neither model, moreover, has been able to suggest a physical mechanism which might produce the phenomena under study. In fact, the absence of any conceivable mechanism by which novel responses to novel stimuli might be generated lies very close to the heart of the dispute, as Chomsky makes clear:

> If by experiment we convince ourselves that another organism gives evidence of the normal, creative use of language, we must suppose that it, like us, has a mind and that what it does lies beyond the bounds of mechanical explanation...(Chomsky, 1972, p. 11).

Recently, however, research in another area has shown some potential for revealing a physical mechanism by which a pattern association model of intelligence might be constructed. Workers in what has variously been called "neural network", "Parallel Data Processing" (PDP) and sometimes "connectionist" models have produced suggestive findings which indicate at least some behaviors often considered "intelligent" may be emergent properties of communication networks. Certain kinds of networks can be shown to receive and store patterns of information, "learn" to associate certain patterns of information with other patterns, and solve logical problems. In fact, since parallel data processing networks develop internal symbolic representations of their environment through interaction with the environment, they may be particularly compatible with an interactionist model of human intelligence.

This paper presents a theory which focuses attention on those characteristics of networks which relate to their capacity to ingest, store, process and output patterns of information. Specifically, the paper presents a general theory of networks which communicate with their environment, and through that communication develop representations of the environment, themselves, and their relationship to the environment which serve as a basis for their subsequent actions. Since interactionist theory considers the central object in any individual's reference system to be the self, we also discuss various network architectures which facilitate self referencing. These networks are called here intelligent, self-referencing networks.

The approach taken in this paper is not meant to imply that work in alternative models of intelligence or language behavior is less promising than the approach taken here, but rather we mean only to explore the extent to which communication networks are capable of forming intelligent, self referencing systems. Nor do we mean to consider intelligence solely a property of individual human beings. If intelligence may be a property of networks and not their components, then it is legitimate to examine the extent to which intelligence may be a property of social networks rather than solely of the individual people of which they are composed. We mean to extend our analysis to communication networks in general, and explore in particular the possibility that large scale social networks such as those which exist in groups, organizations and cultures may themselves constitute intelligent, self referencing systems. Within this system, neural networks make up a subset of the more general category of communication networks.

Basic Components of Information Processing Networks

The foundational concept in the present theory is the concept of communication, which refers to the changing distribution of energy in space as a function of time. Communication in its most fundamental sense, as we define it here, means flow of energy. These flows are in general time dependent energy fields. There is no concept of intention or purpose implicit in this definition of communication; it is understood simply as a transfer of information or energy by whatever means.

The region at which two or more flows of energy intersect is defined as a node. Within this theory, the state of any node is a function of the flows which define it. If the energy fields which intersect to define a node are one dimensional (as the flow of electricity through an ideal one dimensional wire), then the node resulting from the intersection will be zero dimensional, or a point. If the energy flows are dichotomous, that is either on or off, then the node will take on only discrete values. If the energy fields are continuously variable, then the node can take on any positive real value; if the fields may vary in sign, the node may take on any real value positive or negative. If the fields are n-dimensional, then the node will be a diffuse n-dimensional region whose value will be a function of its coordinates in n-space.

In general, a set of energy fields may intersect to generate multiple nodes of various configurations, each of which will be a time-dependent energy field. The set of these intersecting energy fields at any moment will define a network, and the set of nodes resulting from the interactions will represent the "pattern" which the network represents at that moment.

This paper restricts itself to the case of one-dimensional energy fields and their resulting "point-nodes". The simplest node can take on only two values along a single dimension, which may be described for convenience as "off" and "on." The value taken by a node at any point in time is called its "activation value." The set of values taken by any set of nodes at a given moment can be defined as a "pattern". "Communication" in this restricted model may be defined as the transfer of all or part of the activation value of any node(s) to any other node(s).

Like any system, a network may be partitioned arbitrarily so that a subset of the original network is defined as the "environment" relative to the other remaining part. This partitioning may be wholly heuristic, and done solely for the purpose of ignoring the internal properties of the portion of the network defined as the environment. This concept of arbitrary partitioning is particularly important in the case of social networks, where each individual person may be considered a node in an organization and each organization may itself be considered a node in a larger social network. The individual himself/herself may be partitioned into a set of neural networks.

Often the level of communication among an arbitrary set of neurons within a single individual may be small or zero while the communication between neurons in one individual and another (albeit mediated by electromagnetic forms of transmission other than typical neural mechanisms) may be substantial. In this (quite common) case, the communication network does not reside wholly within a single individual, but rather may exists across a set of individuals. This at least gives rise to the possibility that the intelligence of such a network may not reside solely in each of the individuals, but rather might be considered a property of the interpersonal network taken as a whole.

Intelligence as an Emergent Property of Networks

A network (considered at whatever level of aggregation) may communicate with its environment through weights or links from the environment to nodes within the network. Nodes which receive information from links to the environment are defined as "input nodes", and nodes which pass information through links to the environment are called "output nodes." Nodes which have no direct connection to the environment are typically called "hidden nodes."

Input nodes receive information from the environment in the form of signals which alter their level of activation. In the general case, such signals can take on a wide variety of forms ranging from "simple, signed numbers of limited precision" to "...arbitrary symbolic messages to be passed among...units" (Rumelhart & McClelland, 1987, p. 132).

The function by which the activation value of a node is related to an incoming signal is called the "activation function". For a binary node, this function may be as simple as a binary threshold, so that the value of the node is set "on" if the input signals exceed a given threshold level, and off otherwise. For nodes whose activation values may be multivalued, activation functions may be more complicated, particularly when the activation values may also be multidimensional, but the binary representation provides a sound starting point for initial understanding.

For a network whose input nodes are binary, information received from the environment may be represented as a pattern of ones and zeros displayed over the input nodes. Thus, when a network receives information from the environment, it does so by encountering a signal at each input node at each point in time. Those nodes whose input signals exceed the threshold value will be activated, while others will remain off. The pattern of nodes which are activated constitutes a pattern which represents the pattern of signals at that point in time. The changing pattern of activations over time represents processes in the environment of which the network is "aware."

The number, arrangement and character of the input nodes, along with the character of the activation function, determines what kinds of pattern the input system will be able to represent. A one dimensional (vector) array of binary input nodes can record the presence or absence of a set of features. Figure 1 shows a vector of nodes, each of which represents a letter of the alphabet.

A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z
X	O	X	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	X	O	O	O	O	O	O

Neurons represented as a vector. Neurons marked with "X" are activated, all others are off. This pattern could represent "ACT", CAT", "TAC", "TCA", "CTA", or "ATC", since no sequence information is encoded in this pattern. Multiple occurrences of the same letter cannot be encoded within this scheme.

Figure 1 A One Dimensional Locally Encoded Network

The nodes marked "A", "C" and "T" are on, which indicates that the network recognizes the presence of those letters (features) in the environment. The one dimensional array of nodes, however, cannot encode the sequence of those features, so the pattern encoded in Figure 1 might represent "CAT", "ACT", or any of four other sequences of letters.

A two dimensional array of binary input nodes can keep track of not only the presence or absence of features, but also their sequence. Figure 2 shows a two dimensional (matrix) array of input nodes. As in Figure 1, each column represents a letter of the alphabet, but each row represents an ordinal position in a time sequence.

```
A B C D E F G H I J K L M N O P Q R S T U V W X Y Z

0 0 0 0 0 0 0 X 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 X 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 X 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 X 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 X 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 X 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 X 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 X 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 X 0 0 0 0 0 0
```

Input neurons represented as a matrix. Columns represent letters, rows represent ordinal position in a sequence. This network of neurons encodes the phrase "HELLO SPOT".

Figure 2 A Two Dimensional Locally Encoded Network

The pattern of activations shown in Figure 2 represents the English sentence "HELLO, SPOT". Higher dimensional arrays can represent correspondingly more complicated patterns.

Distributed encoding:

Both the models in Figure 1 and Figure 2 represent examples of "local encoding", in which each node represents one feature. A model which encodes a single feature as a pattern of activations among several nodes embodies what is called is called "distributed encoding", and can store considerably more information in a given number of input nodes. A set of 7 binary nodes is sufficient to encode 2^7 or the 128 ASCII characters; a 50X7 matrix of binary nodes can encode the English sentence "The quick red fox jumped over the lazy brown dog," -- or any other string of fifty ASCII characters -- including capitalization and punctuation.

Communication Processes and Network Structure

The model presented up until now has considered only sets of nodes each of which communicates with the environment, and none of which communicates with each other. Theater marquees and television screens are examples of this class of network. But while the patterns they can encode can be very elaborate, they are passive copies of the environmental input and exhibit essentially no internal processing. Nodes may, of course, communicate with each other at various levels. The channels through which nodes communicate have been called variously "links", "connections", "weights" and other terms, and those terms will be used here as synonyms. These weights may in general take on any real value, and are meant here to represent the proportion of the activation level of any node that will be transmitted to another node to which it is connected by that channel. Thus the weight $w_{i,j}$ represents the proportion of the activation value of the i_{th} node that will be communicated to the j_{th} node.

How a node will respond to the inputs it receives from those nodes which communicate with it is determined by its "activation function." The activation function determines how a node will combine the various signals it receives from all those nodes connected to it. The actual array of potential activation functions is infinite, but they may be described in general from simpler to more complicated functions.

The first is the simple linear function, in which all inputs to a given node are summed, and that node then outputs a signal which is the sum of all its inputs. Simple linear networks can have substantial information storage and retrieval capacities, but cannot produce internal representations of environmental patterns that differ from those in the environment, nor can they perform complex inferences, such as the "exclusive or" relation. Included within the class of linear networks is the perceptron, which was studied extensively by Rosenblatt (1962) and Minsky and Papert (1969) who first demonstrated the limitations of inference inherent to the linear two layer network.

A second common activation function is a simple step function, in which a node outputs a given value if the inputs to it sum to more than a given threshold. Even such a simple rule as this introduces important nonlinearity into a network which makes it capable of generating internal representations of external patterns which are not simple linear combinations of external signals, and thus substantially increases its inferential capabilities. Non linear networks can solve problems like the "exclusive or" relation (Rumelhart, et. al., 1986, pp. 318-362, McClelland & Rumelhart, 1988, Chapter 2). The step function, however, is not everywhere continuous, which causes mathematical difficulties for some learning algorithms.

A third commonly used activation function is the logistic function, sometimes referred to as a "sigmoid" function, because its shape when plotted resembles an integral sign:

$$a_{pj} = 1/(1+e^{-net_{pj}})$$

where:

a_{pj} = the activation of the j_{th} node for the p_{th} pattern, and
net_{pj} = the net input to the j_{th} node for the p_{th} pattern from all input nodes.

The logistic function is particularly useful since it provides the nonlinearity and increased inferential capacity of a step function, but is a continuous differentiable function. This is particularly important in supervised learning or "back propagation" models, since these require that the differences between the pattern output by a network and the desired or "target" pattern be expressed as a continuously differentiable function of the weights so that the weights may be changed to produce the correct output (Rumelhard, et. al., 1987,pp. 318-362).

Each of these activation functions establishes the activation value of the node solely as a function of the inputs from other nodes, but more complicated models can take into account the present absolute or relative activation value of the node. These considerations produce another family of activation functions such as "competitive learning", in which nodes already highly activated are more likely to be further activated for a given level of input than those not so highly activated (Grossberg, 1976), or "resonance", in which sets of interconnected nodes, once activated, will tend to maintain each other's activation levels (Grossberg,1978).

Activation functions can take into account variables other than the set of inputs from other nodes and the activation value of the node itself. Time is perhaps the most common such variable, and is usually included to model a decay function such that the node loses a proportion of its activation as a function of time. This decay functions as a "restoring force" which tends to return nodes to their "resting activation levels" as a function of time (Grossberg, 1978; McClelland & Rumelhart, 1988, pp. 12-15).

Activation functions need not be deterministic. Several important models, such as the Harmony Model (Smolensky, 1987, pp. 194-281) and the Boltzman Machine (Hinton & Sejnowski, 1987, pp. 282-317) employ stochastic activation functions, in which the likelihood that a node will be activated is a function of the inputs to that node. Stochastic models may well be better representative of actual neural functioning, but are almost certainly more representative of the way inputs function to activate or fail to activate nodes in social networks than deterministic models, at least insofar as the great complexity of input patterns in social networks usually precludes complete measurement of the total net input to any node.

Information Processing and Network Structure

The weights, along with the activation functions for each node, make up the structure of the network and determine the patterns of flow of information through the network. These flows in turn determine the process by which a network receives information from the environment, constructs an internal representation of that information, and outputs a response.

Conversational Networks

The main characteristic of networks as we have discussed them here is their ability to represent patterns and to associate one pattern with another. In the most general sense, conversations may be construed as sequences of patterns, with each utterance considered a pattern of sounds, words, or even letters. With this in mind, it is possible to construct communication networks whose structures are optimized for the recognition and association of linguistic patterns. The process of constructing a communication network consists essentially of defining the pattern of communication links which are allowed among the nodes.

Figure 3 shows a simple yet interesting information processing network: a three layer feed-forward network. The row of nodes at the top of the figure represent input nodes; they are connected to a row of hidden nodes, which in turn are connected to a row of output nodes. Nodes within a row are not connected to each other, nor are any of the input nodes connected to any of the output nodes except through the hidden layer, and these connections are themselves only one way paths. Input nodes may communicate to the hidden nodes, and hidden nodes to the output nodes, but the reverse processes -- hidden to input and output to hidden -- are prohibited.

A network of this configuration can receive inputs from its environment, form an internal representation of the input patterns in the hidden layer, and output a pattern corresponding to the input pattern. The pattern of weights between the input and hidden layer and the hidden and output layer will determine the relationship of the output pattern to the input pattern.

A network of this general configuration is implemented in the FORTRAN program SPOT. Its input and output layers are each in the form of the 50X7 matrix described earlier, with a 1 X 115 vector of hidden nodes between them. Each of the 7 nodes in each row of the input and output matrices are required for the distributed encoding of each character in the ASCII set, and each row of the input and output layer is thus able to represent one such character. This network can learn to associate a number of utterances or "strings" of up to 50 characters with any other arbitrary set of strings of up to 50 characters. The "memory" of what output strings "go with" what input strings is contained entirely in the pattern of weights among the layers.

The network works as follows: input strings of letters are "encoded" into their ASCII representations which consists of a seven digit array of 1's and 0's; and each node corresponding to a 1 in the appropriate row of the input matrix is turned "on", (that is,its activation value is set to

1), and all others are turned "off", or set to zero. Each letter in the string of letters thus corresponds to one row of the 50X7 matrix of input nodes.

The activation values of the input nodes (either 1 or 0) are multiplied by the weights which represent the communication strengths between the input nodes and the hidden nodes. The activation values of the hidden nodes are then calculated from the activation function given in equation (1) above -- that is, their values are set as the logistic of the sum of the activations of the input nodes multiplied by the weights from input to hidden nodes. The pattern of activations of the hidden nodes represents an internal symbolic representation of the input pattern, and serves an intermediary role between the input pattern and the output pattern (Minsky & Papert, 1969; Rumelhart, et. al., 1986, pp. 318-362, McClelland & Rumelhart, 1988, Chapter 2). The level of complexity of the internal symbolic structures that can be formed, and the level of complexity of the functional relations between input patterns and output patterns that can be learned by a network are related to the number of hidden neurons.

The activations of the hidden nodes are then propagated to the output nodes by exactly the same process. (The values of the weights determines completely what output nodes will be activated for any given pattern of input node activations, and thus determines uniquely what the network will output or "say" for any given input. How the weights are actually set will be discussed below.) These output nodes are then "thresholded"; that is, if their calculated values exceed an arbitrary threshold value, the are set to 1, otherwise they are set to zero. The resulting 50X7 binary matrix of output nodes can then be "decoded" into the appropriate ASCII characters.

A network like SPOT can be taught to associate any input phrase with any output phrase by setting the communication weights appropriately. Thus, for example, it is possible to choose a set of weights such that the pattern of activations of input nodes corresponding to a phrase such as "How are you, SPOT?" turns on the set of output nodes which correspond to the phrase "I'm fine, thank you," while the pattern of input activations corresponding to another phrase will activate a pattern of output nodes corresponding to still another phrase. How many such pairs of input and output patterns the network can learn is a function of the number of nodes and the degree of similarity among the patterns.

Forming and Changing the Network Structure

"Teaching" the network to associate arbitrary input patterns with appropriate output patterns requires changing the connection strengths between input and hidden nodes and between hidden and output nodes. Processes by which network structure can be changed might be called purposive or supervised processes. One such method, which is a variant of the Hebb rule, has been suggested by Rumelhart, et al, (1987, pp 318-362). The essential feature of this "back propagation" model is the existence of a "target" pattern, that is, a pattern which is, for any arbitrary reason, considered to be the "correct" output pattern for a particular input pattern. In the conversational networks described above, for example, the output pattern "I'm fine, thank you." might be the "correct" pattern the network is expected to output when receiving the input pattern "How are you, Spot?"

The target pattern represents a pattern of activation values of the output nodes of a network corresponding to the desired output. The difference between the pattern desired and the pattern actually output by the network can easily be defined as the difference between the activation values of the nodes observed and those expected by the pattern. These differences may be considered the errors produced by the network. These errors can of course be described as a function of the activations of the nodes, which can in turn be expressed as a function of the weights connecting the nodes. It is possible, then, to express the errors as a function of the weights. If the activation functions of the nodes are continuous (as is the logistic function typically used in back propagation networks), then the derivative of this function is defined everywhere on the function, and it is easily possible to modify the weights (usually by a quasi steepest descent algorithm) until the error is minimized. Such a network can learn to produce a desired output pattern for a given input pattern.

Both the SPOT and ROVER algorithms described in this paper are back propagation models; they are supplied with a set of input phrases along with the set of desired output phrases associated with those inputs. Connections between input and hidden nodes and hidden and output nodes are initially randomized, so that when the network receives an input pattern, the response it outputs is simply a random activation of the output nodes. The errors are then calculated as the differences between the actual values of the output nodes and the values associated with the correct pattern. By a quasi steepest descent algorithm, the weights of the connections among the nodes are then modified until all the correct response patterns are associated with the appropriate input patterns.

These networks are "trained" by presenting them with lists of paired patterns. The first pattern in each pair of patterns is an "input pattern", and represents a given pattern of activation of the input nodes of the network. The second pattern in each pair represents the pattern of activation of the output nodes which is meant to be associated with that input pattern.

When the input pattern is initially displayed, the (initially random) connections between input and hidden nodes and hidden and output nodes causes a random pattern of activation of the output nodes. The values of this output pattern are subtracted from the values in the "target pattern" and the differences represent error. These errors can then be expressed as functions of the activations which in turn are expressible as a function of the weights. The derivative of this function is then calculated and the weights are modified, the input pattern is presented again and the process is iterated until the errors fall below a specified tolerance. Because the activation function of the nodes in SPOT, ROVER and ROVER II are nonlinear (logistic) functions, this procedure is essentially an iterative non-linear multiple regression model which finds a set of weights which maps the pattern of input activation values onto the desired pattern of output activations.

Figure 4 shows SPOT learning the "correct" responses for two phrases: to the phrase "Hello, Spot!", it is expected to say "Hello.", and to the phrase "How are you, Spot," it is expected to reply "I'm well, thank you." As implemented in SPOT, the network requires 8 tries to get both responses correct, although the network "overlearns" for two more iterations (not shown) until the error is within the prespecified tolerance.

The network begins by producing a random response to the initial inputs, but quickly learns the correct response through a series of successive approximations, each time closer to the pattern than the last. Figure 5 shows errors for each iteration, along with the elapsed time for each trial.

The values of the weights represent the learned pathways of communication between the input nodes and the output nodes. They represent the network's "memory" of what string of ASCII characters it should output for any given input string of ASCII characters.

Hello, Spot!
^_^__^_!/ ^_^_^_^_^_5!A^_!/' ^_/^_!^_'^_
?^_
How are you, Spot?
Hello.
Hello, Spot!
Hmmlo. ,(0' '_ p(
How are you, Spot?
Jello. 0 (
Hello, Spot!
Hmmlw.$,(0' ("t,
How arė you, Spot?
Jen w. (p' /_d,
Hello, Spot!
Hmllo.
How are you, Spot?
J_m w&'($ t'b$' wof,
Hello, Spot!
Hello.
How are you, Spot?
Igm wed(, tha$d you.
Hello, Spot!
Hello.
How are you, Spot?
I'm well, thafk you.
Hello, Spot!
Hello.
How are you, Spot?
I'm well, thafk you.
Hello, Spot!
Hello.
How are you, Spot?
I'm well, thank you.

Figure 3 Three Layer Feedforward Network SPOT Learning Two Phrases (Dialogue)

Conversation with Galileo*SPOT
O: = Other; S: = SPOT

O: How are you, Spot?
S: I'm well, thank you.

O: How are you, Sopt?
S: I'm well, thank you.

O: How are you?
S: I'm well, thank you.

O: Hou art yee, Spet?
S: I'm well, thank you.

O: How are
S: A'm well, thank you.

O: How you doin', Buddy?
S: Agm weld, t _nk)>v,

O: Howdy do?
S: A'm"weld, phanc yov(

Figure 5 Conversation with Three Layer Feedforward Neural Network SPOT

Table One: Total Squared Error by Elapsed Time for Learning Two Phrases.*

CumElapTime	Tot ErrSqrd	Elapsed Time
16.92000	22.85055	16.92000
29.55000	27.98030	8.40000
42.85000	24.09617	8.68000
55.20000	16.42570	8.18000
67.24000	12.22997	7.86000
78.66000	6.93973	7.52000
89.37999	2.93760	7.09000
100.03000	1.62046	7.03000
110.63000	1.67598	7.03000
120.73000	.76299	6.59000

*) Rate = 1.000 Momentum = .300 Heat = .000
Threshold = .500 Local Tolerance = .300
Nodes:Input = 210 Output = 210 Hidden = 115
Toshiba 30386 @20mhz with 30387 coprocessor

Figure 4 Three Layer Feedforward Network SPOT Learning Two Phrases

Such a network can be taught to carry on a rudimentary conversation. ("Teaching" the network consists exclusively of setting the weights or communication strengths between input and hidden nodes and hidden and output nodes.) For an input phrase such as "How are you, Spot?", it might be taught to respond "I'm fine, thank you." What's more, as shown earlier, because the activation values of the output nodes are determined by the entire pattern of activations in the layers preceding them and the entire pattern of connections among those layers, the complete output pattern can be activated by an input of only part of the input pattern; minor misspellings of the input string, or even leaving parts of the input blank will still result in the output of the entire pattern. Thus, for the input string "How are you; Spot?", or just "How are you?", the network would respond "I'm fine, thank you." As the input pattern deviated further from the pattern the network had learned to associate with the output, the output pattern would degrade fairly gracefully, but would retain the main features of the correct output pattern even with considerable distortion or deletion from the input pattern.

Figure 6 shows a brief conversation with a three layer feed forward neural network (SPOT) in which the input pattern (marked "O:" in the figure) is gradually changed from the pattern the network has learned to recognize. The network is able to output the correct response even after substantial changes in the input pattern, but eventually degrades as the input pattern departs further from the learned pattern.

Conversation with Three Layer
Network with Feedback
O: = Other; S; = Spot

O: How are you, Spot?
S: I'm fine, thank you.

O: How are you; Spot?
S: Still fine, thanks.

O: Oh, I'm sorry.
S: That's O.K.

Figure 6 Conversation with a Three Layer Network with Output Feedback

Innovative Language

As the previous example shows, the thresholding function guarantees that a network can continue to produce without error an output pattern it has learned to associate with a given input pattern, even when the input pattern differs to some extent from the pattern originally learned. One way, then, that a network deals with an innovative input pattern, that is, one it has not previously encountered, is to output the pattern that corresponds to an input pattern which is similar to the novel input pattern. As the example also shows, however, as the input pattern deviates still further from the original form, the network outputs a pattern which also differs from the one learned. When these deviations are arbitrary, as they are in the example, the network can produce an output pattern that is itself arbitrarily degraded or noisy. The network will, in other words, produce a novel output when receiving a novel input, although in this situation the output will typically be meaningless, as in Figure 6. Such productions of novel but meaningless output patterns in response to novel input patterns does not meet Chomsky's criterion that the novel output be meaningful.

It is possible, however, for novel inputs to a network to be related in systematic ways to input patterns the network has already learned. When this happens, it is possible for the network to output a novel pattern which it has not previously encountered, but which is still a meaningful pattern.

A network identical in structure to the network shown in the previous example, although employing local rather than distributed encoding, was taught to associate the input pattern "GREET" with the output pattern "HELLO", and also to associate the input pattern "MY FRIEND" with the output pattern "BOB". When the pattern "GREET MY FRIEND" is input to the network, it responds "HELLO BOB". Neither the input pattern "GREET MY FRIEND" nor the output pattern "HELLO BOB" has ever been encountered by the network before, but the network is able nonetheless to generate an appropriate English sentence which is a "correct" novel response to the novel input pattern.

To be sure, this is a very limited example of innovation, but, in principle, it responds to Chomsky's (1972) argument that the number of possible English sentences is simply too large to have been learned and remembered, but must instead be generated from a set of internal rules. (Chomsky, 1972, pp 11-12). The sentence "HELLO BOB" was "generated" by the network in response to a novel input not previously encountered, but the network was not following any rules in so doing. Nor was the novel response in any meaningful sense programmed into the network, but rather was exclusively the result of its training.

Self Referencing Networks

The network shown in Figure 3 has several interesting conversational properties: it can associate appropriate linguistic outputs with arbitrary language inputs, it can recognize a known input pattern even if it differs fairly substantially from the exact form in which it was learned, and it can produce meaningful and novel output utterances in response to novel inputs. It will, however, always respond in exactly the same way to the same input pattern regardless of the context in which it occurred. The network illustrated in Figure 7, on the other hand, is somewhat more sophisticated. This network resembles the previous network except for feedback loops from the output nodes to half of the input nodes. This means that the input pattern which is associated with a given output pattern includes not only the pattern from the environment, but also the pattern previously output by the network. This network need not respond in exactly the same way twice to any given input pattern from the environment. The network in Figure 7 is self referential in that it takes its immediate past behavior as part of the pattern to which it must respond.

In ROVER, the computer program which implements this design, the feedback from output nodes to input nodes is done after thresholding the output units. It is more appropriate to think of this network as monitoring its behavior rather than its "thinking". If the feedback loop were implemented before thresholding, the input nodes would be aware of what the network was thinking just before it "spoke", but would not be aware of what it actually said. A more sophisticated network (like the one implemented in ROVER II, below) could, of course, be aware of both by taking feedback from both places.

Figure 8 shows a conversation between a network of this type and a person (other). Note that the network responds differently to exactly the same input string depending on what it has said previously. The network has taken its past behavior into account in determining its response to the input from its conversation partner.

The self-referential capability of Rover II adds another important capability to the network. The network takes into account both what it itself has previously said, along with what its conversation partner has responded. But, if its conversation partner does not respond, then ROVER takes into account only what it has just said in determining what it is to say next. This means that ROVER can use its own past utterances to cue its future utterances, and, as a result, may memorize a string of outputs of indefinite length. Although we are not aware of a mathematical analysis of the capacity of back propagation networks, ROVER learned to recite the text of "A Bicycle built for two" in about 20 minutes.

While the network shown in Figure 7 is self-referential in an important sense, the network shown in Figure 9 is even more so. The networks described so far associate input patterns with output patterns through weighted communication connections from input nodes to output nodes through hidden layers of nodes. When the network has learned an association, the activation of the nodes associated with the input pattern will be channelled through the weighted communication channels to the nodes associated with the proper output pattern. It is also possible, as shown earlier, for a novel input pattern to be related in a systematic way to patterns which a network has previously learned, so that the network "knows" a correct response for even these novel input patterns. But when an input pattern that the network has not learned to associate with any particular output pattern is input to the network, it will output an arbitrary nonsensical pattern. The network does not know whether it "knows" what it is about to say, and will produce babbling for unlearned input patterns.

It is quite important that a self-referential network like ROVER not babble, since such a network will necessarily take into account the immediate history of a conversation as the pattern to which it must respond. If that history contains a sequence of random or arbitrary utterances, there will likely never be a consistent pattern for the network to learn, which would seem to present a formidable barrier to developing conversational competence.

The network in Figure 9 (implemented in the algorithm "ROVER II") has an additional node which monitors the other output nodes to determine whether they are patterned or not. In order to understand how this monitor node operates, it is useful to recall that the network represents a pattern by turning some of its output nodes "on" and turning the rest "off". When the network is representing a pattern it has learned, therefore, its output values all be either nearly 1.0 or 0.0. (Since the activation function for this network is the logistic, actual values range closer to .9 and .1.) When the network is representing arbitrary or random nonsense, on the other hand, the values of the output nodes will take on the full range of values between 0.0 and 1.0, with a mean value of about .5. Thus a network which is representing a learned pattern will have output activation values that are maximally different from the mean activation level.

Input to the monitor node, then, consists of the (squared) differences between the actual values of each output node and .5, the mean value expected for an arbitrary nonsense output. Once appropriately normalized, these values are summed and entered into the activation function for the monitor node; if its actual activation exceeds a preset threshold, the monitor node "senses" a learned, patterned output, and activates the network's output. If, on the other hand, the activation value of the monitor node falls below its critical threshold, it is quite likely that the pattern represented by the output nodes is simply an arbitrary, unlearned nonsense pattern. In this case, the network's output is set to "blank". It is important to note that this node does not determine whether the output pattern is "correct" or "sensible", but simply can detect the difference (in most cases) between a systematic, patterned output and gibberish.

While it would be wrong to attribute too much sophistication to the model implemented in ROVER II, the monitor neuron goes beyond simple self reference, and adds a minor but nonetheless important self evaluative dimension to the network. While the model implemented in ROVER is "aware" of its past behavior and takes it into account in determining its subsequent behavior, the model in ROVER II is aware of both its past behavior and certain characteristics of its present "mental state" or "thinking", and it "evaluates" that state before implementing the action implied therein.

Conclusions and Implications

While the networks implemented in the SPOT and ROVER algorithms show in principle that one may construct conversational, self referencing systems of communication networks, they are in fact very simple, small and limited networks. The largest (ROVER II) consists of only 601 neurons, and 39,725 possible communication links. Compared to a single human brain, with perhaps 10^{11} neurons, these networks are minuscule. Further, while the most sophisticated of the networks described here, the architecture of ROVER II is severely limited compared to that of a single human individual. ROVER II has only one input "sense": its input is restricted to 50 ASCII characters from a file or keyboard, while a human individual can receive information from multiple senses. The simultaneous activation of nodes connected to visual, auditory, taste, olfactory and tactile senses, coupled with a simple Hebbian learning rule which enhanced the connection among those nodes simultaneously activated, make possible the formation of complex internal patterns which can be activated by partial inputs, so that a picture of food, for example, could produce the same pattern as the taste or smell of the same food. This is in principle possible for an artificial network like ROVER II, although the technical difficulties of simulating such massive parallelism on serial architecture machines are for the moment quite formidable. (Although the ROVER II architecture is completely parallel, its implementation is simulated on a serial machine. This means that it cannot actually do any two things simultaneously, and must take in information in "batches" and operate in discrete "jumps" or "cycles".)

ROVER II is thus substantially handicapped when taking in information needed to define its social situation; it may well be more appropriate to compare it to a person who received all his or her information about the world from a teletype which could deliver only 50 ASCII characters at a time. In spite of these limitations, however, ROVER II provides a useful basis for understanding the way in which the basic structure of a network functions in the processing of information which can be useful to an analysis of social networks and their information processing capabilities.

While none of the simple networks presented in this paper may be claimed to exhibit anything more than the most rudimentary intelligence or self awareness, they illustrate certain factors that are essential to the development of an intelligent, self referencing, goal directed network:

First, there must exist a set of input nodes which receive information from the environment, a set of hidden nodes, which allow the network to form an internal representation of the input information, and a set of output nodes which the network communicates information to its environment. Second, there must be a pattern of communication channels from the input nodes to the hidden nodes and from the hidden nodes to the output nodes. Third, there must be a set of communication links from the output nodes to the input nodes so that the network can receive information about its own behavior. Fourth, there must exist a node or set of nodes which monitor the output activations of the network to determine whether those values represent previously learned patterned information, and which can activate a "training mode" if the output is not patterned so that the network can learn a response to the new pattern. Fifth, there must be a set of nodes which encode a pattern or goal state which is associated with each input pattern, which is intended to serve as the appropriate output for that input. Sixth, there must be a defined error function which makes it possible to calculate the extent to which the pattern displayed by the output nodes differs from the goal state encoded in the pattern nodes. Seventh, the error function must be able to express the error as a function of the activation values of the nodes. Eight, the activation values of the nodes must in turn be expressible as functions of the weights or communication channels among the nodes. Ninth, there must be some active algorithm by which the network is able to modify its internal pattern of weights to reduce the errors. Tenth, the overall functional relations from input through hidden to output nodes must in general be non-linear.

When these conditions are met, it will be possible for a network to receive information from its environment, form internal symbolic representations of that information, act (produce outputs), monitor its actions, and modify its actions if they are inappropriate. Networks which meet these conditions can not only learn about their environment in a passive way, but can actively modify their own configuration to produce desired outputs for given inputs.

To be sure, the implementation of sophisticated, intelligent, self referencing networks with sufficient capacity to exhibit interesting behaviors involves no minor technical accomplishment, particularly when simulated on serial architecture machinery. Nor are the difficulties solely technical. The monitor function described in the ROVER II model is quite rudimentary, and can only determine whether a proposed output is patterned or not. Much more sophistication is required from a model capable of interesting behavior. Certainly a more sophisticated monitor would take into account the appropriateness of the output for the circumstances under which it was proposed. An satisfactory model would require as well that the network take into account the reaction of others in the communication situation. Cooley's (1902) "looking glass self" model requires that the reaction of others to one's behavior can result in "...pride, mortification or shame," which are emotions well in advance of ROVER II's crude capabilities.

Nonetheless, however crude the level of implementation, the fundamental architecture employed in ROVER II represents a useful first step. Indeed, while the limitations of ROVER II are severe and obvious, it does exhibit cognitive abilities that some have claimed distinguish human intelligence from machine intelligence: First, it can recognize limited language patterns and associate them with appropriate responses. Secondly, it is self-reflexive, and can observe its own activity and take that activity into account when determining its response. Third, it is recursive, and can revise a past judgment based on new information; that is, it need not always give the same response to the same input, but evaluates each input in light of its previous activity. Fourth, it is robust enough to provide the "correct" response even when the input is partially garbled or incomplete. Fifth, it can monitor its own internal cognitive state in a limited way, evaluate its potential activity and modify that activity based on that evaluation. And sixth, it can learn to associate new patterns through interaction with others. Since ROVER II can do all these things, yet is clearly not remotely "human", these characteristics can not be the essential characteristics which distinguish human intelligence from machine intelligence in a qualitative way. While it is impossible to rule out the possibility that there is a qualitative difference between what algorithms like ROVER II achieve and the actions of intelligent organic systems, it is important to point out that at least a major component of the difference in cognitive capacity between ROVER II and a simple organic intelligence is attributable to the sheer size differences between these systems.

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Chapter V

An Introduction to the Study of Information Systems in Modern Society

Tom Jacobson

Since the 1950's or so, four media have as a group characterized the American communication environment: television, radio, newspapers and home telephone service. They have brought into every citizen's life a selection of information and entertainment from the world outside. Newspapers, and later television and radio, brought us information about the goings on in the world. Television saturated us with lowest common denominator, but nevertheless attractive, entertainment. The telephone, unassuming technology though it is, tied the country together into a communication web allowing virtually everyone in this large nation to be instantly in contact with one another, at very low cost.

This environment is not limited to the home but involves society outside the context of the home as well. It functions in ways essential for the daily conduct of business and government. Newspapers not only inform the citizen. They are also "must" reading for government representatives and business leaders who need to keep abreast of social, economic and political developments. Television, too, acts in the news role but it also provides the most powerful advertising vehicle in history, an integral part of growth in the consumer economy. Telephones, in addition to providing home service, are as important to the conduct of modern business as are our roads and the trucks that transport raw materials into factories and finished goods to market.

The various roles played by these media may not seem especially profound to most of us today. No doubt this is because we use them so regularly. Nevertheless, they are quite remarkable. In many ways they are a central feature of our society, and they contribute profoundly to our growth as individuals. If forced to do without them we would be adrift, out of touch with friends, trends and events, and the economy could not function. This is hard even to imagine.

For reasons such as these, communication has over the past few decades attracted increasing attention in sociology, political science and other social science fields. As a result, the field of research exclusively devoted to communication evolved, much of it concerned with mass communication systems like newspapers and television and to technologies like the telephone.

But while these studies still form the bulk of communication research, newer communication processes are emerging that call for the attention of researchers, policy-makers and of the average citizen. These are communication processes enabled by technologies that rely in some essential way on the computer. Computers have impacted the way newspapers are published, through electronic typesetting. They have made live global television coverage possible through satellites, and they have automated the telephone system. They are enhancing old services almost beyond recognition and creating entirely new services as well, which will no doubt play as significant a role in society as did the newspaper, broadcast, and telephone technologies we now know so well (1).

This chapter introduces these new and emerging communication technologies, along with some of the opportunities and problems they are likely to present. All are existing systems and services today, not pie in the sky forecasts. They are matters of considerable interest in business, government, and academic circles. First introduced are the services, including those for the home as well as those used by society's largest institutions. Second, both the benefits and problems that may result from widespread adoption of these services are considered. Also considered are the potential effects of new communication technologies on our system of democracy. Finally, with this background in new communication systems, the study of emerging technologies and their effects is introduced.

New Communication Products and Services

New communication products and services can be divided into two groups: those produced for business and those for consumers. These are reviewed in order.

Begin with changes in large corporations over the last ten years or so. A new management position has opened up in the corporate world during this time, that of the telecommunications manager. Until just a few years ago, all telephone service was handled by American Telephone and Telegraph. Local and long distance services were all that was available, and telecommunication costs represented a simple one line item in corporate budgets. Today, many large companies use telecommunications systems involving everything from touch tone phones to satellite links. Their telecommunication budgets are a sizeable portion of overall corporate expenditures, and telecommunications managers often occupy vice-presidential positions.

The reason for this rise in telecommunications costs and managerial status is that telephone service has been augmented by a host of other communication services now required in competitive companies. One common practice, for example, is related to general management needs. Many large companies have multiple geographic locations. Whether these locations be components of an automobile manufacturing process or outlets of a pizza chain, these must be tied together through use of modern telecommunication systems. For the former, production schedules, parts costs and automated inventory information keep the locations mutually informed on a day by day, or even minute by minute, basis. Pizza chains are able to calculate revenues each evening and place orders for needed ingredients automatically, across the whole chain.

Another common service involves accounting. Increasingly, corporate payroll accounting may be performed by specialized firms hundreds or thousands of miles away. High speed data lines are required to send corporate records to be processed and back. Corporate telecommunication managers must determine the most cost-effective way for their companies to perform such communication tasks. This may involve company ownership of transmission systems, lease arrangements with communication providers, or some mix of these two arrangements.

Automobile and pizza companies aren't the only businesses that have become reliant upon modern telecommunications, and site coordination and payroll accounting aren't the only common uses. Airlines as we know them today, for example, could not operate without global reservations systems having hundreds of terminals each in cities of all sizes. American Airlines operates the largest such reservation system allowing instant updating of schedules and reservations minute by minute around the globe. This system is used by all the major airlines. Banking is another example of a business that is essentially dependent on modern telecommunications. The Society for Worldwide Interbank Financial Telecommunications (SWIFT) maintains a system that allows banks around the world to balance their books at the end of each day's transactions. This dependence on telecommunications is repeated in many other industries, including textile manufacturing, clothes retailing, aircraft design and others.

It is safe to say that computer communication has become indispensable in the business world. Around this growth in the use of telecommunications has grown a whole new industry, and a whole new set of large and important corporations. These are corporations that provide communication services. MCI, Western Union, General Electric, AT&T and all the large telephone companies offer not just telephone or telex service. Each offers a wide array of services, primarily aimed at corporate America. Some of these are telephone services; some are high-speed data network services. Some companies do computer processing. Collectively, they are referred to as the primary information sector of the U.S. economy.

The largest market for new information services actually lies in office automation systems. In-house "switch-boards," now offer integrated capacities for electronic mail, fax, voice mail, access to company databases, word processing, and others. Referred to as Automated Private Branch Exchanges (PABXs), these systems are offered both large and small, tailored to the needs of individual industries and specific companies' needs. All the new information industry firms mentioned here, plus a great many others, are struggling for a share of this office automation market.

The IBM corporation is emblematic of these changes, itself having changed dramatically in recent years. IBM owns and operates tens of thousands of miles of data networks and offers network services to its computer clients. It no longer bills itself solely as a computer company. IBM's business today is to provide "information services," including home database access, office automation systems, and corporate data transmission services, as well as computer capacity.

The preceding pages provide an introduction to changes in the business sector resulting from innovation in information technology. But consider now changes emerging in the consumer sector, beginning at home with the telephone. This communication technology has always been rather marvelous, if only for its availability and reliability. Advancements in telephone technology have been consistent through the years, though seldom apparent to the home user. Recently, however, the telephone system has evolved rapidly. We now have "enhanced" telephone services that allow call forwarding, call interruption, and automatic answering and recording. Soon to come are services that will allow telephone users to screen selected numbers, automatically dial a return call to the number that called most recently, and to place voice messages without the use of a home answering machine.

Another home oriented service is newer but promises rapid growth. This is Videotex. Videotex services provide textual and graphic information to consumers at home, delivered over telephone or cable lines. They use desk-top computers as display and control devices, and they are inexpensive. X*Press, a service of TCI International, delivers news, sports, weather and many other kinds of information through cable systems as part of cable packages with no added cost. Prodigy is a joint venture of Sears & IBM which offers similar information, as well as electronic mail and an extensive home shopping services for a flat rate fee of $10 per month.

For homes having personal computers, and cable in the case of X*Press, these services offer a wide range of types of information at a low cost. Being a cable service, X*Press has potential access to the 45 or so million cable connected homes. Prodigy projects its market at 11 million homes. While these services will not be likely ever to reach the nearly universal use that television and the telephone have enjoyed, they will very likely reach a sizeable portion of the upper-middle class in the near future.

A brief review of emerging home services must also mention electronic mail. Electronic mail systems use computer networks to transport messages among individuals. Fast, reliable and very simple to use, electronic mail systems have become common in higher education, government and larger corporations. Well known companies such as MCI and Western Union offer electronic mail services. And, the Prodigy system mentioned above offers electronic mail for home PC owners. With a subscriber base of over 10,000 and growing fast, Prodigy's electronic mail is on its way to becoming part of many American households.

Benefits and Problems Associated with New Products and Services

Reviewing new products and services, then, provides some evidence that a new communication environment is emerging. If the old environment is symbolized by newspapers, television and the telephone, then the new environment is symbolized by computers and computerized communication networks. Whether in the household, the business office or the industrial sector, new products and services have sprung up and are being widely adopted.

However, upon reflection it becomes clear that problems may arise in this new communication environment. Some of these problems affect us as individuals. Others are noticeable more broadly at the economic level. Yet others become apparent at a broader scope still, within the social and political institutions comprising society. Considered one at a time, the opportunities for each tend to be matched by existing or by potential problems.

Benefits and Problems for Individuals

It may be said that our society places a premium on the rights and happiness of individuals above all else. When looking at the new technologies one can identify many that can be used to enhance the quality of life for individuals, and others that threaten it.

The potential benefits are many. For example, education and self-improvement may benefit greatly from new communication systems. Communication networks allow those for whom travel to schooling places is inconvenient or impossible to "log in" to educational system computers and use educational resources from home. This is referred to as Distance Learning. The educational resources available include number-crunching computers, of course, and electronic card catalogs. They also include tutorial type computer programs that simulate physical and social problems and that teach geometry (2). These educational programs have the advantage that they can be run at a level and pace suitable for the needs of students, tailoring learning at the individual level.

Still other resources available include "discussion groups" whose interchanges take place over computerized versions of bulletin boards and computerized conferences. Accessible through both schools and services such as Prodigy, these discussion groups are often on educational topics. Equally common is discussion on casual topics such as hobbies, sports, cooking, wine tasting and a wide range of other topics. Conversations range from serious to silly, reflecting in each case the subject matter under discussion and the personalities of individuals involved. These are popular and growing for many reasons, but high on the list of such reasons is the fact that people with like interests don't all live in the same geographic locale.

Since networks offer interactive capabilities at low cost, communication on such topics can be made available without the cost and inconvenience of travel. In short, computerized discussion groups offer individuals the opportunity for social interaction previously unavailable.

There are many areas where individuals may benefit from new communication systems that cannot be discussed at length here. New technologies offer new opportunities for self-expression, often made possible through publication allowed by desk-top publishing systems. Abundant opportunities for small personal businesses are also made possible. Computers and networks can help individuals manage the planning, bookkeeping, and other work involved in running a business that sometimes right from home. Writers, software engineers, consultants, graphics artists and those in many other career areas may benefit in this way, allowing each to conduct the business of their choice in the comfort of their homes, in the lifestyle of their choice.

Educational, social, and business opportunities are promising, and some are available today. All impacts on individuals are not necessarily so rosy, however. Problems seem to be arising as well. Perhaps chief among these is the threat to individual privacy. The same set of networks that allow businesses to efficiently process paychecks and individuals to social interact in online conferences also make it possible for large institutions to gather information about individuals and disseminate it rapidly. Credit bureaus such as TransUnion and TRW, for example, have always kept, and sold to those who'll pay, records on the credit worthiness of individuals. But only in the last ten years or so have they had such a vast amount of information and been able to distribute it so easily. There are over 2,000 credit bureaus in operation. The largest five of these firms have over 450,000 records, covering at least 80 percent of Americans above the age of eighteen.

The difficulties here are numerous. First, many individuals would prefer to keep their personal histories private as a matter of principle, even if their credit histories are good. Second, credit records are not always accurate. They sometimes contain errors or are out of date. Third, they can be used for purposes that have no connection with credit checks or buying anything at all. They may be, and sometimes are, used to evaluate job applicants for reliability or apartment rental applicants for general character without the applicants' knowledge. One might argue that credit references are useful indicators of good character and reliability. But it is also true that credit references seldom tell the whole picture. Do we really want important judgments being made on individuals without giving each individual an opportunity to explain their life from his or her own point of view?

Privacy is highly valued in our society, and the Congress of the United States has given potential threats to privacy careful consideration. Privacy Acts were passed in 1973 and 1984, designed to protect against at least certain forms of intrusion. Other threats to the individual are given less consideration. For example, the new communication environment is increasingly technical. Higher and higher degrees of literacy and technical capability are required to participate in social and economic institutions. What effect might this have on individuals raised out of reach of such systems, on those who are unable to learn the literacy and capability required? It seems likely that they will be relegated to jobs which use technology to routinize and degrade job quality rather than to enhance it. New technologies have not resulted in large job losses as some had feared early on, but the jobs new technologies create are often dull and repetitious, such as standing on a production line watching the work performed by machines, or working in retail checkout lines where even simple addition is not required, because the computer does it all. Some analysts fear that the longer an individual works in such an environment the less suited they may become for more complex and meaningful work.

Another set of potential problems related to both privacy and work quality may result from the use of computers to monitor work performance. Management has been quite successful in recent years finding ways to monitor work speed and quality in great detail. In typing and data-entry positions, keystrokes are counted, minimum-output levels strictly maintained, and high-output bonuses rewarded. In telephone operator positions, supervisors randomly listen-in to conversations between operators and callers, checking for efficiency, courtesy, and speed.

What is the difficulty here? One can argue that such supervision is the right of the employer. At the same time, human beings have never received such detailed scrutiny in the workplace. Even highly efficient and reliable workers complain that such monitoring creates psychological stress, and that it is personally demeaning because it implies a lack of trust. As we become increasingly automated, we must ask ourselves whether we really want to foster such an environment in the workplace. As workers relate more and more often simply to machines and even have their performance monitored by machines, psychological isolation and frustration may become a widespread side-effect of new communication technologies.

Benefits and Problems for the Economy

In addition to its emphasis on individual rights, our society has placed premium value on the importance of economic well being and the centrality of the market place in promoting this well-being. As indicated earlier, a host of new products and services has made telecommunications much more important in the business world than in previous decades. This increased dependence on telecommunications translates into a number of specific opportunities and problems.

The opportunities have appeared in numerous areas, ranging from production to marketing, sales, and customer service. For example, one of the more commonly noted innovations in production results from advances in two related areas: Computer Automated Design and Computer Automated Manufacturing, or CAD/CAM, systems. The design process has been moved from the drafting table to the computer. Graphics software now allows auto parts designers and others to "draw" using the computer, with all the benefits of precision in measurement that computers have to offer. At the same time, computers have been introduced into the production line, controlling assembly processes, measuring amounts of needed materials, and monitoring supplies levels.

Both of these innovations have been significant in their respective fields, but together they are even more useful. Today, parts specifications represented in design drawings on computerized (CAD) systems in a design department can be fed directly into computer automated manufacturing (CAM) systems on a factory floor. This saves time required for reprogramming the CAM's, speeding up product development, and vastly improving the flexibility of manufacturing processes. Robots are the most visible and dramatic manifestation of computer automated manufacturing, but are also the least common. Very large factories of all kinds now employ CAD/CAM systems of varying designs and with varying functions.

In addition to improving speed and flexibility in existing processes, new information systems offer businesses new opportunities to generate revenue. Newspaper publishers had initially worried about the possibility that delivery of text directly to homes through videotex systems might make newspapers obsolete. More recently, publishers have realized that videotex services are more likely to supplement newspapers than replace them. As a method of hedging their bets, many publishers have gotten into the videotex industry, by making their newspapers available electronically. DataTimes is a database firm offering the contents of over 30 newspapers. VU/TEXT is another database firm, offering over 40. This postures the involved companies for a videotex future, while providing a new source of revenue today.

Customer service processes also benefit directly. Computerized inventories allow maintenance departments to know instantly whether a part needed for repair purposes is available. Toyota's Lexus automobile comes with a maintenance package that involves satellite distribution of maintenance records on each vehicle sold, maintained over the life of the car and made available to Toyota repair shops around the world instantly upon request.

Such innovations have in fact impacted the economy as a whole. Research and development is more effective. Traffic over transportation routes is maximized. Coordination between offices, factories and warehouses is improved. And economies in whole industrial sectors have been made generally more efficient.

Not all impacts are beneficial however. Automation seems to be having two contradictory effects on workforce requirements. As mentioned earlier, automation has resulted in creation of many jobs, but lots of these are very low skilled positions. On the other hand, highly skilled technicians and managers are required to develop new systems and services and to manage them. The need for such skilled personnel is so great that despite a vigorous university system we now have a shortage of scientists and engineers. This makes it necessary for many corporations to provide training, something they seldom had to do previously.

Another workforce related problem comes simply from the fast pace of change. The average American today is expected to have at least 6 career changes in their lifetime. As in the case of auto workers who have lost jobs due to Detroit's declining sales, significant retraining is often necessary to work in other labor markets. This retraining is often a difficult process for the individuals involved, and it now involves hundred of thousands of people each year. Retraining, in addition to training, then, has become such a common and widespread need that it becomes a problem for the economy as a whole, one to which our educational and business institutions will have to attend.

Effects of rapid change have been felt in the white collar sector as well. Computerized communication systems have allowed companies to spread out geographically, as previously mentioned. They have also allowed information to be diffused within corporate organization structures, breaking down management hierarchies that have long been taken for granted. Increased frequency in product changes, new product developments, corporate acquisitions and product repositionings have resulted in management environments where even top managers feel constant performance pressure. Upper management may have its privileges, but fat-cat company presidents who make a few decisions a year and vacation the rest of the time are in a minority.

Finally, it should be noted that even as innovation and increased efficiency offers opportunities within our economy, the competitive environment internationally is rapidly heating up. The same telecommunication systems that maximize management, production and distribution systems within this country's economy also produce such benefits globally. Firms can compete internationally with increasing ease. The United States is increasingly vulnerable to competition from countries such as Japan and Germany. And, this has effects on internal conditions such as availability of financing. In many industries small firms no longer compete just against other American firms, but against firms in all the world's countries.

In summary, it may be the case that new communication technologies have had a beneficial effect on the economy as a whole, and on specific businesses in particular. But the pace of change, troublesome results in the workforce and management, and increased competition present conditions that must be addressed if our economic opportunities are to be maximized, or if we are simply to hold our own.

Benefits and Problems for Government

While the pursuit of individual happiness and freedom to conduct business have been pillars of the American way of life, the system through which these are protected has been the institution of political democracy. Representative government is designed to provide equitable access to these and other basic rights. The realm of government is as subject to technological change as are the realms of private individuals and businesses.

The role of communication in the democratic process has changed remarkably during our historical evolution, most notably of late with the dramatic role assumed by television. Despite the fact that we may not yet fully comprehend the impact of television upon our political institutions, emerging computer communication systems threaten to change the role of communication in democracy once again. Citizen access to, and discussion about, political information will almost certainly be enhanced through use of electronic mail and bulletin boards. And, much discussion has been devoted to the possibility that computerized systems may allow instantaneous and direct voting as well as more efficient administration of governmental programs. But again, we should anticipate both problems and opportunities.

Use of electronic mail and bulletin board type systems for political discussion have assumed a number of forms. One way in which they have been used is exemplified by the Campaign Hotline operated out of Washington D.C. by two former political reporters. As a combination clearinghouse and news service, the hotline collects campaign information and tips and then makes these available via computer for the price of 150 to 350 dollars per month. The hotline also offers a service in which candidates themselves can post a 200-word, unedited message on the hotline bulletin board. While not of significance to the average voter, subscribers include campaign staff members, consultants and news reporters. The service provides them access to information not available elsewhere.

Another way in which computerized information systems foster political communication is represented in use of bulletin boards by special interest groups. Organizations such as Amnesty International, Greenpeace, and other human rights and environmental groups now use computerized bulletin boards to rally support in favor of causes they promote. Governmental meetings and voting sessions at both federal and state levels are often scheduled, sometimes purposely, in such a manner that citizen input is difficult, if not impossible. Usually, this is done by scheduling so that there is not enough time for opposing interests to organize themselves. Discussion on computerized systems "gets the word out" days ahead of the postal service, and makes letter writing campaigns and other forms of citizen input to legislators more effective.

Another potential benefit of computer communications for governance is more practical. It makes more efficient the administration of governmental services such as health, welfare and law enforcement programs. These programs are now immense, and large databases have been constructed in federal agencies to serve them. The Department of the Treasury has a database of people coming into the country. The Social Security Administration and the Immigration and Naturalization Service have large databases accessible by other federal agencies. The Federal Bureau of Investigation maintains a National Crime Information Center. While these databases are geographically separate, access to them for practical purposes makes them a centralized service. Each can be used to serve the other in avoiding fraud, abuse of federal programs, and to serve administrative needs in other respects.

One commonly discussed application of computer communication to governance involves use of computerized voting mechanisms. Composed of push-button inputs from homes to centralized vote tallying computers, these would allow citizens to, for example, watch a debate among candidates on television and then vote within minutes of the debate's conclusion. This is <u>Direct Democracy</u>, heralded by some as the ideal form of governance.

Ideally, the future might make information more systematically available to voters. Databanks containing past voting records of elected representatives, campaign contributions, and pending legislation could be developed and maintained by governments for the benefit of informed voting.

However, while proposals for new politically-oriented information sources may have much to recommend them, such proposals are accompanied by associated risks and feasibility problems. For example, the use of electronic mail and bulletin board systems to enhance political communication of human rights and environmental groups seems of unquestionable benefit. At the same time, use of such systems will remain for some time to come a privilege of those with the education and affluence to use them. Similarly, governmental supported databanks containing information on political representatives, legislation, campaign costs, etc., would improve public knowledge of political processes, but which public? The poorer and less educated segments of society stand to gain less from such systems. In short, computerized political information systems are fraught with what are called <u>equity problems</u>.

The idea of direct democracy through instantaneous voting shares this problem but has other, in some ways more fundamental, problems. The ideal is said to be direct democracy in which citizen participation is enhanced; candidates will know exactly what voters think at any one given moment. Opponents of such plans, however, argue that direct democracy may not be such a good thing. James Madison, one of the founding fathers, argues in the <u>Federalist Papers</u> that direct democracy is fraught with peril. People will vote with their emotions, he argues, rather than with their reason. Neither are most citizens capable of making informed decisions on many issues, nor have many of them the time or inclination to become informed. Finally, such a system may allow the simple force of numerical majority during votes to completely dominate decision-making. This would lead to the domination of the minority by the majority, sometimes referred to in political theory as the problem of the "tyranny of the majority." All these problems our representative, not direct, form of democracy is presently designed to handle. Electronic democracy, in short, should not be considered only as a technical problem; it should also consider the principles and practicalities of self-governance.

The Study of Information Systems

In the preceding pages we have noted new products and services being offered both to consumer and business markets. We have seen the emergence of a new information industry. And we have noted that along with the many benefits promised by computer communication systems a number of potential drawbacks for individuals, businesses, and for the democratic institutions that comprise our socio-political system have resulted. After recalling traditional media such as newspapers, broadcasting, and the telephone in the opening paragraphs of this chapter, the bulk of the discussion has been intended as a brief introduction to newer communication processes that call for the attention of researchers and policy-makers.

The aim of this chapter is to introduce the study of such processes. While studies of mass media, interpersonal communication and rhetoric still make up the bulk of academic communication work, there is a rapidly growing contingent of researchers and theorists who've found the aforementioned processes to be of great interest. Broken down into categories, these range from technical concerns regarding network design, to legal aspects of regulation, to sociological discussion of the nature and evolution of modern society. Some of the more central topics are reviewed in the remainder of this chapter.

The work that is perhaps most prominent concerns speculation about the "nature" of modern society. Historians have always found it convenient to characterize the progress of human civilization as going through a series of stages. Hence, we are taught in school to think of the period in which the Greek and Roman civilizations flourished as the Classical Period. Before this one refers to Pre-Classical or perhaps Ancient civilizations. When referring to more recent times there is the Medieval Period and the emergence into Modernity, etc. Each of these periods can be broken down, in turn. The birth of modernity is said to begin with our emergence from Medievalism during the Renaissance and to include the Protestant Reformation and the Enlightenment periods.

Each of these categories and subcategories is characterized not only by a name but also by certain attributes, practices or values that distinguish it from those going before and after. The medieval period may be characterized as one in which the social system was feudal, revolving around a feudal lord and a land tenure system in which anything of value was owned by the feudal manor. Practice of Catholicism then was not a matter of individual religious preference as it is now, but an institution having power to rival kings. Everyone was Catholic and the well-being of individuals great and small was subject to blessings of religious authority.

With the rise of the modern period, this feudal land tenure system broke down. Cities separated from feudal castles began to grow. Craft guilds emerged allowing those who were skilled to trade their labor for money. A work force independent of feudal obligations emerged, and the worlds of business and commerce began the slow process of asserting freedom from both Church and State. Modern capitalism was born and thrived, first in small crafts, then textile production, transportation, financial institutions and especially in great industrial enterprises. This period is sometimes known as the Industrial Age.

Modern capitalist society, then, varies from medieval society in having a completely different system, in being comparatively secular, free of dominating religious values, in having popular participation in government, and in a host of other ways. But, returning to the issue of communication theory and research, the question some ask now is, "Are we still in the industrial age?" Perhaps with all the innovations in telecommunications and information systems, has society passed into a new age, an Information Age?

In 1962, economist Fritz Machlup produced a book entitled, The Production and Distribution of Knowledge in the United States, and made an assertion that has gotten a lot of people thinking (3). His method was simple. He marshalled a vast number of observations and thought about them. He noticed that a large proportion of businesses are devoted to publishing books, magazines, movies, and television programs. He noticed that lawyers, managers, technicians and accountants had by the late 1950's grown from a small and highly specialized set of professions into a special class of society. He also noticed that "below" these specialists in rapidly growing public and private bureaucracies were typists, secretaries, messengers, typesetters, copy editors, and others whose work revolves around paper pushing. It then struck him that despite the differences between the jobs these people held they all had one thing in common: they worked with information, not material goods. These workers comprised by his estimate 31 percent of the non-farm workforce and produced 29 percent of the gross national product.

He had noticed that the nature of our economic system was changing away from an industrial economy toward what he called a knowledge production economy. The central idea is that what makes a modern economy competitive is its mastery over production and management of information. Since communication is basic to culture, information processing has been with us throughout all stages of economic evolution. However, Machlup argued that at no time previously has information processing been so central as it is today.

Over twenty years later, a recent graduate of Stanford University was hired by the United States Department of Commerce to follow-up these ideas. In 1976 Marc Porat produced a 9-volume study of occupations entitled, The Information Economy (4). Results indicated that 46 percent of the gross national product was produced by the information sector. The data he gathered also showed a rather remarkable shift in America's labor force over the period from 1860 to 1970. During the 1860's nearly 50 percent of the U.S. labor force was engaged in agricultural work. By 1970, only about 5 percent remained in agriculture. Conversely, the information workforce occupied less than 10 percent of the total in 1860, but grew by 1970 to over 46 percent. Porat's work documented in a rather dramatic way the trend earlier identified by Machlup.

Also during the 1970's, a sociologist named Daniel Bell was working on related studies. In 1973, he produced The Coming of Post Industrial Society (5). Contemporary society, he explained, is historically unique in its reliance on knowledge, and specifically on theoretical knowledge. Not only do most workers now work with information of some sort, but our modern institutions couldn't operate without theoretical knowledge and the technologies this knowledge makes possible. Theoretical economics was not directly applied by government to manage the national economy until after the Great Depression. Theories of chemistry are required to produce the medicines and chemicals that make possible products we take for granted. Management theories using input/output and systems analysis are not merely convenient, but are indispensable in coordination of large enterprises both private and public. For Daniel Bell, Post-Industrial Society is here. And its leaders are highly skilled technicians, designers and managers.

Phrases such as "The Age of Information," and "The Information Explosion," have become common parlance, used in headlining news magazine articles. But it is the work of individuals such as Machlup, Porat and Bell who've provided the intellectual justifications for this usage. Not all theorists agree that we've entered an new historical stage based on information, but the possibility of its being true is a subject of active research and discussion in the field of communication research.

Few research topics in the computer and information area are as lofty as this, but there are many that are interesting. Consider the field of organizational research. Organizational communication research is concerned, among other things, with organizations' use of information to fulfill their aims given changing environments. One result of new information systems is a rapid increase in the rate of change. As noted earlier, it is commonly said today that the average American will have six careers in their lifetime. The same is true of organizations. New products come and go so rapidly today we don't even notice most of them. Cars, clothes, breakfast cereals all are in a constant process of change, and the companies producing them are constantly on the lookout for new products, as well as for competition from new companies. In other fields, things are changing even faster. New <u>kinds</u> of products come and go. Micro-computer companies are a good example. Most companies that were early leaders, with the exception of Apple, are gone. A late comer, IBM, is king. Mergers and takeovers represent rapid diversification over the last 10 or 20 years. Each evolution in corporate structure is a monumental exercise in organizational change which is made even more complicated by their current reliance on complex telecommunication systems.

One very active area of research deals with this and related problems. Studies of the "Diffusion of Innovations" directly address change processes and the role of communication in them. The question is, What kinds of people adopt innovations? What kind of managers adapt new practices? What kinds of organizations adopt innovations? How quickly do innovations diffuse and how long does it take for them to saturate their potential populations? Do certain communication processes help or hinder diffusion? (6)

Another set of research interests related to information systems concerns individual uses of new information systems. We referred earlier to electronic mail and bulletin board systems rapidly diffusing throughout educational, managerial and research populations. Consider also the current adoption of online card catalogs in college libraries. A considerable amount of research goes into designing these and into determining how well individuals, both specialists and non-specialists, will be able to use them. Will computer phobia translate into card catalog-phobia? If not, will computerized systems really make library research more effective? Perhaps software rigidity will render such systems useful only for selected research areas. Current research endeavors to determine whether theories of cognition can give us clues about how to design computer information systems so they are both user friendly and effective.

Yet another area in which research has been conducted concerns use of new technologies relative to older communication technologies. For example, as computer communication systems come into the home will they take up time that would otherwise be used for television? Will this make us less dependent on the mind-numbing effects of too much TV? Perhaps the new technologies will be used for education. On the other hand, perhaps they'll just be used for game playing and threaten to change couch potatoes into video junkies. A research tradition that inquires into the "Uses and Gratifications" of media use has been applied to such questions.

The field of education has responded to potential advantages of computer communication systems in a broad way. One line of research concerns use of computerized graphic systems to teach subjects ranging from Shakespeare to trigonometry. Another line of research considers potential applications of networks. We discussed Distance Education above. Research has been conducted to explore in detail the possibilities and problems associated with use of microcomputers for giving learners access to information at remote locations. Questions are asked concerning effective design of printed material that can be used in combination with computer programs, and overall effectiveness of learning processes during which there are relatively low levels of face-to-face communication between student and teacher.

Still another area of research focuses on macro-level social processes. Many analysts have tried to determine the prospects for diffusion of new services into various social strata. We referred earlier to the possibility that computer communication systems may widen social and economic disparities because only those with the education and affluence to use them will benefit. One line of research considers the prospect that perhaps local libraries can evolve from their current focus on books to include more sophisticated information services such as computerized databases, some local and other national or even international. In this case, libraries would change profoundly. They would grow to encompass information access services as well as book storage and lending. Researchers would like to know the effect on society of such a profound transformation of the traditional library.

Clearly, with all the changes new communication technologies have brought with them, research opportunities abound. Those just discussed are primarily academic in nature, but research designed to help governmental decision-makers is common, too, and should be mentioned at least briefly in any overview of this subject (7).

It is important to first bear in mind some of the reasons that the government might be interested in new information systems. Chiefly, these reasons have to do with the occasional need for government "intervention" in societal processes, in the form of regulation or legislation. This need can most easily be considered by recalling previous instances of intervention. For example, the Federal Communications Commission today regulates broadcast stations because the early days of broadcasting showed that some central authority was necessary to allocate spectrum space. Otherwise stations broadcast "on top" of one another producing mixed signals and generally poor quality broadcasting. In this case, the government intervened in a private sector affair in order to assure maximum benefit of broadcasting to all.

In another example, the federal government intervened in the historical development of the telephone system by giving American Telephone and Telegraph (AT&T) exclusive rights to provide telephone service nationally, in 1949. This seemed necessary to prevent dozens of companies from stringing up their telephone wires simultaneously, resulting in bird's nests of telephone wire along the streets of urban areas. In exchange, the government required AT&T to make telephone service available at lost cost to all Americans, with a provision called "universal service."

A major policy question being asked today is, "Is there need for federal intervention with regard to newly emerging computer communication systems?" The Congressional Office of Technology Assessment (OTA) has recently completed a study entitled, Critical Connections: Communication for the Future, for this very reason (8). For example, we've noted that the telephone, developed under a universal service policy evolved in such a manner that almost all Americans had access. Should there be an analogous universal service principle for more sophisticated systems? What would Congress need to know in order to intelligently debate this issue? The OTA's research asked how much would such service cost, who would provide it, exactly where the financing would come from, and related questions.

This is only one of the topics addressed by policy researchers in the communication field. Returning to a subject discussed earlier, OTA and other researchers have asked whether new technologies should be used to provide citizens with political information during campaigns, whether databanks listing jobs should be provided by government, and whether the government should become involved in setting technical standards. In each case, policy researchers ask whether such intervention is in accord with American political principles, whether it is technically feasible, how it would be managed, and other questions essential for reasoned consideration by policy makers.

Summary

Traditionally, the word infrastructure has been used to refer to the roads, bridges and public utilities maintained by government as essential public services. The justification for government involvement is that the infrastructure benefits all citizens. Good infrastructure is required for efficient economics and for good quality of life in general.

In the field of communication, the word infrastructure has come to take on another meaning. It refers to the information storage and transmission technologies over which the services discussed in this chapter are provided. While this infrastructure is nearly invisible, it is immense in its size and complexity. It involves hundreds of satellites and thousands of satellite dishes, thousands of microwave relay towers, tens of thousands of miles of fiber optic cable, and hundreds of thousands of miles of coaxial cable and twisted-pair telephone wire. It also includes countless computers that knit these transmission systems together in a set of overlapping communication networks. One author refers to the infrastructure as the Geodesik Network (9), another calls it The Matrix (10), and still another simply refers to the emerging telecommunications Grid (11).

Over these networks flows a truly incomprehensible amount of information, on a daily basis: telephone calls, military and defense information, television signals, bank transactions, payroll accounts, inventory data, credit card balances, correspondence courses, and exchanges among wine lovers. It is owned partially by government, partially by private and public corporations, partially by research and educational institutions, and partly by consumers.

Whatever it may best be called, this infrastructure makes possible communication of all kinds and amounts unheard of just a few decades ago. And, this communication is rapidly changing society. It creates new opportunities, and it is resulting in problems. Both the opportunities and the problems pose challenges for those in education, government and business. One of these challenges lies simply in keeping track of new communication processes in society and in understanding how they work. This is one essential aim of communication theory and research.

Endnotes

1) For wildly optimistic, cautiously hopeful, and worried introductions to this subject, see, respectively:
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Chapter VI

Daytime Serial Drama Message Analysis: The Cultural Indicators Pilot Study Preliminary Report

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The Cultural Indicators Message Analysis project currently being undertaken by *Project Daytime* at the State University of New York at Buffalo emanates from a content analysis of the full lineup of daytime serial dramas currently on the air. One of the goals of *Project Daytime* is to develop a databank and carry out a content analysis of one week of soap opera programming on an annual basis in order to assess trends in message systems of daytime serial drama, to make comparisons between the symbolic worlds of daytime and primetime television, and to allow for the exploration of the relationship between the symbolic world and the common assumptions that these symbolic worlds tend to cultivate in audiences. This report examines the development and execution of the pilot study designed to analyze the workability of the Cultural Indicators message analysis instrument and to refine the process by which data is collected.

Cultural Indicators: An Introduction

The measurement of culture by means of leading cultural indicators has been systematically studied since the late 18th century. The coinage of the concept "cultural indicators," however, is a more recent occurrence, being first introduced by George

Gerbner at the Annenberg School of Communications in the United States in 1969. Since 1969, the Gerbner research group has produced an outpouring of cultural indicators research centering upon prime time television drama and weekend daytime programming. Gerbner's work, which has focused on the "violence profile," has been both criticized and praised; and has been replicated successfully in the United States and perhaps more unsuccessfully in other parts of the world. The main criticism has been directed at the Cultivation Analysis part of his work, rather than on his message system analysis (content analysis) -- the necessary prerequisite for cultivation analysis research.

Gerbner's annual violence profile -- measuring the amount, character, tone, and other dimensions of American television violence -- is the most widely known of the cultural indicators in his prodigious database. But according to Bock (1984), the other parts of this database are not discussed simply because they are not widely known or as accessible as are national public surveys.

Other societal sectors and systems have been studied worldwide. In these studies, other perspectives -- politics, religion, the economy, literature, advertising, the newspaper press, education, intolerance -- indicate that in principle, the prism of culture can be applied to any societal phenomenon. Bock (1984), a doctoral student at the Annenberg School, for example, used the Gerbner Cultural Indicators instrument to compare American with German television dramatic programs. She found the American instrument to be a poor fit for measuring cultural indicators in German programs, concluding that her results showed that she was actually measuring the presence of American cultural indicators in German programs and was ignoring indicators indigenous to German culture. Each culture, being different, must develop its own system of cultural indicators.

Cultural Indicators and Daytime Serial Drama

The theory of American Cultural Indicators is rooted in the philosophy that story telling is the essence of civilization. In tribal days, it was the elders who passed along the culture to their audiences; in western countries today, that function rests predominantly with television. Newcomb (1982) argues that the "soap opera is the most appropriate form for telling stories on television. It makes use of the continuous nature of the medium in a way that opens narrative to new possibilities for the representation of human experience" (pp. xxxi). The soap opera creative community maintains that *they* are in fact the storytellers of today, engaging millions of viewers each and every day in their never ending stories of human experience (Irwin, 1990).

The Cassata/Irwin Cultural Indicators research deals exclusively with the daytime television soap opera genre (as compared to Gerbner's prime time T.V. drama and daytime weekend children's programs) and has as its centerpiece what everyone who's ever watched a soap opera knows to be their essence -- the family and interpersonal relationships (as compared to Gerbner's emphasis on violence). It is the soap opera audience and its relationship to their "stories" that make the cultural indicators daytime serial drama message analysis research project so compelling. These stories focus on universal themes which are presented as individualized conflicts with which the audience identifies. Soap opera viewers relate to characters and show concern for their fate. These characters are tied to many of the same social networks as the viewers -- families, friends, neighbors, colleagues, etc. The activities they engage in and the values that guide their behavior are familiar, and the emotions the characters feel are the very same emotions which the viewers have experienced at some point in their lives. The fourth wall concept -- the phenomenon of television characters and their activities entering into the living rooms of the viewers -- is more appropriately applied to the soap opera than any other television genre. Soap opera characters are born, go through puberty, get married, become pillars of the community, retire, grow old, and die, and the audience goes through these life stages with them. Soap viewers, therefore, share a commonality with all other soap viewers about what they see, feel, experience, and comprehend regarding certain events and aspects of life -- values, priorities, and relationships (Cassata and Irwin, 1992).

Daytime Serial Drama Message Analysis Recording Instrument

Prior to the pilot study, a team composed of the principle investigators and a group of graduate students worked intensively over a period of two years to develop and refine the Cultural Indicators instrument. The instrument consists of three major areas of study: character, storyline and episode characteristics, and the centerpiece of the project, family and interpersonal relationships. Questions are designed to measure what is important in the soap opera world, what is right, what is wrong, and what is related to what. More specifically, the analytical measures (Gerbner, 1969) will coalesce around the following:

1. Attention -- the presence and frequency of subject elements
2. Emphasis - what stands out, the featuring of certain topics and themes
3. Tendency -- the directionality of presentation, i.e., good/bad, right/wrong, favorable/unfavorable
4. Structure -- that which reveals relationships among components of the message system

The Pilot Study

The pilot study was conducted in Spring 1993 as a class project for the seminar courses on Cultural Indicators in daytime serial drama, taught both on the undergraduate and graduate levels at the State University of New York at Buffalo. The subject content of the course served as a framework for the project and covered such topics as characters, their personal and social problems, sex role portrayals, families, minorities, and morality indicators present in the soap opera world. Graduate students had a role in the refinement of the instrument and the training of the undergraduate students who acted as coders. The goal of the pilot study is to examine the workability of the instrument and the process by which the data is to be collected.

Because we were carrying out the pilot study within the parameters of a semester's coursework, the decision was made to divide our massive instrument into its three major areas: character, storyline and episode characteristics, and family and interpersonal relationships.

We are studying the soap opera as a system in order to gain insight into the features, processes, and relationships expressed in this genre as a whole rather than in specific serials. All eleven soap operas on the air at the time of the study were recorded during the third week in September, 1992, corresponding to the time period chosen by the Annenberg School for their prime time Cultural Indicators project. Moreover, the selection of this particular week was deliberate to avoid "hot" summer soap opera storylines designed to attract the teenage audience, sweeps periods, and special holiday episodes.

Although the Cultural Indicators study of daytime soaps will be designed to embrace the totality of the extant soaps on the air which will be analyzed annually, the pilot study consists of the analysis of three one-hour soaps, representing all three networks. Because it was determined that we would study the soaps from a zero baseline in order to determine modifications necessary to polish the instrument and criteria by which to select the coders, students were assigned to soaps with which they were not familiar. Because students are apt to know several soaps, the only way we could ensure novice viewers for each soap in our sample was to select the only three one-hour soaps that compete against each other in the daytime schedule: *Another World* (NBC), *As The World Turns* (CBS), and *One Life to Live* (ABC).

Assignment of Coders

Students were randomly assigned to specific serials and instrument sections. Two independent coder pairs were assigned to each soap opera for each section of the instrument. More specifically, two coder pairs completed the family section, two coder pairs completed the character section, and two coder pairs completed the storyline and episode characteristics section for each of the three serials in the sample.

Training

The primary training sessions for each section of the instrument were incorporated as units in the course curriculum, thereby ensuring that all students would have a basic understanding of the project in its entirety. After these initial training sessions, specific out-of-class training sessions were held for only those students involved in the coding of the particular sections. During these sessions, an intensive line-by-line item review of the instrument was carried out, along with practice coding of videotaped scenes taken from soap operas that were different from the three soap operas used in the sample. Attempts were made to answer all questions that the students raised, and at times we incorporated some of their suggestions into the instrument (making the instrument an organic entity) before the actual coding began. In total, each coder underwent approximately six hours of formal training, with additional instructions supplied as required during the coding period.

Logistics

Two copies of each episode of each serial were placed on reserve in the undergraduate library to be viewed only during those times when the library facilities were open. Each coder was required to complete the coding of the soap in its sequential order before proceeding to the next day's episode. Coders viewed independently, and were encouraged to pause the tapes as necessary, or to view as many times as necessary to ensure accuracy. In order to make the process work with a limited number of coding stations and videotapes, the assignments were staggered by section of the instrument: the family and interpersonal relationships section was coded first, followed by the character section and finally, the storyline and episode characteristics section. Each coder completed their assigned section of the recording instrument for each of the five episodes included in the sample week.

Analysis of the Data

Upon completion of the coding, the undergraduates will have fulfilled their role in the project, with the exception of their critique, due at the end of the semester. They will be required not only to evaluate the instrument, but the entire experience as well, including training and coding. At this point, the students in the graduate soap opera course are to move to a position of greater prominence, taking over the role of comparing the results of the data recorded by coder pairs, establishing reliability levels, and doing a preliminary analysis of the findings. Additionally, it will be their responsibility to evaluate the validity of the instrument and the data collected -- i.e. will the results allow us to draw conclusions about such concepts as family size and configurations, power structure, sex role stereotypes, and other such information on values, political views, social contacts, and consciousness. It is our intention to use this information to further refine the instrument, hopefully simplifying it and making it more efficient before proceeding with the next level of the study: a full scale message system analysis of the universe of soap operas presently on the air.

Conclusions/New Directions

Among the decisions to be made are whether we will use naive versus expert soap opera viewers/monitors, or a mix of both. It is entirely conceivable, once the evaluations have been completed, that a decision might be made to supply historical background data for characters. For example, in terms of marital history, since some soap opera characters have married and divorced many times over, it would be unlikely that the naive coder would encounter such information in a single week's worth of snapshots in the life of a soap. By the same token, unless "family components" were to be specifically identified for the naive coder, the interactions of family members may not be accurately recorded. Our decisions, once all the evidence is in, would encompass, therefore, whether a combination of analytical methods (content analysis, historical analysis) and a combination of knowledgeable soap viewers versus virgin soap viewers are to be used in carrying out the actual study.

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Chapter VII

From Everyday Sensemaking to Professional Understanding: Comparative Uses of Everyday Conversation

Allan Canfield

Overview

Personal knowledge, reasoning and expression are brought together in everyday conversation. Humans make sense of daily events by discussing them, interpreting them, and elaborating upon them in the conversational process.

This article discusses human cognition as it relates to everyday conversation. It is assumed that all humans may be assigned a spot on a continuum of cognitive-scientific development, ranging from 'naive' to formal science.

Sean, a freshman in this article, creates a plan to capture a girlfriend's attention. As he thinks about and develops his plan, he acts like a 'naive scientist' at work. Although he has the ability, he lacks the experience and practice of the professional scientist.

Professional researchers analyze everyday conversations to find clues or evidence to determine how inner thinking and information processing occur, assuming a connection between hidden, inner thought processing and overt expression. They are referred to as informed social scientists.

Social scientists stress the role of rationality and planning in reasoning processes. They use various terms such as silent speech, metacognition, metatalk, thinking and other expressions to describe cognition. They think that everyday conversations reflect inner cognitive activities and that symbolic elaboration of information or knowledge is a necessary precursor to everyday conversation.

The word, 'sensemaking', is used to describe ways that people use both inner and outer talk to create meaning in their everyday lives. A comparison is made between Sean's planning activities and work of a professional researcher in Communication. Sean develops a plan to marry Jennifer. The researcher develops a plan to study human conversation and cognitive processes, following a scientific protocol.

The article incorporates a general approach to social cognition; it is meant to be somewhat provocative and speculative. At the end of the article several issues related to cognitive research are discussed. A bibliography is provided.

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"The whole of science is nothing more than a refinement of everyday thinking" (Albert Einstein)

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"Science is trained and organized common sense;
theory building is something we engage in everyday
of our lives" (Thomas Huxley)

. . . .

"There is nothing so practical as a good theory"
(Kurt Lewin)

. . . .

Everyday Sensemaking

Humans create meaning through the conversational process not only by what is said in messages but also by interpreting other relational features of conversations, such as why, where, when, and to whom things are said.

To create meaning, humans form plans before enacting their conversations. The plans may be drawn roughly or they may be refined through careful practice. Pre-formed plans include goals, strategies, and tactics.

The interior planning-goal process involves self-talk and self-thought, sometimes referred to as silent speech or metatalk. People define their situation; they elaborate ideas and work out a plan of verbal action; they implement the plan through strategies and tactics; and, they interpret the results, or the responses. Thus, goals and plans are embedded in everyday conversations, to be observed and acted upon by others. Meaning is created through this interactive process.

Getting the "Yes" Response; Sean's Naive Planning

To illustrate the cognitive planning process noted above, a simple, hypothetical, but recognizable, everyday example is provided, as follows.

Sean is crazy about Jennifer; he wants to marry her. Irrationally, he has fallen head over heels in love with her; unfortunately, he doesn't know Jennifer very well. Even the thought of taking her to a movie is scary!

Her overwhelming attraction captivates him! He must find ways to know her better! She is the ultimate -the embodiment of his ideals!

He is temporarily insane! Yet he has enough cool to make a plan. Excitedly, he talks with his best friend about his fuzzy plan; he struggles with his emotions and his thoughts; he works out a solution. He is a pragmatist! His fragmented plan emerges.

His plan includes signing up for a class that she is taking, sitting next to her, talking to her about anything at all, asking her for her notes, doing things that force her to see him, and then finally, asking her to go to the movies.

His planning continues. He wants to see Jennifer more and more, to invite her home to his folks, to take her to Toronto for the weekend, to go on Spring break with her, and so on. His inventive mind cannot relax!

A year or more of little ego-boosting successes gives him confidence. He sets up the circumstances, sets the mood, and says, "Let's get married!". She says, "Wow, sure! Whew! I thought you'd never ask!". Then, in accordance with the formula, they live happily ever after!

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Some Observations About Sean's Plan

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A careful observer of Sean's conversations would pick up dozens of clues about his intentions over a period of time. In fact, one careful observer turned out to be Jennifer! She, too, apparently, had a plan!

The point of the story is that, in making and carrying out his plans, Sean acted like a struggling scientist. He had a topic of interest; he held some assumptions about the topic of marriage and Jennifer's role in it; he devised a plan or method of action; and, after he succeeded in the effort, he evaluated his action plan and congratulated himself, sharing his enthusiasm with his friends.

Professional scientists also make assumptions about a topic: they have theories; they create action plans for research; they obtain results; and, they share the results with the scientific community, receiving feedback. The similarities between Sean's planning and the planning of the experienced social scientist seem obvious.

It is likely that Sean didn't lend the slightest thought to scientific method as he developed his plan. In fact, he may have been unaware of any resemblance. He merely followed his hunches, uncertain one moment and confident the next. His was a risky, awkward, emotional game. It could have flopped!

Had Sean kept a diary of his planning activities and outcomes, he would have benefited from the derived insights and objectivity. Professional researchers occasionally use diary-keeping as a tool to gather data.

Professional Sensemaking: The Social Scientist's Plan

Like Sean, social scientists are sometimes passionate about their work, contrary to a prevailing image. They have territories to defend, points of view to maintain, puzzles to solve, and arguments to win! Their passion about their work is less romantic, but, often it is present.

However, the researcher must try to be objective about his or her work, a task that requires continual re-working of ideas and the answering of key questions. This is the sensemaking work of the professional researcher. The researcher must be keenly aware of her or his work.

Everyday conversations, like those involved in Sean's marriage plans, are of interest to scholars and social scientists who research cognitive processes. Although everyday conversation appears to be 'natural' -- that is, it seems to flow without serious restriction or artifice, and, people appear to speak without much effort -- the social scientist knows that there is more here than meets the eye.

Researchers try to find plans and patterns embedded within conversations, which, in turn, they believe, provide evidence about inner cognitive activity. They conclude that various hidden, inner, processes account for human conversations. Rom Harre's statement below indicates this thinking.

> "Behind the statements that people make, the calculations they perform, the attitudes they evince, and the emotions they display, there is another shadow world of information being processed. Rules, scripts, and plans, in this picture, are features of the cognitive processes that are allegedly running behind our everyday activity." (The Second Cognitive Revolution. American Behavioral Scientist, 36, p. 5)

The recognition that this 'shadow world' exists, intrigues researchers who are interested in the way that the mind works to produce everyday utterances--utterances that are loaded with meaning in the conduct of human affairs.

Despite this strong interest, the researcher can only make inferences about hidden cognitive processes, a confounding fact that complexifies the research task. In addition, the researcher is forced to simplify or restrict his or her topic so that it can be managed.

The complexities in cognitive research may be noted from a list of current topics and approaches sometimes associated with cognitive study:

> Linguistic analysis; discourse analysis; text analysis; nonverbal communication analysis; mediated talk analysis; neural networking; artificial intelligence; speech production; neuro-chemical analysis; brain-scanning; mathematical representation; and, metacognitive-philosophical analysis.

These approaches are associated with a variety of fields of study, assumptions and practices. Of course, they must be associated in some way with a specific cognitive theory or practice. Research from a physiological standpoint is different from social-cognitive research. Literary analysis is different from an artificial intelligence approach.

Given the complexities of topics and approaches, the researcher must 'bound' his or her research, restricting it so that at least a small portion of human behavior may be understood. 'Boundedness' may restrict research so narrowly that the research findings lack wide application and explanatory power, isolating it from other theoretically related work. (See Mitroff and Linstone in the bibliography for a discussion of this research problem.)

On the other hand, the researcher may borrow approaches from bordering areas of inquiry, offsetting the narrowness problem, as discussed below.

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Borrowing and Lending: Field Interdependence and the Wheel of Study

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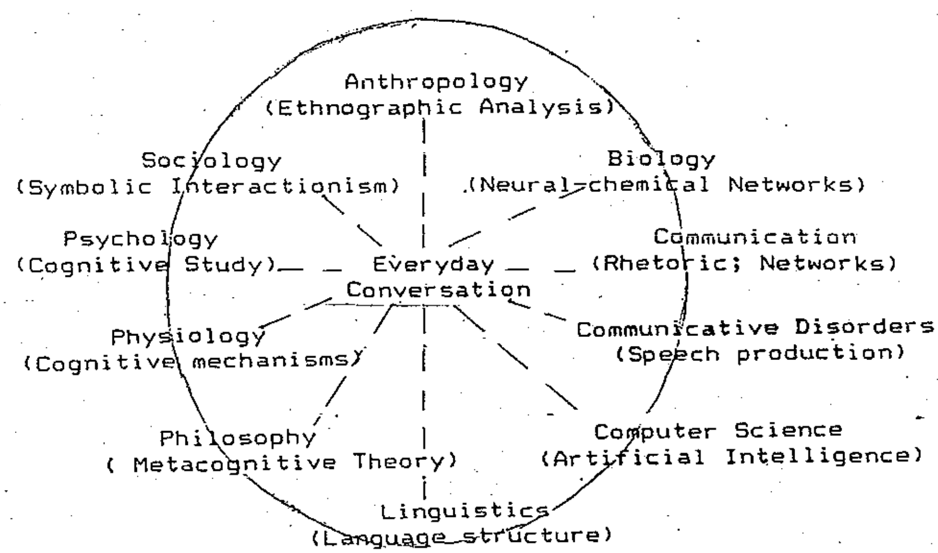
The Wheel of Study below shows many of the fields in which researchers have focused upon human communication and conversation. Cognitive study is not limited to one field. The Wheel includes at least one approach (not necessarily the main approach) that has been associated with each discipline.



Borrowed themes and approaches are found in the work of professionals in Communication; professionals in other fields borrow work from Communication. This article borrows from Social Psychology, emphasizing social cognition. Social cognition feeds into the more general field called Cognitive Science, an emerging interdisciplinary field.

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Levels of Analysis

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Global Analysis
Cultural/Societal Analysis
Institutional/Organizational Analysis
Large Group Analysis
Small Group Analysis
Dyadic Interpersonal Analysis
Monadic Analysis
Intra-Psychological Analysis
Biological & Neuro-Chemical Analysis

The chart above shows levels of analysis in research. In the illustration of Sean's cognitive activity, a single dyad is involved, including Sean and Jennifer. Sean's interior planning occurs at the intra-psychological, silent, covert level; his conversations, at the dyadic level, are overt.

The physical level forms the base; all other levels are essentially psychological, social or cultural. The global level is the most complex social level.

The study of dyads, seemingly simple, is more complicated than the casual observer may think. Sean's and Jennifer's lives are located in a complicated social context. Each has a personal history, each has other friends, and each has future plans. Social processes and societal institutions profoundly affect their lives. Different cognitive scholars focus on different aspects of this social complexity.

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The Academic Toolbox

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Not only are theories and themes exchanged between disciplines, but the methods and tools that are used to do research may be borrowed as well. Generally speaking, some tools are appropriate to literary analysis; others are appropriate to physical or biological analysis. The listing below shows a few of the tools being used to study everyday conversation and human cognition.

> Ethnographic analysis; content analysis; computer modeling; questionnaires; case studies; laboratory design; interviewing; field experiments; interaction analysis; rhetorical criticism; text analysis; audits; close procedure; film and video use; diary-keeping; story-telling; word association; mathematical representation; cognitive mapping; and, the use of anticipatory schemata.

The cognitive researcher wants to determine how the mind works. Depending on the level of research, the approach, and the task at hand, the researcher selects the appropriate tool(s). For example, in an article about 'cognitive architecture', Kintsch discusses problem-solving and comprehension as key aspects of cognition, noting the difficulties involved in finding out what 'is in the mind' (see Pick, Van Den Broek, and Knill in the bibliography).

Cognitive researchers use the computer, taking it for granted. It enables researchers to do things that were not possible in earlier research due to its speed, capacity, and modeling capabilities.

Contemporary researchers believe that computer modeling will help them understand human thought processing. Computers can 'talk', seemingly like humans. Ideas can be represented on a computer screen. Hundreds of articles have been written in recent years discussing whether a computer can 'think.' Human chessmasters play against computer 'chessmasters'. In theory at least, the computer can model mental processes.

The fields of cognitive science, artificial intelligence and communication networks reflect the influence of the computer and similar telecommunicative technologies. The 'fitness' of these tools for her or his research is decided by the professional scholar who studies everyday conversation.

For example, a researcher interested in learning about Tagalog and the Filipino culture, might use a type of ethnographic analysis or participant observation. This form of research, though very important, is only recently associated with the computer. Imagine the communication expert, in the jungle, learning more about Tagalog, using a laptop computer! Of course, not all research--or even the majority of research-- about Tagalog is done in the jungle.

The researcher interested in mediated conversation or in text analysis, may do his work without living subjects, relying upon video or written text to accomplish the research task.

Or, as in this article, the researcher interested in cognitive planning and everyday conversation might use his classroom as a type of laboratory, handing out surveys and questionnaires, from which he or she will eventually draw conclusions about cognitive processing. A variety of methodologies might be used to research this topic. The tools that are chosen must fit the researcher's approach and needs (See Pick in the bibliography for examples of research methods and problems).

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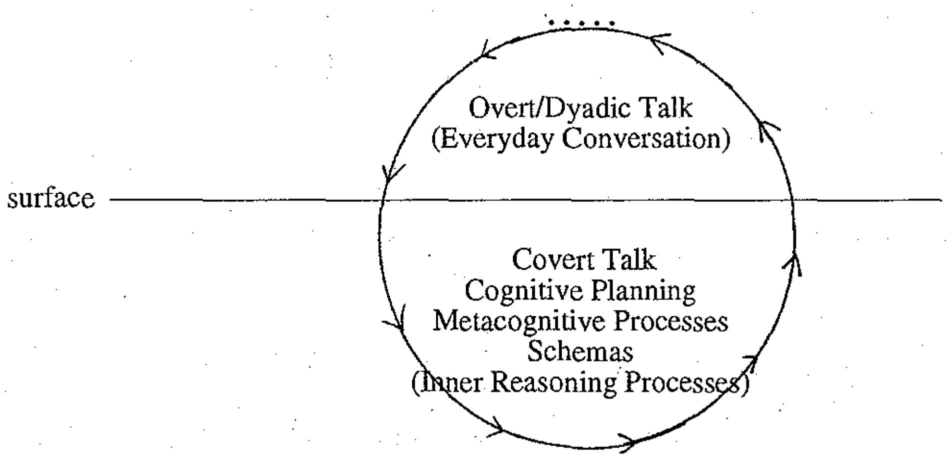
The Conversational-Behavioral Iceberg



It is assumed in this depiction that there is a fundamental relationship between the hidden, interior area, which is below the surface, and the external, or overt area, above the surface. Cognitive planning occurs below the surface. But, it cannot occur unless there is a cycle of activity between the areas. Plan actualizations expressed as conversations occur above the surface. When responses are made, they are interpreted below the surface, either consciously or unconsciously through schemas. The word schema refers to a knowledge base(s) possessed by Sean. Schemas may be simple or complex, depending upon the person's experiences.

Sean plans and talks to himself, making interior sense; he then expresses his plans overtly in everyday conversation with Jennifer. He receives feedback, which he evaluates further.

Stages in Studying Sean's Conversational Behavior

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The Theoretical Stage

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At the theoretical stage the researcher is interested in these questions: What is a cognitive plan? What underlying cognitive processes do I assume exist? How are goals and plans related to everyday conversation? How does everyday conversation reveal the existence of thinking, or silent speech? What theories guide my study?

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The Methodological Stage

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After answering these questions to his or her satisfaction, the researcher moves on to methodological considerations.

Major questions are: How shall I state my research problem? What is it specifically about cognitive planning and conversation that I want to know more about? What hypotheses shall I make?

And, other questions might be: What tools will I use? Shall I use questionnaires? laboratory studies? text analysis? computer modeling?

How shall I obtain my subjects, if I am to use them?

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The Implementation and Outcomes Stages

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The study is implemented following a careful selection of tools and methods that support the assumptions of the study. After the study has been implemented, an analysis and interpretation of the results of the study follow. It is at this stage that the research becomes public and by becoming public, it becomes useful to other researchers who may disagree with the findings, or, who may find that the study replicates their own studies, supporting a theory. The research may turn into a useful textbook. It becomes part of the general literature associated with the study of cognition. Examples are found in the bibliography below.

An example of the work done on cognitive planning is found in the book by Donohew, Sypher, and Higgins listed in the bibliography. Berger, a researcher whose article is included in the book, is interested in cognition and action sequences in everyday behavior. In his research he graphs the verbal and behavioral action sequences that characterized his subjects as they planned to get a date. This mundane approach to cognition, using everyday experiences, has become common. Everyday conversation, of course, is an authentic human experience, worth studying. It is patterned and repeatable, Berger studied his subjects 'live'.

The Naive Scientist and the Professional Scholar: Comparative Differences

The scientific method is based on observation and the testing of assumptions, or hypotheses, against 'what is out there' in the 'real world'. By contrast, one might resort to intuition, authority, or that which seems to be self-evident. Humans resort to any or all of these as they slowly manufacture their beliefs.

Scientists, on the other hand, attempt to rationalize and control their sources of information so that their evidence lends itself to lawlike statements that can yield valid interpretation. (This does not mean that religious experience, for example, is invalid. It merely means that it is difficult for the scientist to assess its validity, given its uncontrolled origins.)

The point, nevertheless, is that there is a similarity between Sean's work and the work of social scientists. Sean held some assumptions (theories); he made plans for action (hypotheses); he enacted his plans (methods); and, he achieved his goals (outcomes); and shared them with his friends (evaluation). The similarities to the work of professional scholars seems obvious. But, of course, there are major differences.

Consider the following differences between Sean's naive science and the work of social scientists who study his planning.

Sean is involved in the construction and actualization of a personal plan but the researcher is involved in an impersonal plan. (This does not imply say that the scholar is disinterested; nor does it say that there is no emotional satisfaction in scholarly work)

Sean is subjective about his plans. The researcher is attempting to be objective about them. The inability of social scientists to be objective leads to serious difficulties. In addition, that which is important to one researcher may be less important to another.

Sean is participating in his plan. The researcher is observing from a distance. This secondary character of research provides the necessary distance for the researcher to study human behavior with some detachment. Even in participant observation, researchers are trained to engage and detach themselves so that they can observe and become somewhat objective.

Sean may not have done much thinking about his own plan. It was not necessary for Sean to understand his own cognitive experience in order to achieve his goals. The professional researcher, however, must understand his or her own thinking process. The word, 'science', essentially means, 'to know'.

The professional researcher has at her or his disposal a variety of useful tools which he or she is trained to use. Sean must use his everyday common sense and the advice of others. This is not meant to demean Sean. It merely suggests that it is likely that Sean will have had little contact with formal science.

Sean's plans and goals will be evaluated by himself and by others on a practical or pragmatic and evaluative basis. The work of the researcher will become part of a body of literature to be formally evaluated by scholars interested in the work.

Sean's work is to benefit himself and his companion. The work of social scientists is meant to benefit the work of all researchers who are interested in the same cognitive research.

Final Comments and Discussion

The major purpose of this article is to show that cognitive planning underlies much of everyday conversation and that there is an intimate connection between everyday conversation and silent speech, or thinking. It is assumed that planning is one key to the ways that humans make sense of everyday life.

By comparing Sean's naive planning to the planning of the professional researcher one can see how knowledge and planning are brought together to produce results in each situation.

The differences between the experience of Sean, the naive scientist, and the experience of the professional researcher is largely a result of scientific training. There is no implication that Sean is inferior in ability to the professional researcher. Both persons are making sense of things through their respective plans.

Rarely is research as neat and clean as this article implies. There are several issues and problems associated with cognitive research, not the least of which is the complexity of approaches and the general absence of powerful integrating theories. Cognitive research is conducted within a variety of disciplines. No single theory runs through the disciplines. Echoing Kurt Lewin, one might say that "there is nothing so practical as a good theory".

But, of course, there is no theory mentioned here. Rather, the article is written based on hypothetical possibilities and practices that are useful. In a sense, the research is pre-theoretical and exploratory. Scientists do not really know what thinking mechanisms exist within us. Much is inferred and inconclusive. Models must be revised continually. Research is at the beginning level in many instances.

For example, everyday sense tells us about the power of emotions. Our thoughts certainly do not operate separately from our emotions. Psychotherapists know about the power of emotions and their corresponding symbols. Yet, cognitive scientists prefer usually to leave out the study of emotion in their work. Can reasoning processes really be separated from emotions? See Donohew, Sypher and Higgins for a discussion of this issue. Fortunately, there is an emerging interest in the study of emotions.

Much of our everyday conversational interaction does not result from planning. A pianist may play Rachmaninoff while she is carrying on an intelligent conversation. This is habituated behavior. Her pianistic performance is habituated and automatic. Otherwise, how could she perform both activities at the same time? How much of everyday conversation is habituated behavior?

How does spontaneous speech fit into cognitive planning?

In the everyday conversational process, the next piece of conversation is usually governed by an antecedent remark, suggesting that creative planning occurs on the spot. How do long-term planning and spontaneous planning work together?

What are the major biological restraints on cognition? To some extent, human behavior is affected, or conditioned by, differentially developed senses. For example, some people understand things better when they see them instead of hearing them. Does this 'sensationseeking' difference mean that inner cognitive mechanisms function differently for different people?

Do women think and plan differently from men? What part might age play as a variable? How does socialization enter into or affect the ability to reason, think and plan? What cultural differences exist and affect the process? Rationality is a value-laden Western idea. What is intuition?

What philosophy of human communication might underly the study of human cognition? Philosophers have been concerned with cognitive relativism, or how, in the absence of absolute and universal truths, scholars and scientists in different disciplines approach research questions (see Raven, Tijssen, and de Wolf in the bibliography). One might ask the question whether or not the type of cognitive research described this article is culture bound, limiting its explanative value.

Given the assumption that rudimentary scientific thinking and cognitive planning influences the conduct of everyday conversation (ANTCOG: Adult Normal Typical Cognition), how much is understood about the mechanics of this inner cognitive process? Scientists understand some things about the relationship of age, gender, mental health and other variables to everyday conversation, but can researchers build models of inner cognitive processes and mechanisms based on these findings?

Many researchers believe that this is possible, otherwise the work would not proceed. The use of brain-scanning tools (PET) and other mental representation devices such as computers that can 'read' thought patterns, will, no doubt, influence the answer to the question. Soon it may be possible to think a word, letter or thought and have it appear as a representation on a computer screen? In short, the study of human cognition is at a beginning point, not at an end point.

A Summary Statement

It is an interesting assumption that human conversational behavior is governed by relatively stable and researchable, but hidden, cognitive processes and mechanisms.

It is posited that a crude form of scientific sensemaking is a precursor to human conversation-making. It is also assumed that this hidden process underlies written discourse, filmmaking, artistic performances, and other communicative activities.

It is posited that all humans can be placed at a spot on a continuum of cognitive development, ranging from naive science and epistemology to informed science, and that untrained planning behavior resembles roughly the scientific method or protocol employed by trained scientists.

It is claimed that humans make sense of their lives through the cognitive planning and conversational process.

The study of the connection between everyday conversation and silent, or inner speech, is but one approach to develop a better understanding of this hidden activity. Research, though diversified and extensive, is rich with questions and answers. Yet, it is hypothetical and provocative to some extent, lacking a powerful, interdisciplinary, integrating theory, due to the hidden nature of cognition.

Definitions

ANTCOG: Refers to adult normal, typical cognition. This is the standard assumption in cognitive research.

Artificial Intelligence : Refers to mental and discourse modeling using the computer and mathematical representation.

Cognition: Refers broadly to the hidden process of knowing, symbolic representation, elaboration and reasoning.

Content Analysis: Refers to the use of analytic methods to describe characteristics of messages and their contents.

Discourse Analysis: Refers to the study of the communication of ideas, semantics, and information through conversational processes.

Ethnographic Analysis: Refers to methods researchers use to describe human events and to draw inferences from them without necessarily resorting to hypotheses.

Model: Refers to a theoretical and simplified representation of the real world.

Schema: Refers to a network of interrelated elements that define a concept for an individual.(Crockett)

Sensemaking: Refers to the way in which humans make sense of their daily lives through cognitive planning, enactment, and interpretation. Conversations provide the forum for the enactment of plans.

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ORESME™

User Manual

Rev. April, 1993

Terra Research & Computing

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Neural Networks

The human brain is perhaps the most complicated device we know, and it is folly to believe we understand it fully. Deep questions of consciousness, coordination and control remain unsolved. But it is fair to say that fundamental understandings of how the networks of interconnected neurons in the brain store and retrieve patterns of information in principle are beginning to emerge. A natural neural network (like the brain) consists of neurons, each of which may be connected to many other neurons. (In a human brain, there are about 100 billion neurons, each of which is connected, on the average, to about a thousand other neurons.) When a neuron is stimulated, it becomes "active", and sends signals to all the other neurons to which it is connected.

Neural networks store information as patterns in the same way that a TV screen or theater marquee or electronic scoreboard does: By activating some of the dots or light bulbs and leaving others off, any pattern can be displayed. (Researchers have actually identified more than a dozen maps of the visual field in the human brain.) But because the neurons in a neural network are connected to each other, the neural network can do more than simply display patterns of information: it can store and retrieve those patterns, and recognize patterns it has stored even if they are distorted or incomplete.

Although the actual functioning of a neural network like the human brain can be extremely complicated, in principle the way a neural network works is very simple and easy to understand. A neural network learns by connecting together the neurons which represent any particular pattern. Since they are connected together, *when some of them are activated, they spread their activation to the others connected to them, which turns on the rest of the pattern.* The neurons in the pattern may also be *negatively* connected to neurons not in the pattern, so that when the neurons in the pattern are active, they tend to turn off all those neurons not in the pattern. Thus, when a network sees part of a pattern, it can recall the rest of the pattern, even in spite of incomplete or erroneous information, as long as enough of the pattern is there to activate the rest.

ORESME

Figure 1 shows a network consisting of six nodes representing the words "Cat", "Dog", "Barks", "Howls", "Meows", and "Purrs". Each of the nodes may take on the value "0" (off), or "1" (on).

The nodes are connected to each other by weights which represent their relative "closeness" in the network.[1] They communicate with each other by a simple linear threshold rule: the signal sent from any node *i* to any node *j* equals the product of the activation value of *i* and strength of the connection between *i* and *j*. Thus the total signal received by any node *j* will be the sum of the signals received from all the other nodes, or

Input = "Meows"

		Cat	Dog	Barks	Howls	Meows	Purrs
	Cat		-.8	-.9	.2	.8	.9
	Dog	-.8		.9	.3	-.8	-.7
	Barks	-.9	.9		.5	-.3	-.9
	Howls	.2	.3	.5		-.2	-.1
+1	Meows	.8	-.8	-.3	-.2		.8
	Purrs	.9	-.7	-.9	-.1	.8	
		on	off	off	off	on	on

FIGURE 1

$$anet_i = \sum_{j=1}^{W} w_{ij} a_j$$

The way a node responds to the set of signals it receives is determined by its activation function; in this case we adopt the rule that the node will be activated if the sum of its input signals is positive; otherwise it will be turned off, or

$$a_i = \begin{cases} +1 \text{ if } x > 0 \\ \text{unchanged if } x = 0 \\ -1 \text{ if } x < 0 \end{cases}$$

[1] In the present example, the weights are essentially the correlations between frequencies of occurrence of the various words. Thus "Meows" and "Cat" tend to "go together", with a weight of .8, while "Meow" and "Dog" have a negative coefficient of -.8.

Following this rule, we assume the network receives the input "Meows" from its environment (i.e., the node which represents "Meows" has been activated). This sets the activation value of "Meows" at +1, and the activation values of the other nodes at 0. Multiplying the weights in each column by the activation values of the corresponding rows, then summing within each column shows that the activation of the node "Meows" will "spread" to the nodes "Cat" and "Purrs", setting their activations to 1, but will leave the nodes "Dog", "Barks" and "Howls" off.

Figure 2 shows that activating the node "Howls", will also activate the nodes "Cat", "Dog" and "Barks".

Figure 3 shows that activating both the nodes "Barks" and "Howls" will also activate "Dog", but will leave "Cat", "Meows" and "Purrs" off.

Input = "Howls"

		Cat	Dog	Barks	Howls	Meows	Purrs
	Cat		-.8	-.9	.2	.8	.9
	Dog	-.8		.9	.3	-.8	-.7
	Barks	-.9	.9		.5	-.3	-.9
+1	Howls	.2	.3	.5		-.2	-.1
	Meows	.8	-.8	-.3	-.2		.8
	Purrs	.9	-.7	-.9	-.1	.8	
		on	on	on	on	off	off

FIGURE 2

This example shows clearly that communication among the nodes of the network produces an apparently qualitative change in the pattern recognition and storage capabilities of the network. When the nodes do not communicate, the network can represent a pattern of virtually any complexity when activated directly by the environment, but the complete input is required to produce the complete pattern. When the nodes communicate, however, the complete pattern can be produced with only a partial input. When a sufficient subset of the nodes in a stored pattern is activated, the activation of those nodes will spread through the links and in turn activate the rest of the nodes in the pattern.

It is worth emphasizing the fundamental role communication as it has been defined here plays in this process. A pattern is stored by "connecting" its elements together. Things that "go together" are "close". Nodes or elements in turn *communicate* their activation values to other nodes in proportion to their closeness in the communication network. If a node is "on", it will tend to transmit that "on-ness" to other nodes through the links between them, so that the "on-ness" will spread to other nodes which represent the other elements in the pattern. Similarly, if a node is "off", it will tend to communicate its "off-ness" to other nodes through the links between them. *The entire pattern is encoded in the pattern of communication among the nodes as connections or weights, and can be recovered by the activation of any suitable subset of nodes.*

Input = "Howls" and "Barks"

		Cat	Dog	Barks	Howls	Meows	Purrs
	Cat		-.8	-.9	.2	.8	.9
	Dog	-.8		.9	.3	-.8	-.7
+1	Barks	-.9	.9		.5	-.3	-.9
+1	Howls	.2	.3	.5		-.2	-.1
	Meows	.8	-.8	-.3	-.2		.8
	Purrs	.9	-.7	-.9	-.1	.8	
		off	on	on	on	off	off

FIGURE 3

Self Organizing Neural Networks

All of a network's "memory" is stored in the weights or connections among the neurons. A network learns by setting these weights. One way self-organizing neural networks (often called "unsupervised" networks) learn patterns is by a simple Pavlovian conditioning rule: When two or more neurons are simultaneously active, the connection among them is strengthened. This means, quite simply, that neurons that have behaved similarly in the past are likely to behave similarly in the future. Self-organizing networks receive information in the form of patterns, which they learn to recognize, and which they can recall later. Self-organizing networks develop an internal representation of the information to which they have been exposed. They are useful because one can enter fragments of a pattern the network has learned, even in somewhat distorted form, and the network can recover the original pattern.

ORESME

ORESME is a self-organizing neural network which simulates the cognitive processes of individuals or groups of people, such as markets or market segments. ORESME represents objects, products, attributes, people or any other concept as neurons in a network. Mentioning one or more of these objects (as one would in an advertisement) activates the neurons which represent those objects. These activated neurons in turn activate those other neurons to which they are closely connected, while turning off those neurons to which they are negatively connected. This *interactive activation and competition network* thus simulates the process by which one or more ideas stimulates still other ideas.

Threshold = .000 Restoring Force = .250 Damping Factor = .000

Concept	Cycles X 1									
	1	2	3	4	5	6	7	8	9	10
SPORTY LOOKING	.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
FUN TO DRIVE	1.0	.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
FAMILY CAR	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
GOOD VALUE	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
PRACTICAL	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
AFFORDABLE	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
EXCITING	.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
APPEALS TO OLDER PEO	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
LUXURIOUS	.0	.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
RELIABLE	1.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
HONDA ACCORD	.0	1.0	.0	.0	.0	.0	.0	.0	.0	.0
SUBARU LEGACY	1.0	1.0	1.0	1.0	.0	.0	.0	.0	.0	.0
FORD TEMPO	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
TOYOTA CAMRY	.0	1.0	.0	.0	.0	.0	.0	.0	.0	.0
NISSAN STANZA	.0	1.0	.0	.0	.0	.0	.0	.0	.0	.0
CHRYSLER LEBARON GTS	.0	.0	.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
PONTIAC GRAND AM	.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
YOURSELF	.0	1.0	.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0

An ORESME analysis indicates that advertising SUBARU LEGACY as "fun to drive" and "reliable" might increase its appeal in the short run, but might eventually result in the decision to buy a PONTIAC GRAND AM or a CHRYSLER LEBARON GTS in the longer term.

FIGURE 4

Figure 4 illustrates an example that shows how **ORESME** might be used to test a particular advertisement for an automotive vehicle.

ORESME

ORESME can be helpful in alerting advertisers to the potential problems which might arise from unexpected connotations of otherwise useful message strategies. **ORESME** can accept inputs from CATPAC or GALILEO, or can develop its own network interactively.

INSTALLING ORESME

To install **ORESME**, place the installation diskette into the A: drive, change to that drive, and type

A: INSTALL

If your drive is named B:, you will first have to issue the DOS command

ASSIGN A: B:

This will create a directory called C:\GALILEO that contains four sub-directories: C:\GALILEO\RUNNER, C:\GALILEO\HELP, C:\GALILEO\DOC, and C:\GALILEO\DATA. RUNNER contains executable files, HELP contains help files, DOC contains the use manual and reference documents, and DATA contains sample data sets. When the installation is complete, the program will write a message telling you it has successfully installed **ORESME**. You may find it convenient to put the C:\GALILEO\RUNNER directory into your path on your AUTOEXEC.BAT file. If you are not sure how to do this, consult your DOS manual.

RUNNING ORESME

To run **ORESME**, change directories so that you are in the RUNNER sub-directory and type **ORESME.** If you have edited your path, you need only type **ORESME**. (If you are running **ORESME** as a part of the complete Galileo system, you can select ORESME from the Galileo

Menu and press **[ENTER]**.

ORESME will then ask you a series of questions to determine the type of analysis you want to perform, and you need only type the answers to set-up your run. Here's what **ORESME** will ask:

Hey Boss! How many nodes?

The basic input into **ORESME** is CATPAC output. If you are inputting the output from a CATPAC analysis, the number of nodes corresponds to the number of unique words CATPAC generated from its analysis.

Essentially, *Node* is another name for *neuron*, and **ORESME** needs to know how many neurons to create. Each neuron corresponds to one concept or word. Presently, **ORESME** can handle up to 160 neurons.

Do you want to start a new problem?

ORESME can read networks made by other programs, such as **CATPAC** or **GALILEO**, or the output from a previous (ORESME) run. **ORESME** can also create a new network on the fly. That is, you may enter a network by hand at the terminal. If you are entering output from another program (like CATPAC) type **NO** at this prompt.

If you wish to create a new network on the fly, type **YES**. If you type YES **ORESME** will ask you the following questions:

Do you have a labels file?

You can save some time if your labels are already listed in a file, one label per line. If so, just say yes and the program will ask you later for the name of that file. If you haven't done this, the the program will give you the opportunity to enter them here.

ORESME

Where do you want to put the labels?

Each of the neurons in the network stands for some concept or word; these words are called "labels." **ORESME** wants you to tell it the name of a file where it can store the labels you are about to give it. Just enter the path of any file where you would like to store the labels. If the file does not already exist, **ORESME** will automatically create it. (You can name this file anything you want, but at **Terra** we end all labels files names with the suffix **.LBL**.) After you've named a file to store the labels, **ORESME** will prompt you for each of them:

Please enter label 1
Please enter label 2
.
Please enter label n

Then **ORESME** will ask you:

Where should we put the data?

Once again, **ORESME** needs to know the name of a file, this time to put the network of connections or weights that it will build. This file will be in the form of a matrix of weights, where each weight represents the strength of communication between two of the neurons in the network. When you are starting a new network, these weights will initially be random numbers; later the program will give you the opportunity to output a new set of weights after **ORESME** has learned them.

Randomizing

When **ORESME** first constructs the network, it randomizes the connections among all the neurons. You don't have to respond to this; it's just informing you of this.

Where are the data?

If you answered *NO* when **ORESME** asked if you wanted to start a new problem, **ORESME** will need to know where the previously made network is stored. Answer with the complete path to the previously made weight input network (.WIN) file. (See **INPUT** below.)

Where are the labels?

In every network, the neurons represent some words or ideas. The labels (.LBL) file contains the names of each neuron. Tell **ORESME** the exact path to the file containing the labels for this network.

And where would you like the output, Air Breather?

ORESME keeps an exact record of what appears on your screen during your conversation, and stores it on a file of your choice. You can specify the name of any file whatever, and **ORESME** will write a copy of your conversation to that file for saving or printing.

Where would you like the modified weights saved?

When **ORESME** learns, it does so by modifying its weights. Rather than changing the original weight input network (.WIN) file, **ORESME** makes a new matrix with the changed weights in it. That way you can keep **ORESME** as it was, and still have a modified matrix as well. Just tell **ORESME** the path of the file on which you'd like the modified weights saved. (At **Terra** we use the extension **.WGT** to denote a file that contains modified weights. But you can call it whatever you want.)

ORESME

Care to set any values?

ORESME can simulate four different kinds of neurons, and the overall performance of **ORESME** depends on three parameters. The most generally useful neuron and some reasonable values for the three general parameters have been chosen as defaults in **ORESME**. But you can change them if you wish, and none of these neuron types or parameters are sacred, even those selected by Terra as defaults. You might well find **ORESME** performs better for some tasks with a different choice of neurons and/or default parameters. In order to change any defaults, just say yes. If you say no, you will get the defaults. If you say yes, you will be asked four questions:

Do you wish to set a new threshold?

Each neuron in **ORESME** is either turned on by you assigning it a value, or else it receives inputs from other neurons to which it is connected. These inputs are transformed by a *transfer function*. **ORESME** can use one of four transfer functions: a linear function varying between -1 and +1, a logistic function ranging between 0 and +1, a logistic function varying between -1 and +1, and a hyperbolic tangent function varying between -1 and +1.

After the inputs to any neuron have been transformed by the transfer function, they are summed, and, if they exceed a given threshold, that neuron is activated; otherwise it remains inactive. The default threshold is 0.0, which is appropriate for three of the four transfer functions (.5 would be a more reasonable value for the logistic varying between 0 and +1.) By lowering the threshold, you make it more likely for neurons to become activated; by raising the threshold, you make it less likely for neurons to become activated.

How about a new decay rate?

When you see an object, neurons which represent that object are activated. When the object is gone, the neurons (fortunately) turn off again. (If they didn't, you'd be seeing everything you ever saw all the time.) The decay rate specifies how quickly the neurons return to their rest condition (0.0) after being activated. The default rate is .9, which means that each neuron, if not reactivated, will lose 90% of its activation each cycle. Raising the rate makes them turn off faster; lowering the rate means they are likely to stay on longer.

New Learning Rate?

When neurons behave similarly, the strength of the connection between them is strengthened. The learning rate is how much they are strengthened in each cycle. Default is .001. Increasing this rate makes **ORESME** learn faster. Faster is not always better, though, since too high of a rate can make **ORESME** oscillate back and forth as new information is read. No one knows the optimum rate, or even if there is an optimum rate, however, so feel free to experiment.

Care to speculate on a functional form, Chiphead?

This option allows you to try different transfer functions. You can choose from four: a logistic varying between 0 and +1, a logistic varying between -1 and +1, a hyperbolic tangent function varying between -1 and +1, and a linear function varying between -1 and +1. Some writers speculate that different functions are better for different kinds of task, but no one knows for sure at this time.

The default threshold is 0.0. If you choose the logistic function that varies between 0 and 1, you might want to change the threshold to .5 or thereabouts (see *Do you wish to set a new threshold?* above.) If you'd like to experiment with different transfer functions, just say yes, and **ORESME** will prompt you to select the transfer function you want.

A Chiphead is a person with an exceptional commitment to computing. If you plan to do basic research on various transfer functions, you are one.

ORESME

Do you need to see the labels, Chemical Brain?

ORESME works by allowing you to turn on or off some or all of the neurons in the network, and then operates by communicating that pattern of activation throughout the network, turning other neurons on or off. Each neuron represents some idea or concept; the labels remind you of which is which. If you can remember which is which, you don't need to see the labels; if you don't, just say **YES** and **ORESME** will remind you.

Do you have a training file?

ORESME looks at words (labels) that occur together in the same "window." A window is any arbitrary set of words. You can build a training file which lists windows of words or labels, one per line, with each window separated by a -1 in columns 1 and 2 of the line following that window. **ORESME** will then read that file, learn which words "go together," and revise its understanding according to those new patterns. If you haven't made such a file, you can enter the data live and on line. If you have a prewritten training file, say "yes." If not, say "no" and you will be given the opportunity to enter the windows of labels live.

Enter concept label (Ctrl z when done)

Just enter the name of the neuron you want to activate. **ORESME** will keep on asking you for concept labels until you enter a [CONTROL] Z code, so you can turn on as many as you like.

Enter activation value

You may not only activate any neuron or neurons you wish, but you can set an activation value for each. You can enter any real number whatever, positive or negative.

Do you want these values clamped?

Clamping the value of a neuron means that you turn it on and make it stay on. Not clamping means that you assign a value to the neuron, but that value is free to change in the next cycle. Basically it's the difference between sending a message at one time, and sending the same message continuously.

How many cycles, hysteresis breath?

When words are present in the scanning window, the neurons assigned to those words are active, and the connection among all active neurons is strengthened. But the activation of any neuron travels along the pathways or connections among neurons, and can in turn activate still other neurons whose associated words may not be in the window. These neurons can in turn activate still other neurons, and so on.

In an actual (biological) neural network, these processes go on in parallel and in real time, so that the signal coming into the network is spreading at different rates of speed throughout the network, and neurons are becoming active and inactive at different times. (This process of delay is called *hysteresis*.)

In a serial computer like yours, however, this is extremely difficult to model, and so the network is updated periodically all at once. Each update is called a cycle. Letting **ORESME** cycle two or three times allows second and third order relationships among the words to be considered.

Very little cycling (or especially none at all like the concurrence model) tends to find only very superficial associations. Too much thinking, however, is not always a good thing, and **ORESME** can tend to see things as all pretty much alike if its allowed to cycle too many times. Experiment.

ORESME

Should I learn?

Unlike human beings, who are always being influenced by their surroundings, **ORESME**'s learning can be turned on or off. When learning is on, the weights of the connections among the neurons are allowed to change in response to the patterns of activation that are cycling through **ORESME**. The old weights, in any case, are saved and left in their original file unchanged; the new revised weights are written out to a new file which you named earlier. (See *Where would you like the modified weights saved?*)

Analog?

ORESME operates in either digital or analog mode. In digital mode, if the inputs to a given node exceed an arbitrary threshold (see above), the node is set to +1. In analog mode, the neuron just emits the actual value of its activation. These two kinds of networks work quite differently. Experiment.

Shall I think it over 1 more time?

When **ORESME** studies word connections, it take notes of words that associated with each other, and displays them for you. After its initial analysis, if you type **YES** at this prompt, **ORESME** will re-adjust the connection weights among words, strengthening some, weakening others, and again display the word associations it uncovered. If the network has stabilized, NO new words will appear, and none will be deleted from your original list. On the other hand, you may see that some words which were on the "fringe of association" have now been included, and/or some words that were "barely associated" have now been included. **ORESME** can do this type of "re-thinking" up to ten times.

Do you want to go again, Sack of Mostly Water?

ORESME is just asking you if you want to run through the program again. If not, it will terminate and put all your files in the places you told it.

CREATING A NEW PROBLEM -- AN EXAMPLE

Figure 5 shows an example of a new problem created using ORESME. After answering "yes" to the question *Do you want to start a new problem?*, the files PLANES.LBL and PLANES.WIN were created. In PLANES.LBL, the names of 10 World War II aircraft were listed: 6 fighters and 4 bombers. **ORESME** assigned random weights to PLANES.WIN.

FIGURE 5

As Figure 5 shows, during the first pass through **ORESME**, all the nodes representing fighter planes were turned on, while all those representing bombers were turned off. During the second pass, all the bombers were activated, while the fighters were turned off.

During both passes, learning was activated, so the weights connecting nodes which were simultaneously active (first fighters, then bombers) were strengthened. By the third pass, **ORESME** has learned to associate the fighters with each other, since activating any one of them (in this case, the Zero) activates all the remaining fighters but none of the bombers. And, by fourth pass, the bombers have also been classified as a category by **ORESME**, since activating one of them (the B26) activates all the other bombers, but none of the fighters. These patterns that **ORESME** has learned are written out to the modified weight matrix, PLANES.WGT

OTHER INPUT

Regardless of how complicated a neural network may be in nature, in principle a network consists solely of a set of neurons, each with its characteristic activation function, and a set of connections or weights linking the neurons to each other. In principle. this set of connections can be described completely by a square matrix of numbers, n x n, where n is the number of neurons in the network, and each entry w_{ij} represents the strength of the connection between the i_{th} and the j_{th} neuron. In **Terra** terminology, such a matrix is called a *weight input matrix*, or .WIN matrix. Any square matrix which meets these formal requirements will suffice as input to **ORESME.**

Typically, .WIN matrices most frequently come from either **CATPAC** or **GALILEO,** but any covariance, correlation, co-occurrence matrix or other square matrix can be read easily by **ORESME.** (This is not to say that any square array of numbers will give a reasonable output. There is -- prophets to the contrary -- no mathematical technique whatever that can turn useless inputs into useful outputs. But, formally speaking, a wide array of analytic procedures yield data that is appropriate input to **ORESME.**

Figure 6 shows an analysis of several interviews about pizza. The text of these interviews was analyzed by **CATPAC,** which output the weight input network PIZZA.WIN. This file served as input to **ORESME.** When the neurons which represent *fast* and *delivery* are activated, **ORESME** responds *Domino you want faster.* When *Pizzahut* is activated, the network responds with *quality,* and also with *Little Caesar two one inexpensive place.*

ORESME can also accept data directly from the **GALILEO** program. **GALILEO** accepts data about the perceived similarity among concepts, objects, words, products, attributes and the like, and represents these perceptions as objects in a multidimensional space.

In Figure 7, a group of people who planned to buy a Pontiac Grand Am filled out a complete paired comparisons questionnaire reporting their perceptions of the differences among all the cars and attributes listed in Figure 7.

Figure 7 shows that, when *YOURSELF,* the concept which represents the respondent's own position, is activated, many attributes are immediately activated, but ultimately the system

Threshold = .000 Restoring Force = .100 Learning Rate = .050
Concept Cycles X 1

Concept	1	2	3	4	5	6	7	8	9	10
LITTLE	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
CAESAR	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
DOMINO	.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
INEXPENSIVE	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
PIZZAHUT	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
TWO	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
GOOD	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
FAST	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
LIKE	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
DELIVERY	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
YOU	.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
ONE	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
QUALITY	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
WANT	.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
PIZZA	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
FASTER	.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
PLACE	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0

Threshold = .000 Restoring Force = .100 Learning Rate = .050
Concept Cycles X 1

Concept	1	2	3	4	5	6	7	8	9	10
LITTLE	.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
CAESAR	.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
DOMINO	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
INEXPENSIVE	.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
PIZZAHUT	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
TWO	.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
GOOD	.0	.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
FAST	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
LIKE	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
DELIVERY	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
YOU	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
ONE	.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
QUALITY	.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
WANT	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
PIZZA	.0	.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
FASTER	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
PLACE	.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0

FIGURE 6

settles down until only the attributes *SPORTY LOOKING, FUN TO DRIVE, EXCITING*, and *LUXURIOUS*, are left active, along with *YOURSELF, PONTIAC GRAND AM*, (the car the people in this group plan to buy) and *CHRYSLER LEBARON GTS*. Running the program again in analog mode shows that the *PONTIAC* is more highly activated than the *CHRYSLER*.

PONTIAC INTENDERS

Threshold = .000 Restoring Force = .100 Learning Rate = .050

Concept	Cycles X 1									
	1	2	3	4	5	6	7	8	9	10
SPORTY LOOKING	.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
FUN TO DRIVE	.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
FAMILY CAR	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
GOOD VALUE	.0	1.0	.0	.0	.0	.0	.0	.0	.0	.0
PRACTICAL	.0	1.0	.0	.0	.0	.0	.0	.0	.0	.0
AFFORDABLE	.0	1.0	.0	.0	.0	.0	.0	.0	.0	.0
EXCITING	.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
APPEALS TO OLDER PEO	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
LUXURIOUS	.0	1.0	.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
RELIABLE	.0	1.0	.0	.0	.0	.0	.0	.0	.0	.0
HONDA ACCORD	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
MAZDA 626	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
FORD TEMPO	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
TOYOTA CAMRY	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
NISSAN STANZA	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
CHRYSLER LEBARON GTS	.0	.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
PONTIAC GRAND AM	.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
YOURSELF	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0

Threshold = .000 Restoring Force = .100 Learning Rate = .050

Concept	Cycles X 1									
	1	2	3	4	5	6	7	8	9	10
SPORTY LOOKING	.0	.2	.3	.5	.8	1.0	1.1	1.1	1.1	1.1
FUN TO DRIVE	.0	.2	.2	.5	.7	1.0	1.1	1.1	1.1	1.1
FAMILY CAR	.0	-.1	-.2	-.4	-.7	-.9	-1.0	-1.1	-1.1	-1.1
GOOD VALUE	.0	.1	-.1	-.2	-.5	-.8	-1.0	-1.0	-1.0	-1.0
PRACTICAL	.0	.1	-.2	-.3	-.7	-.9	-1.1	-1.1	-1.1	-1.1
AFFORDABLE	.0	.1	-.1	-.2	-.6	-.9	-1.0	-1.1	-1.1	-1.1
EXCITING	.0	.2	.2	.5	.8	1.0	1.1	1.1	1.1	1.1
APPEALS TO OLDER PEO	.0	-.3	-.2	-.5	-.7	-1.0	-1.1	-1.1	-1.1	-1.1
LUXURIOUS	.0	.0	.0	.3	.5	.8	1.0	1.1	1.1	1.1
RELIABLE	.0	.0	-.1	-.2	-.4	-.6	-.8	-.9	-.9	-.9
HONDA ACCORD	.0	-.1	.1	-.1	-.2	-.5	-.7	-.8	-.8	-.8
MAZDA 626	.0	-.2	.0	.0	.2	.2	.3	.3	.3	.3
FORD TEMPO	.0	-.2	-.2	-.3	-.5	-.8	-.9	-1.0	-1.0	-1.0
TOYOTA CAMRY	.0	-.2	-.1	-.2	-.3	-.5	-.7	-.7	-.8	-.8
NISSAN STANZA	.0	-.1	-.1	-.1	-.1	-.2	-.3	-.4	-.4	-.4
CHRYSLER LEBARON GTS	.0	-.1	.1	.1	.3	.5	.8	.9	.9	.9
PONTIAC GRAND AM	.0	.0	.3	.3	.7	.9	1.1	1.1	1.1	1.1
YOURSELF	1.0	.1	.4	.2	.5	.6	.8	.8	.9	.9

FIGURE 7

Terra Research & Computing

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Troy, New York 12180

518 235 8391

The Galileo System:

System Overview and Program Descriptions

GALILEO MANUAL

PLEASE DON'T LOSE THIS PAGE. IT CONTAINS THE REGISTRATION NUMBER YOU WILL NEED TO UPGRADE TO LATER RELEASES OF CATPAC.

Your
Name ——————————————

Your Registration Number ——————————————

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The Galileo System

Galileo™ is a set of procedures which model thought processes. Although it is widely used by the scientific community, by far the most common use of the **Galileo** system is modelling the beliefs and attitudes of markets and market segments toward products and services. For nearly two decades, **Galileo** has been available to the scientific community via special license on mainframe computers, and to leading corporations worldwide on a consulting basis. Now, for the first time, this powerful set of procedures is available for the personal computer.

Technically, **Galileo** may be considered as a *fuzzy logic artificial neural network.*

A natural neural network (like the brain) consists of neurons, each of which may be connected to many other neurons. (In a human brain, there are about 100 billion neurons, each of which is connected, on the average, to about a thousand other neurons.) When a neuron is stimulated, it becomes "active", and sends signals to all the other neurons to which it is connected.

Neural networks store information as patterns in the same way that a TV screen or theater marquee or electronic scoreboard does: By activating some of the dots or light bulbs and leaving others off, any pattern can be displayed. But because the neurons in a neural network are connected to each other, the neural network can do more than simply display patterns of information: it can store and retrieve those patterns, and recognize patterns it has stored even if they are distorted or incomplete.

Galileo

Although the actual functioning of a neural network like the human brain can be so complicated as to be beyond comprehension, in principle the way a neural network works is very simple and easy to understand. A neural network learns by connecting together the neurons which represent any particular pattern. Since they are connected together, *when some of them are activated, they spread their activation to the others connected to them, which turns on the rest of the pattern.* Thus, when a network sees part of a pattern, it can recall the rest of the pattern, even in spite of incomplete or erroneous information, as long as enough of the pattern is there to activate the rest.

Galileo is an artificial neural network in which products, attributes and people are represented as neurons. Each of these products, attributes and people may be more or less tightly connected to each other. Products that are similar may be tightly connected, so that activating "Coke" in the network will probably activate "Pepsi" as well. Products will be tightly connected to their attributes as well, so that activating "sweet", "brown", "carbonated" will probably activate Pepsi and Coke. Attributes can also be connected to each other, so that activating attributes like "sweet", "satisfying", "filling" and the like may well also activate other attributes like "delicious" or "fattening."

Galileo also represents people as neurons. People can be connected to both attributes and products; they are tightly connected to attributes that make a difference to them, and they are more tightly connected to products and services that they buy and use than to those that they don't buy or use. All product development, advertising and marketing strategies can be seen as efforts to connect a product or service more tightly to people.

Galileo doesn't represent neurons as simply "connected" or "not connected" to each other, but instead measures the precise *degree* of each connection. This means that **Galileo** includes not only information about whether a car, for example, is smooth riding, but also represents precisely how smooth riding it is. **Galileo** does not simply say a product, service or object belongs to a category, but instead says *to what degree* it belongs to that category. A system which quantifies the degree to which objects belong to categories is called a "fuzzy logic."

In a natural neural network, neurons that are tightly connected are typically located close to one another. **Galileo** provides diagrams based on this principle in the form of "maps," which can help give an intuitive picture of the structure of the network. Figure 1 shows a map of Dessert Preferences for Tom and Becky. It shows that "Ice Cream" is closer to cold than "Cherry Pie", which is closer to "Hot." Both are about the same distance from "Sweet."

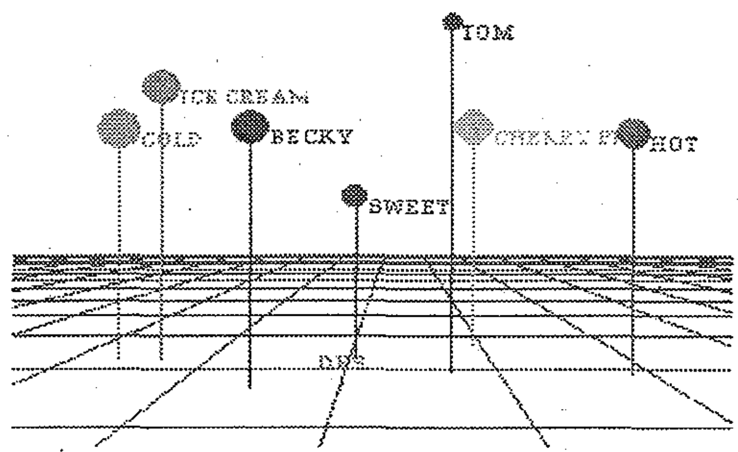


Figure 1 Dessert Preferences

Tom prefers a hot dessert, and the map shows him closer to "Hot" than "Cold." Becky prefers a cold dessert, and is closer to "Cold" in the map. She's also closer to "Ice Cream" than Tom, who is closer to "Cherry Pie" than Becky. We should expect Tom to choose Cherry Pie more often than Becky, while Becky would be expected to choose Ice Cream more often than Tom. We'd also expect Tom to choose Cherry Pie more often than Ice Cream, and Becky to choose Ice Cream more often than Cherry Pie.

While the map is useful for getting an intuitive feel for the structure of the network, more precise information is always available. **Galileo** can write out any distances desired in a simple format, as Table 1 shows.

One of the major reasons **Galileo** has been so widely used in advertising and market research is its ability to calculate optimum strategies for strengthening and weakening connections between the neurons. Using **Galileo**'s strategic planning abilities, it's possible to find strategies which will strengthen the connection of a product or service with its potential customers.

In order to design an effective strategy for repositioning a product or service in the customers' minds, it is only necessary to specify what position in the market the product or service is meant to fill. **Galileo** software will automatically calculate what connections need to be strengthened and which weakened to achieve the desired positioning.

Table 2 gives several examples of strategies developed by **Galileo** to reposition Ice Cream closer to Tom. The first strategy **Galileo** suggests tightens the connection between Ice Cream and both "Hot" and "Cherry Pie", while weakening the connection between Ice Cream and "Sweet." The second strategy suggests tightening the connections between Ice Cream and "Hot," "Cherry Pie", and Becky. The third suggests weakening the connection between Ice Cream and "Sweet", while tightening the connections to "Cherry Pie" and Becky.

MEAN GALILEO DISTANCES

Tom and Becky's Desert Preferences

Attribute	Distance	N
	CHERRY PIE	
HOT	16.50	2.
COLD	76.50	2.
SWEET	32.00	2.
TOM	24.00	2.
BECKY	56.00	2.
	ICE CREAM	
HOT	98.50	2.
COLD	8.50	2.
SWEET	41.00	2.
TOM	55.00	2.
BECKY	19.00	2.

Table 1: Tom and Becky's Dessert Preferences

```
ICE CREAM
ASSOCIATED  WITH
-----------------------------
  13.667 PERCENT  = HOT
 -15.667 PERCENT  = SWEET
  70.667 PERCENT  = CHERRY PIE

VALUE OF MINIMUM =       1.060

ICE CREAM
ASSOCIATED  WITH
-----------------------------
  32.333 PERCENT  = HOT
  31.583 PERCENT  = CHERRY PIE
  36.083 PERCENT  = BECKY

VALUE OF MINIMUM =      14.395

ICE CREAM
ASSOCIATED  WITH
-----------------------------
 -21.167 PERCENT  = SWEET
  73.917 PERCENT  = CHERRY PIE
   4.917 PERCENT  = BECKY

VALUE OF MINIMUM =      13.664
```

Table 2: Strategies to Reposition Ice Cream Closer to Tom

There are as many ways of strengthening and weakening connections as human imagination can devise, but the most common are advertising and actually changing the product or service. However one proceeds to implement the strategies, **Galileo** provides a convenient way to track the progress of the repositioning.

Galileo

INSTALLING GALILEO

To install the Galileo system on your PC, insert the diskette into either the A: drive and type
A:INSTALL then press the [RETURN] key

If your floppy drive is named B:, you will first need to issue the DOS command
ASSIGN A: B:

You will need an IBM PC or compatible computer with a 486DX chip, or a 486SX, 386 or equivalent with a co-processor. The Galileo System will take up about 5 megabytes on your hard drive. The Galileo system assumes your hard drive is called "C", or that you have a section of the hard drive named "C". If this is not so, please call Terra for assistance.

Setting your path:

All your GALILEO software resides on a directory called C:\galileo\runner. Your life will be greatly simplified if you insert this directory into your path. Please consult your DOS manual for instructions on inserting the GALILEO directory into your path. If you don't set your path to c:\galileo\runner, you will only be able to run your Galileo software after setting C:\galileo\runner as your default directory.

Running the Software:

All Galileo programs are designed to be run interactively, and have context sensitive help online. The best strategy for learning the system is simply to type "GALILEO" and ask questions as needed. At first this may seem bewildering, but after a short time, the online help will serve as an interactive training course.

Setting your Expectations:

Galileo Software is very easy to run -- you only need to select a number from the menu on the screen and press the **[ENTER]** key. But, at the same time, the technology that's controlled by this software is quite advanced, and not every analyst, even very advanced analysts, can be expected to know what Galileo can do. If you have no background in Galileo technology, you'd probably be well advised to spend at least a day or more training with a qualified consultant from Terra. There is also a very extensive scientific literature concerning Galileo techniques.

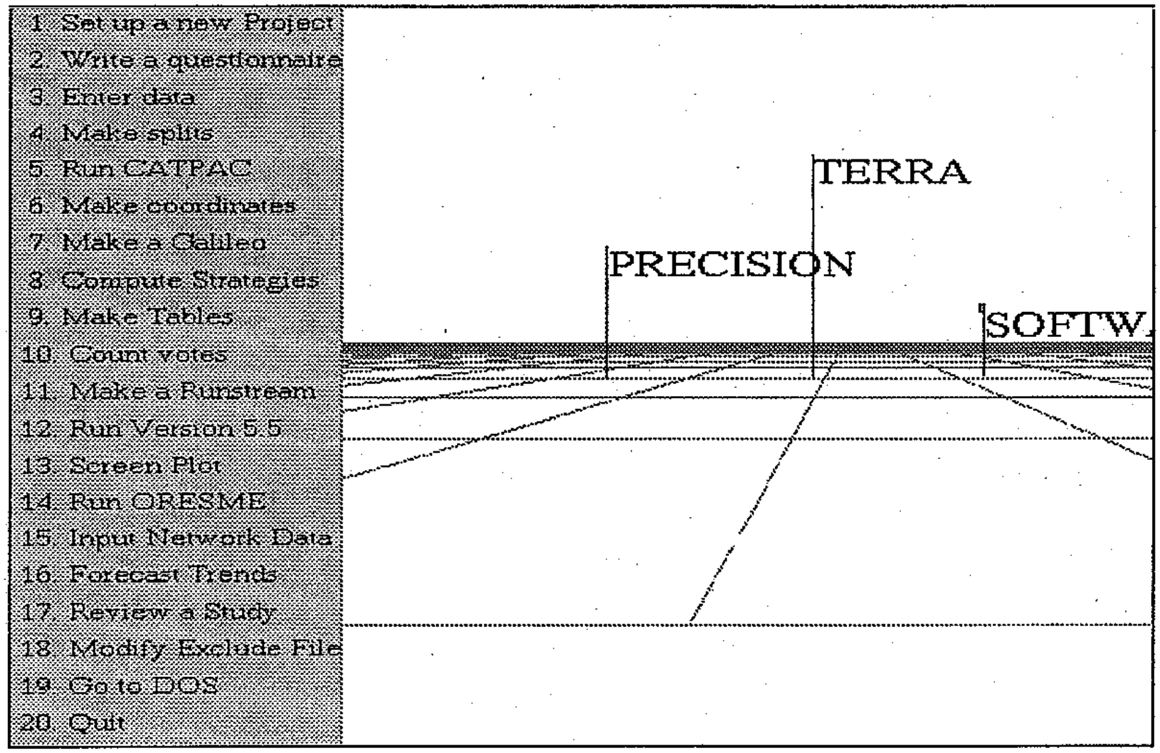
For more information about special training and for bibliographic advice, contact your Terra Representative.

Good Luck!

Galileo

The Software

After you've typed GALILEO, the Galileo Menu will appear on the screen.



The menu has 20 options from which to choose. To select any option, type its corresponding number and then press the **[ENTER]** key. Eighteen of these options will execute one of the 18 programs in the Galileo System. Option 19 suspends the Galileo system and returns to DOS, while option 20 terminates the Galileo session. (Expert users will want to know that the GALILEO program shell is not needed to run the programs -- each of the 18 Galileo programs can be run independently just by entering its name.)

We'll see what program each option calls up, and let each program describe itself and its uses:

Option 1: Set up a new Project: Galileo*ELQM

I'm ELQM (Electronic Questionnaire Maker), and I'm the program that can let you build a CATI system especially designed to work with Galileo software. I'll ask you a series of questions, and then build a filing system, write an electronic questionnaire, and coordinate the other programs in the system. I need only know the name of a directory on which you want the study to reside. If you are going to have several different versions of a questionnaire, then a separate directory will be required for each questionnaire. (You might find it useful in such cases to create a master directory for the study as a whole, with a sub directory for each questionnaire version.)I can make four kinds of question (which is all there are, I think.) First, I can make a complete Galileo(tm) type magnitude estimation paired comparisons instrument. I can also make magnitude estimation scales, category scales (like male=0, female=1) and Likert-type scales,and open-ended or in-depth questions. Once I've made your electronic questionnaire, you or your agents run SPED (the Simplified Process for Entering Data), and SPED will prompt you with the questions. When you (or your respondent)answers, the answers will be directed automatically to the correct files. I always create 3 files on the study directory: study.dat, study.lbl, and galileo.dat. Study.dat is the master control file, and contains all the information about the study, including the exact wording of every question and the file handling information. Study.lbl contains a list of the concept labels for the Galileo questionnaire, which are needed for subsequent processes. Galileo.dat contains all numerical data, including the paired-comparison responses and responses to all quantitative and categorical questions. The Galileo paired comparison data and the other questions are interspersed in this file in an obvious way; the exact format of these files is stored in study.dat.

Study.dat is read by a program called Read. Just run Read and name the study directory; Read will write out the information there,including all relevant formats. In addition to these files, I will create a file for each open-ended or qualitative question, named after the ordinal position of the question. If the third question were, for example,

3.) Discuss your summer vacation. Be brief.

I would create a file called quest03.dat, and I would tell SPED to append all responses to that question to quest03.dat.

Galileo

Option 2: Write a questionnaire: Galileo*AQM

ELQM (the Electronic Questionnaire Maker) makes an electronic questionnaire that can be administered online or by phone through a skilled interviewer who enters data live onto the computer using SPED (The Simplified Process for Entering Data). But every now and then, as in mailed questionnaires, mall intercepts and the like, there comes the need for that primitive technology, the paper and pencil questionnaire. I make these. (Actually, I only make the Galileo paired comparison parts of it, along with a few standard questions scientists at The Galileo Company always use.) That's because paired comparison questionnaires are very difficult to make using a word processor. The rest of the questionnaire is easier to make using a word processor like Microsoft Word or WordPerfect, so I don't do that. I'll write out the Galileo questionnaire on a file you choose. You can edit it as you like and print the questionnaires then.

Option 3: Enter data: Galileo*SPED

I'm the chief data entry program in Galileo*CATS. All I need to know from you is the name of the directory on which the study resides (the "study directory"). After that, I'll prompt you for all the questions and automatically post the responses to the correct files.

Option 4: Make splits: Galileo*ALLSPLIT

I'm a general purpose splitting utility. You can just tell me what columns you want to split on, and where you want the split files, and I'll do it. I can split on values or ranges. I can read the study.dat file made by ELQM, and so I know where your variables are and can help you during the split run. I can write out a list of the variables, and I can split by variable name as well as by column. I can write out all of a case or any subset of it; you tell me what you want written out. (Some Galileo processors don't want to see anything but paired comparison data in their files; you can get rid of all the other data using this option.)

It may take a while to master me, but it's well worth it. I'm very versatile.

Option 5: Run CATPAC: Galileo*CATPAC

I'm a self-organizing neural network optimized to read and understand text. I can read any ASCII text and determine its underlying conceptual structure. Technically this means that I can learn the patterns of association among the various words in the text, and perform a diameter method hierarchical cluster analysis of these relations.

I also write out the matrix of interrelations in a file with the appendix .win (weight input network). This square matrix represents the pattern of interrelationships among the top N words in the text (you have to tell me what N you desire). You can input this matrix to other programs (such as your favorite statistics package), or to other neural networks, particularly ORESME.

I also make .CRD files which contain Galileo coordinates. These can then be plotted by PLOT. Perceptual maps from text is a Galileo exclusive! (You not only saw it here first, you can't see it anywhere else!)

Option 6: Make coordinates: Galileo*GALNET

I make metric coordinates for generalized input data. I will read either a square matrix of dissimilarities, similarities, covariances, correlations, connections among neurons or other user supplied input, and project the concepts or variables corresponding to the rows of that matrix onto coordinates which retain the metric of the input matrix. Alternately, you may input a rectangular objects by attributes matrix in which each row represents some object and each column represents some attribute. Cell entries represent the numerical value of the attribute for the corresponding object. In this second case, the labels file must contain the names of the endpoints of the attributes following the names of the objects scaled. In the following example, several people and a cat are rated according to their height, weight and age:

SALLY
BOB
JOE
ROSS
GEORGE
RALPH
FELIX
LEON
SHORT
TALL
LIGHT
HEAVY
YOUNG
OLD

Galileo

The data matrix for this example is as follows:

(8f10.0)

64.	112.	26.
68.	148.	44.
55.	90.	12.
65.	135.	18.
67.	120.	17.
65.	110.	17.
21.	12.	2.
66.	145.	23.

Each of the people (and the cat) are rated according to their height in inches, their weight in pounds, and their age in years. These labels can be found in \galileo\data\us.lbl and the data can be found in \galileo\data\us.dat. I am also useful for taking .WIN matrices made by CATPAC or ORESME and converting them into Galileo-type coordinates which can then be displayed using PLOT, or may serve as inputs into ASG. To use me to convert ORESME outputs into a form that can be read by PLOT and ASG, simply run me (GALNET), and name the .WIN file made by CATPAC or ORESME when I ask where your data are. When I ask if this is a real Galileo, say "yes", and when I ask if this is a CENTROID SCALAR PRODUCTS MATRIX, say 'yes.'

Option 7: Make a Galileo: Galileo*MICROGAL

I am the PC version of the mainframe Galileo computer program. I expect to read raw data in standard Galileo paired comparison format. This is the format which SPED writes. For a detailed description of standard Galileo formats, consult Woelfel and Fink, (1980) *The Measurement of Communication Processes: Galileo Theory and Method*, New York, Academic Press. (An example of complete paired comparison data is provided on your \galileo\data directory in the file AUTOS.DAT. The corresponding labels file for these data are in the file AUTOS.LBL.) I calculate the coordinates of the concepts in Galileo space. These coordinates may be plotted to produce a graphic picture of the data, or they may serve as input to other Galileo programs, such as Strategy and Compare.

I also calculate the standard error for each of the points. These standard errors can serve as an estimate of the uncertainty around the location of the points. In graphic representations, the standard error or some multiple usually serves as the diameter of the circle or sphere which represents the concept in Galileo space. If all standard sampling distribution assumptions are correct (which, of course, they never are) there will be about a 67% likelihood that the concept is actually located within plus or minus one standard error of the location given by its Galileo coordinates.

I ask for the number of concepts, the maximum value above which it will ignore data, the location of the labels file (the file were the names of the concepts are kept), the name (and complete path) of the file where the data are kept. I will also ask whether a logarithmic transformation of the data are desired, and what you want to name the output file and the coordinates file. The output file is the place where an output file suitable for printing is written, and the coordinates file is where coordinates for plotting or input into other Galileo programs are stored. You should supply the complete path for each of these files, otherwise I will write them into your current directory.

Option 8: Compute Strategies: Galileo*ASG

I'm the Automated Strategy Generator (ASG). I can read Galileo Coordinates made by Microgal, V55, or Galnet, and calculate the likely effects of every possible strategy for repositioning any concept in the Galileo space. In doing this, I follow the theory of Woelfel and Fink, *The Measurement of Communication Processes:Galileo Theory and Method*, Academic Press, New York, 1980. Unlike the model in V55, I provide weighted strategies; that is,I can tell you my best guess as to how much to emphasize each element of a strategy. I can even consider negative strategies(such as "I am not a crook") and mixed strategies, such as"Luxurious, but not expensive."

To be candid, however, the practical differences between weighted strategies and unweighted strategies is fairly small relative to today's (1991) ability to measure. Improved measurement precision (sure to come) will make these differences crucial, however, so it's not OK to put the question out of mind. I can only make strategies if I know what your goals are, though, and I'll ask you a series of questions to find out what you want to accomplish. If you don't know what to do at any point, just enter a '?'.

Option 9: Make tables: Galileo*TABLES

I make tables out of pair comparison data. Most brand managers (and most social scientists, for that matter) follow Aristotle in dividing up their experience into objects and attributes. In this model, objects are defined by their attributes,so that a ball might be round, yellow and soft, or a car might be economical, reliable and stylish. In more advanced models, objects may have differential amounts of each attribute (every quality exists in some quantity).

In paired comparison dissimilarities data typical of Galileo data, objects are arrayed at various distances from various attributes, so that an economical car can be close to the attribute "economical", but a more economical car can be even closer, and so forth. I'll ask you for Galileo data in standard format (that is, the paired comparison format described above in the description of Microgal), and I'll ask you to tell me which of your concepts are objects and which are attributes. Then I'll make tables which give the mean distances between each object and each attribute. I'll also make tables of Z for each pair of objects, which shows how they differ in their scores on each attribute. The difference is given in standard units (z-scores), and a mark ('S') is made if the differences are significant at the 80% level.

Option 10: Count votes: Galileo*BALLOT

I am a variation of TABLES. I'm particularly useful when the topic you are studying involves discrete choices. Elections are examples of discrete choices, since voters may either vote for a candidate or not. Expensive products such as automobiles usually may be considered discrete choices as well, but inexpensive products typically are not, since you can buy variable quantities of them.

My main function, curiously, is to "ruin" perfectly good data. Professional market or election researchers, for example, may make very precise measurements about *how much* respondents like or prefer a specific candidate or product. But elections don't let you express a degree of preference; you can either vote for or against a candidate[1]. The same is true for most big ticket products; customers don't tell dealers, for example, how much they like a car; they either buy it or they don't. My job is to make good quality numerical scales into simple dichotomous choices.

I read complete paired comparison datasets, in which each product, candidate and attribute is compared to each other product, candidate and attribute on a numerical scale, which is probably the most precise measurement format known to the market researcher. I make the same inquiries as TABLES: I ask how many concepts there are, on what file the concept names or labels are to be found, whether or not you want a logarithmic transformation of the data, what the name of your data segment is (this becomes the title of your table), where your data (in standard GALILEO raw data format) may be found, and on what file you'd like the output written. I also ask you to identify two or more "candidates" or products and a "self-concept", which represents a self-point or ideal point.

I then divide up the cases into several piles: the first pile contains those cases closer to the first candidate

[1] This is an interesting point of public policy. Whenever a political poll fails to predict an election outcome accurately, we routinely say the poll was inaccurate. It's much more likely, however, that the *election* is inaccurate as a gauge of the public's actual opinions. After all, in an election the sampling is non-random, the polling method is cumbersome and incredibly expensive, biases are known to be extreme, and the scaling method is simply dichotomous choice. If any young market researcher were asked to design a survey to measure people's opinions toward a set of issues, and recommended that polling stations be established, the public be invited to come to them and fill out a questionnaire consisting of 2 point scales, he or she would be fired. And rightfully so. But the election process was established by the constitution before scientific polling was invented, and is "accurate" by legal definition, not by scientific merit.

or product; the second contains those closer to the second candidate or product; the third contains those closest to the third candidate or product, and so on for **n** piles for **n** candidates of products. The second last pile contains those equidistant from all candidates or products (the "undecided"), and the last contains those for which the crucial data are missing. The results are displayed on the screen and written to the file you named in a standard ASCII format ready to print. The result is my best guess as to how the share of vote or share of market would come out, assuming respondents were only allowed to make dichotomous choices.

Option 11: Make a Runstream: Galileo*INTERGAL

Galileo Version 5.5 (V55) is the current version of the original mainframe Galileo program. Designed in the 1970's, V55's architecture is antiquated, but, like the dinosaurs it resembles, it's still quite powerful and can do several things that have not yet been ported to the PC platform. For that reason, it remains alive and is still supported. I write a runstream that makes V55 work. I'll ask you a series of questions, then write a command file that executes a V55 run. Crude, but effective.

```
AUTOS.PRT
AUTOSR.CRD
RUN NAME        A TEST OF V55 FORMATS
N-CONCEPTS      18
N-DATASETS       2
CRITERION PAIR I DON'T RECALL
CONLABELS
               SPORTY LOOKING
               FUN TO DRIVE
               FAMILY CAR
               GOOD VALUE
               PRACTICAL
               AFFORDABLE
               EXCITING
               APPEALS TO OLDER PEO
               LUXURIOUS
               RELIABLE
               HONDA ACCORD
               MAZDA 626
               FORD TEMPO
               TOYOTA CAMRY
               NISSAN STANZA
               CHRYSLER LEBARON GTS
               PONTIAC GRAND AM
               YOURSELF
OPERATIONS      COMPARISONS
```

Galileo

```
SPECIFICATIONS
MAXVAL          999
MAINSPACE         1
FCONS           18
END OF SPECIFICATIONS
OPTIONS         1,23,24,22,18,8,9,12,13,14,15,16
READ DATA
AUTOS1.DAT
AUTOS2.DAT
```

V55 is very versatile, and I can't design every possible job V55 might do. Often more advanced work with V55 will require me to make a run stream like this one which you will then edit with an ASCII editor. If you don't already have a favorite of your own, you can use EDWIN supplied with the Galileo System.

Option 12: Run Version 5.5: Galileo*V5.5

I'm a PC version of the original Galileo mainframe computer program. I'm a general purpose program that can do a huge variety of things. Learning what I can do is beyond the scope of this manual, and I should really only be used by advanced analysts. A good introduction to what I can do, along with a manual illustrating how to get me to do a wide variety of things is *The Measurement of Communication Processes: Galileo Theory and Method*, by Joseph Woelfel and Edward L. Fink (Academic Press, NY, 1980). If you have trouble finding this volume, please contact Terra Research and Computing Company.

Galileo Version 5.5 (V55 on the Galileo Menu) is a powerful and sophisticated program for the advanced user. While a complete mastery of V5.5 requires advanced understanding of Galileo technology, the typical advanced user will use it for three primary functions: to provide comprehensive statistical analysis of the raw data, to generate unweighted message strategies, and to compare multiple Galileo spaces.

Statistics

Galileo Version 5.5 provides a much more extensive statistical analysis of raw paired comparison data than is provided by the more convenient Micrgal. In a normal Galileo analysis, the dissimilarities among all possible pairs of a set of concepts (typically products and their attributes) are measured on a ratio-scaled questionnaire. For N objects, this will produce

$$n_{pc}=N(N-1)/2$$

paired comparisons. For each of these paired comparisons, V5.5 will compute the mean, standard deviation, standard error, index of skewness, index of kurtosis, maximum value, minimum value, count and percent relative error.

In addition to these local statistics, V5.5 will also flag values beyond a user-supplied maximum (EXVAL) and eliminate values beyond another user-set value (MAXVAL). Cell with the largest value and the smallest values are also flagged. V5.5 will also search for illegal keypunches in the data and eliminate them, and will produce warning messages for cells (paired comparisons) with sample sizes under 30. (In certain cases, sample sizes under 30 might be perfectly acceptable, but you should be aware of them in those cases where statistical inference to a larger population is required.)

```
                    A TEST OF V55 FORMATS
Raw data set number  1


 DISTANCE GT MAXVAL       33100201    ADDRESS  5  1POSITION  4
DISTANCE 1000.
 CELL ADDRESS ERROR      33100221   ADDRESS 25  4POSITION  3

 Cell with an N of .LT.30  2  1Count is  23.
 Cell with an N of .LT.30  3  1Count is  24.
        61 errors detected in data set  2

                        Statistics for A TEST OF V55 FORMATS
             Set number   1


  ROW  COL           MEAN    STAN. DEV.            STD ERR
SKEWNESS            KURTOSIS   COUNT  MIN. VAL  MAX. VAL      ERROR
   1    2          36.913      52.320               10.909
  1.732              2.258      23        .0     200.0        29.6
   1    3         153.542     138.178               28.205
  1.461              1.543      24        .0     541.0        18.4

  Average observations per cell    22.9804
  Count of all non-zero cells   153
  Mean of all non-zero cells    83.2763
  Cell with maximum distance is  8  1  Distance is       173.3636
  Cell with minimum distance is  6  5  Distance is        20.0435
```

Galileo

Cells which have no values at all will be estimated by the program, which will insert the grand mean of all non-zero cells in each empty cell. This may or may not make sense in your particular case. It is not good practice to leave any cells unmeasured unless you are very confident on theoretical grounds that this will not adversely affect the geometry of the neighborhood. Cell adjustment is provided solely because it is usually better to do something moderately wrong than to do nothing when circumstances beyond your control have left you with incomplete data.

Normal Coordinates

In addition to complete statistical information about the original paired comparison measurements, V55 calculates the *complete eigenstructure* for the data. This means that Galileo Version 5.5 calculates all eigenvectors, both real and imaginary, which are needed to represent the original pairwise dissimilarities *exactly*. If any of the original dissimilarities violate triangle inequalities constraints, at least some of the eigenvectors will be imaginary, and their corresponding eigenroots will be negative. V55 provides all these eigenvectors and eigenroots, along with a complete analysis of any non-euclidean aspects which the space may incorporate. A simple summary measure of the degree to which the space is non euclidean is given by the Warp Factor, which is the ratio of the sum of positive eigenvalues to the total sum of eigenvectors. If this ratio is 1.0, the space is completely euclidean; greater values indicate greater degrees of warp.

GALILEO Coordinates of 18 Variables in Riemann Space for Data Set 1

Normal Solution

0	1	2	3	4	5	6	7	8
1 SPORTY L	81.581	-29.796	15.491	19.250	-.307	-12.650	-5.877	-14.337
2 FUN TO D	68.880	-12.055	-15.928	14.624	5.430	-2.295	-7.588	13.274
3 FAMILY C	-62.677	36.077	12.025	22.710	-7.156	-26.582	-4.296	-6.625
4 GOOD VAL	-43.567	-17.890	17.070	-18.162	-2.508	9.102	-6.590	22.681
5 PRACTICA	-52.675	-25.301	11.887	4.492	5.881	1.526	13.052	.027
6 AFFORDAB	-55.396	-33.485	14.169	-17.403	-3.042	1.443	-8.400	-18.929
7 EXCITING	64.175	2.628	.240	-12.578	-15.193	10.551	-17.789	8.042
8 APPEALS	-65.520	39.026	-23.459	-32.140	-2.567	11.096	-2.130	-1.990
9 LUXURIOU	49.476	67.742	-30.893	-18.798	-6.157	2.260	7.804	-14.856
10 RELIABLE	-17.249	-10.854	13.669	3.357	14.772	-15.763	.706	-6.558
11 HONDA AC	-7.735	-38.072	-33.782	-9.889	-24.725	-29.815	-14.972	-4.805
12 MAZDA 62	-.396	-10.120	-11.974	18.225	-34.460	10.483		

```
25.005          8.269
 13  FORD TEM              -28.322          12.332           5.379          44.264          -13.210          36.389
-20.004          -1.400
 14  TOYOTA C              -16.502           4.054         -24.307          11.752           20.082         -19.374
11.885          27.098
 15  NISSAN S               -1.971         -12.472         -27.404          21.618           37.752          16.084
14.089         -15.640
 16  CHRYSLER               21.734          59.769          34.079          -2.127           21.041          -8.451
-15.387          6.773
 17  PONTIAC                37.961           9.178          42.078         -13.223          -15.681           -.444
33.002          -1.950
 18  YOURSELF               28.202         -40.761           1.659         -35.973           20.051          16.441
-2.512            .925

      Eigenvalues (roots) of eigenvector matrix--
                          38073.530       17846.850        8553.307        7777.015         5516.946        4746.127
3698.842       2753.560
      Percentage of variance accounted for by individual factors-
                             56.617          26.539          12.719          11.565            8.204           7.058
5.500          4.095
      Percentage of variance accounted for by individual factors in their own spaces-
                             40.690          19.073           9.141           8.311            5.896           5.072
3.953          2.943
                  Sum of Roots       67247.770          *********  WARP FACTOR =      1.3914 **********
                  Number of dimensions in real space 11
                  Number of dimensions in imaginary space  7
```

Automatic Message Generator (A.M.G.)

In a typical perceptual map, the positions of objects and their attributes are determined only within very course limits. One can get a crude overall "feel" for the structure of a market or market segment, but confidence intervals around the location of each product and attribute are typically as wide as the entire picture -- or wider. This means that objects and attributes location cannot even be guaranteed to be in the correct quadrant using typical perceptual mapping techniques. Moreover, since the computation of the configuration requires that the majority of the values be estimated rather than measured, the results are highly dependent on (typically unstated) assumptions about the geometry of the space which spans the market or market segment.

In a Galileo ratio-scaled complete paired comparison design, however, results are typically much more precise. Moreover, since *all* non-redundant pairwise dissimilarities are measured, Galileo does not need to make as many strong simplifying assumptions about the geometry of the neighborhood in order to calculate the coordinates of the objects and attributes.

As a result, it is possible to produce Galileo maps within which the positions of the objects and attributes is sufficiently precise to allow the program to calculate the most likely effects of possible *message strategies* on *relocating* objects in the space. In Galileo theory, a *message strategy* is *anything that can be done to change the relation of an object or product toward the attributes in the neighborhood.* (This usually involves either associating the object with certain attributes in advertising, or changing the actual product in manufacturing.)

To develop a message strategy, you must first decide where in the market you wish to reposition the object. Most Galileo users include either an *ideal point* or a *self point* (yourself)in their original concept list, and either of these can serve as a useful target for repositioning. Ideal points can work well with low cost products, such as most consumables, (e.g., the ideal dessert) but don't usually work well with big ticket items like automobiles, because most consumers consider ideal automobiles to be too expensive for them. The self point is usually a good choice regardless of product category. Whichever you choose, V5.5 refers to it as the *target*. The object you wish to reposition is called the *start concept.*

The A.M.G. in V5.5 differs from the algorithm in the Automatic Strategy Generator (ASG) in several ways. In many ways, ASG is the more sophisticated tool, since it allows the choice of multiple target points. This can allow you to reposition an object *in the middle of several other objects*. This can be useful when you wish to attack a particular product by positioning between it and the self point of its market segment. Or it can be useful if you wish to reposition a product in the vicinity of several attributes. ASG also produces *weighted strategies*, which can tell you not only what attributes to emphasize in advertising or remanufacturing, but *how much of each to use.* ASG also allows the calculation of *negative strategies*, that is, attributes which you can claim your product does not exhibit (e.g., not harsh).

On the other hand, ASG pays a certain price for its sophistication. It can be slow in computing strategies for a large number of concepts, since it involves complicated non-linear iterative procedures. And often, weighted advertising strategies are beyond the budgeting capabilities of many clients. Moreover, the understanding of negative strategies is not well developed and probably ought to be considered experimental. A.M.G. in V5.5, on the other hand, is quite fast, provides strategies that are easier to implement, and in general are not very much less powerful than the best weighted strategies produced by ASG.

```
A. M. G.    1-PAIR Message Solutions
                   Start IS 11         Target is 18         Distance to Target is   72.83

            THETA        CORR.      ST-R        TG-R       TG-CAP      ST-CAP       PCT
01-         38.6         .782       87.39       54.70      45.42       56.92       75.10
02-         30.6         .860       67.13       37.39      37.12       62.65       51.34
```

A. M. G. 2-PAIR Message Solutions
Start IS 11 Target is 18 Distance to Target is 72.83

	THETA	CORR.	ST-R	TG-R	TG-CAP	ST-CAP	PCT
01-02-	33.6	.833	75.70	43.06	40.34	60.63	59.13
01-04-	i	-67.36					

A. M. G. 3-PAIR Message Solutions
Start IS 11 Target is 18 Distance to Target is 72.83

	THETA	CORR.	ST-R	TG-R	TG-CAP	ST-CAP	PCT
01-02-03-	48.5	.663	38.65	55.39	54.55	48.25	76.06
01-02-04-	i	-57.06					

A. M. G. 4-PAIR Message Solutions
Start IS 11 Target is 18 Distance to Target is 72.83

	THETA	CORR.	ST-R	TG-R	TG-CAP	ST-CAP	PCT
01-02-09-13	39.7	.769	74.29	50.01	46.55	56.01	68.67
01-02-10-11	5.9	.995	43.24	30.15	7.50	72.44	41.39

And the winners are.....

Message	Concepts	% Remaining	Distance Remaining
1	SPORTY LOOKING FUN TO DRIVE AFFORDABLE PONTIAC GRAND AM	1.54	1.12
2	FUN TO DRIVE PRACTICAL EXCITING HONDA ACCORD	2.44	1.78
3	SPORTY LOOKING GOOD VALUE APPEALS TO OLDER PEO	2.48	-1.81
4	SPORTY LOOKING PRACTICAL EXCITING NISSAN STANZA	2.73	1.99
5	FUN TO DRIVE AFFORDABLE PONTIAC GRAND AM	4.95	-3.60
6	FUN TO DRIVE PRACTICAL EXCITING TOYOTA CAMRY	5.81	-4.23
7	FUN TO DRIVE AFFORDABLE EXCITING PONTIAC GRAND AM	6.77	4.93
8	FUN TO DRIVE AFFORDABLE NISSAN STANZA	7.01	5.11

9	SPORTY LOOKING GOOD VALUE RELIABLE NISSAN STANZA	7.11	-5.18
10	SPORTY LOOKING FUN TO DRIVE PRACTICAL TOYOTA CAMRY	7.62	5.55

Notice that some of the message distances are marked with an "i", which means that these distances are imaginary. Some analysts believe that imaginary distances ought to be interpreted in the same way as real distances, but a more conservative approach would assume that imaginary distances are not yet well understood among market researchers. In the conservative view, which we recommend, messages involving imaginary distances ought probably not be considered for commercial practice until further research clarifies their applicability.

Notice that V55 calculates *all* possible message strategies, but prints only those which actually improve the position, that is, result in the START concept moving closer to the TARGET. V55 also rank orders the message strategies and prints out the ten best strategies. This can be very helpful, since the number of possible strategies is equal to the number of combinations of concepts taken one, two three and four at a time -- a very large number for large spaces.

Comparison of Spaces

Look at Figure 4. Figure 4 shows the Galileo map of a sample of all households in the Capital District of New York State prior to the 1988 presidential election. Notice that the map does not realize we like to place "liberal" to the left of our political representations and "conservative" to the right. (There is, of course, no way it could, since this is simply a popular convention and not a fact of nature.)

On the other hand, Figure 5 shows the decision the program made when it examined only Democrats in the same region:

Notice that, for the Democrats, the software "decided" to place "liberal" to the left of the plot and "conservative" to the right. There is, once again, no logic to this decision, but it is simply a mathematical artifact of the way the points lie in space. If you have only one map, this is of no consequence. But if you have several maps representing several different segments of the population (as in the present case) or representing the same population over successive points in time, comparisons can be next to impossible. You should convince yourself that the map of the Democrats and the map of the total sample look *very different.*

These are not real differences.

Although Democratic voters differ from the total population by a certain amount, they do not differ by as much as these maps seem to show, since the largest part of the apparent differences are due to the artifactual differences of orientation.

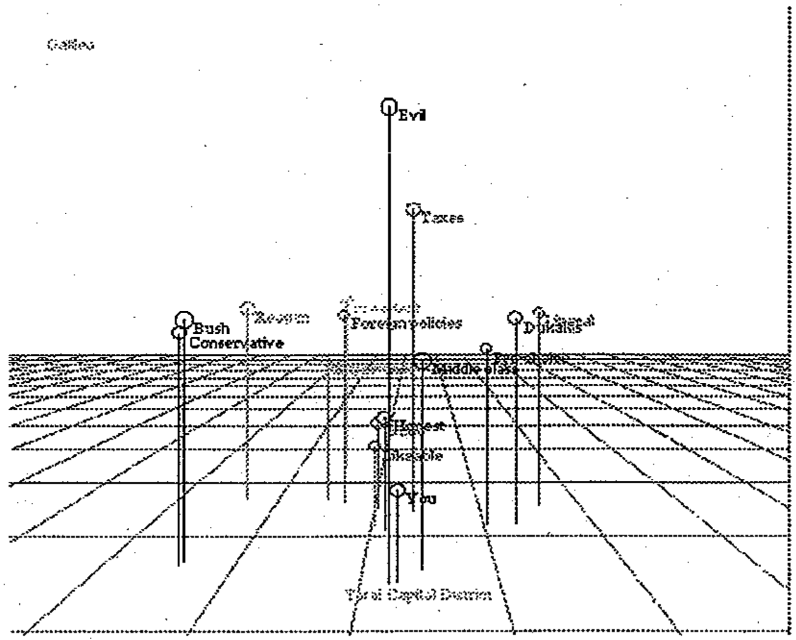


Figure 4: Map of All Voters

V5.5 is able to do away with artifactual differences due solely to the orientation of the maps.

Figure 6 shows the map of all voters after V5.5 has *rotated* it to match the map of Democrats as closely as possible. It is important to understand that V5.5 has not

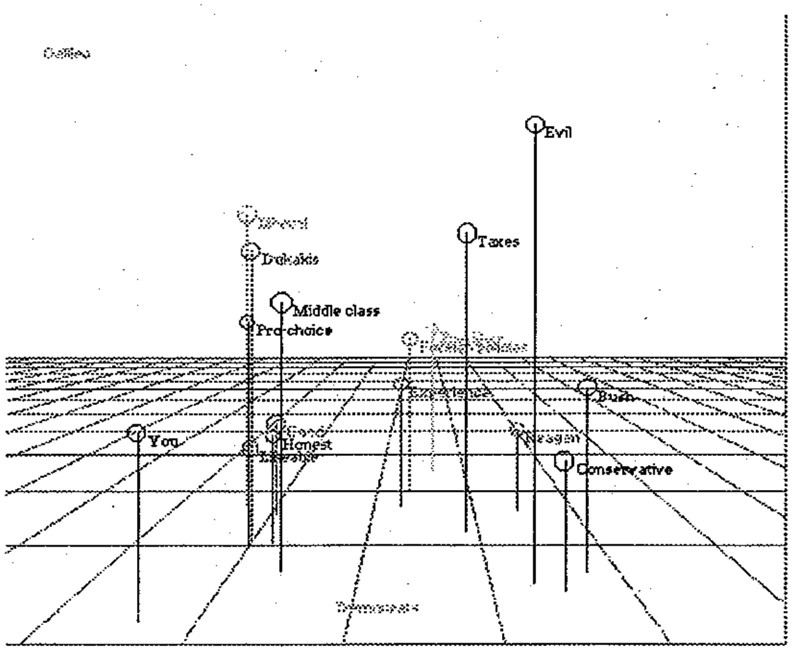


Figure 5: Unrotated Map of Democrats

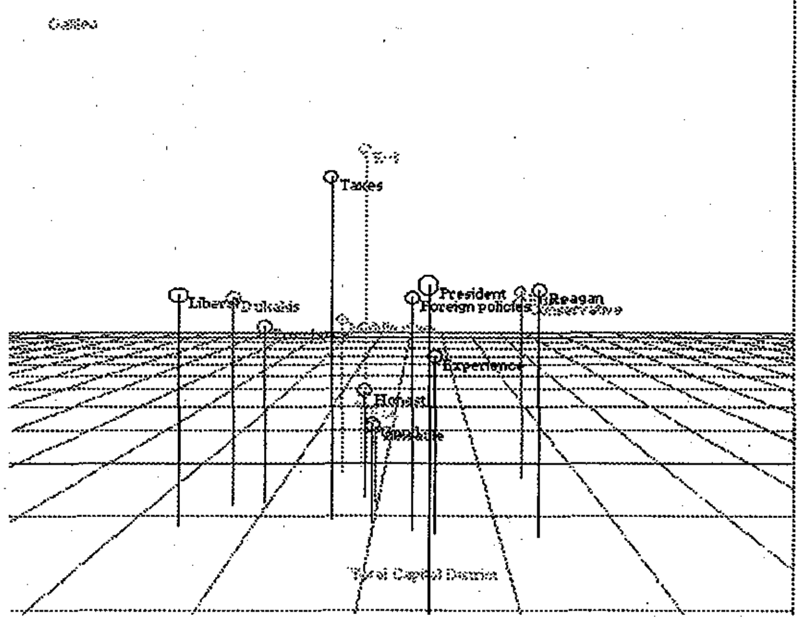


Figure 6: Rotated Map of All Voters

distorted the map or changed it in any way whatever. All the distances or dissimilarities in the rotated map are identical with those in the unrotated map.

But all artifactual differences of orientation have been removed, enabling us to see the true differences between the Democrats and the general population. As examination of Figures 5 and 6 reveal, both Democrats and the general population agree substantially about where the attributes lie, and they agree on their perceptions of the candidates. They differ, however, in where they position *themselves*, with the Democrats placing themselves more to the left or liberal side of the map, while the general population lies much closer to the center.

Maps of the 1988 election were chosen for this demonstration because most people are familiar with the structure of the political domain, and you might have been able to figure out for yourself that the maps were more similar than they first appeared after some careful study. But in neighborhoods with which you are unfamiliar it can be virtually impossible to distinguish real differences from artifacts of orientation, so rotation is always recommended when different maps are to be compared.

Free Concepts

When V5.5 matches two or more maps, it rotates one of them until the location of all of the concepts in one map is as close to the location of the same concept in the target map as possible without changing any distances in either map. But sometimes such a complete match is not desirable. If you have conducted an experiment, for example, where different groups of respondents were exposed to alternative message strategies, you may have very good reason to believe that some of the experimental (treated) concepts *have changed their locations due to your* *intervention.*

If this is so, it is obviously not wise to try to match them from one space to another. In that case, Galileo*V5.5 allows you to name the concepts you believe have moved, and it will try to match only the remaining concepts. In this way it is possible for you to determine whether, where and how far the treated concepts have moved.

In essence, when you specify free concepts (FCONS) in a V5.5 comparison of spaces, you are telling the program: "Rotate this map onto the target map, but do not use the free concepts as part of the criteria by which you judge how well they fit." Galileo V5.5 will then compare one space to another, but will only use the stable concepts (SCONS) to determine when the fit is as close as it can be.

Regardless of the set of options chosen, V55 writes out the complete eigenstructure of the spaces after rotation. In addition to the coordinates, V55 also provides extensive information about the differences between pairs of spaces, including the correlations among the concepts' position (row) vectors, correlations among the dimensions themselves (column vectors), various lengths and angles, and distances from each concept in one space to its counterpart in the other:

The Rotated Coordinates of Space Number 2

	9	10	11	12	13	14	15	16
1 SPORSPOR	9.830	9.683	15.203	.090	-15.596	2.487	-14.601	-.057
2 FUN FUN	12.072	-2.232	-12.118	.050	8.071	-2.213	32.831	-13.901
3 FAMIFAMI	40.077	15.576	-.754	-.112	-4.435	7.058	-8.670	-3.721
4 GOODGOOD	31.874	-.177	6.604	.055	-.924	-7.290	-21.563	24.808
5 PRACPRAC	-6.524	-17.636	10.756	.087	14.863	5.673	9.828	-2.025
6 AFFOAFFO	-.812	-11.554	-35.795	.068	-18.846	-6.786	-1.099	-15.019
7 EXCIEXCI	8.555	6.260	-1.072	.065	-.215	-11.272	-4.002	-13.368
8 APPEAPPE	-6.690	8.230	19.258	-.062	8.899	2.622	19.818	11.835
9 LUXULUXU	-3.229	-.843	.214	.065	10.698	6.433	-2.123	9.643
10 RELIRELI	-.457	13.444	28.254	.097	-14.131	-16.658	9.126	-28.102
11 HONDHOND	-21.721	-15.114	3.524	-.088	19.204	13.704	11.499	7.847
12 MAZDMAZD	-19.161	-22.745	12.223	-.116	-11.352	2.263	-15.233	3.042
13 FORDFORD	-24.368	9.715	-17.060	.037	1.156	-7.042	-8.321	3.831
14 TOYOTOYO	-11.429	20.822	-16.415	-.020	-7.359	6.487		

```
-10.994        -3.512
 15  NISSNISS          18.217        -12.661        -3.788        -.058        5.737        -1.243
9.262            .388
 16  CHRYCHRY         -28.000        -18.960         2.891        -.075      -15.489         3.227
-16.386          -8.495
 17  PONTPONT           1.766         18.192       -11.925        -.084       19.718         2.549
10.628          26.807
 18  YOURYOUR          27.086         20.543         1.075        -.122         .188        18.080
-.293           -11.615
```

Distances moved in the interval between time 1 and time 2

```
Concept  1 (SPORTY LOOKING          ) moved   10.866i units.
Concept  2 (FUN TO DRIVE            ) moved   51.601  units.
Concept  3 (FAMILY CAR              ) moved   12.350  units.
Concept  4 (GOOD VALUE              ) moved   10.365  units.
Concept  5 (PRACTICAL               ) moved   14.886  units.
Concept  6 (AFFORDABLE              ) moved   21.579  units.
Concept  7 (EXCITING                ) moved    3.082i units.
Concept  8 (APPEALS TO OLDER PEO    ) moved   36.906  units.
Concept  9 (LUXURIOUS               ) moved   25.758  units.
Concept 10 (RELIABLE                ) moved   23.303  units.
Concept 11 (HONDA ACCORD            ) moved   50.483  units.
Concept 12 (MAZDA 626               ) moved   31.124  units.
Concept 13 (FORD TEMPO              ) moved   15.741  units.
Concept 14 (TOYOTA CAMRY            ) moved   17.587  units.
Concept 15 (NISSAN STANZA           ) moved   15.646  units.
Concept 16 (CHRYSLER LEBARON GTS    ) moved   15.377  units.
Concept 17 (PONTIAC GRAND AM        ) moved   25.251  units.
Concept 18 (YOURSELF                ) moved   71.347  units.
```

The Mean Distance Between All Points in Space 1 and their Counterparts in Space 2 is 25.181

2Row Vector Correlations Between Time 1 and Time 2

- Concept	T 1 Magnitude	T 2 Magnitude	Scalar Product	Correlation	Angle
1	85.14	70.86	6193.67	.973300	13.3
2	69.09	48.57	2235.24	.666048	48.2
3	63.56	61.99	3864.74	.980955	11.2
4	44.27	58.50	2637.38	.981652	11.0
5	47.25	53.53	2438.37	.964011	15.4
6	66.24	60.67	3801.35	.945922	18.9
7	67.63	62.35	4235.35	.995577	5.4
8	64.55	71.73	3975.06	.858484	30.9
9	77.70	77.00	5650.95	.944591	19.2
10	19.78	27.85	311.94	.566235	55.5
11	55.50	74.53	3043.80	.735754	42.6
12	49.13	71.68	3291.32	.934637	20.8
13	64.36	77.48	4948.50	.992399	7.1
14	50.29	61.55	3004.20	.970548	13.9
15	62.79	60.22	3662.39	.968503	14.4

Correlation	Angle		T 1 Magnitude	T 2 Magnitude	Scalar Product
.989400	8.3	16	67.35	86.31	5874.76
.977154	12.3	17	66.49	85.90	5580.75
.073492	85.8	18	50.12	54.60	201.09

2Col Vector Correlations Between Time 1 and Time 2
-

Correlation	Angle		T 1 Magnitude	T 2 Magnitude	Scalar Product
.928148	21.9	1	195.25	175.27	31762.25
.913699	24.0	2	133.98	115.83	14178.94
.736367	42.6	3	92.49	100.58	6849.51
.868421	29.7	4	88.64	86.11	6628.34
.805446	36.3	5	74.44	97.46	5843.60
.879610	28.4	6	69.01	95.15	5776.27
.828018	34.1	7	60.82	92.25	4645.92
.859884	30.7	8	52.47	66.77	3012.72
.488869	60.7	9	50.09	80.33	1967.02
.368248	68.4	10	32.58	60.17	721.85
.727375	43.3	11	32.28	62.27	1462.09
.129603	82.6	12	.47	.34	.02
.777226	39.0	13	13.18	50.13	513.45
.536489	57.6	14	43.30	35.71	829.47
.452336	63.1	15	49.93	58.71	1326.01
.563065	55.7	16	56.61	57.25	1824.82
.621029	51.6	17	90.08	81.80	4576.32
.814261	35.5	18	102.99	105.26	8827.56

Using Galileo*V5.5

Galileo*V5.5 is an advanced product, and requires more skill than most of the other programs in the Galileo system. After a little practice, however, it can become quite easy.

V55 runs usually begin by running the program INTERGAL ("Make a Runstream" on the GALILEO menu). INTERGAL asks a series of questions which set up the V5.5 run. INTERGAL has complete online context sensitive help, and so it's easiest to learn to use it by using it. But some specialized runs can be tricky.

Galileo

Statistics

Statistics is a default option in INTERGAL, so you get them automatically when you use V5.5 to analyze your paired comparisons. Option 18 on the option control line specifies that statistics are to be calculated.

A.M.G.

To get the Automatic Message Generator to run, it is only necessary to answer "yes" when INTERGAL asks if you have any specifications. Then say yes when it asks if you want messages. It will then ask you to specify the start and target concepts. After that, message strategies will be calculated. V5.5 will produce every possible strategy using one, two, three and four attributes. It will also list the ten best strategies. Remember, though, V5.5 only knows what strategies will be most effective; it has no way of knowing whether they're true or not -- that's up to you. (In the 1972 election, A.M.G. found that one of George McGovern's most effective strategies to win the election was to claim he was Nixon.)

Comparison of Spaces

To rotate raw paired comparison data, simply run INTERGAL, answer "yes" when asked if you have any specifications, and "yes" for comparison of spaces. You will also need to tell it whether there are any free concepts, and, if there are, which ones they are. INTERGAL will also ask if this is a time series. (That means a set of datasets from the same population collected at multiple points in time.) If you say yes, it will automatically compare each dataset to the one which immediately preceded it in time, (that is, 2 to 1, 3 to 2, 4 to 3, etc.) If you say "no", it will ask you for a "MAINSPACE." A MAINSPACE is one space to which you wish to compare all the others. Typically, you might have a total sample which has been broken down into subsamples; you might want to compare each subsample to the main sample. Usually,spaces which have all been rotate to a single common space can then be compared (visually) to each other without further rotation.

If you need to rotate coordinates you already made, *you must append them to the runstream file.* V5.5 can't read them directly from their own file. You must also change the first "1" on the OPTIONS line of the runstream file to "3". ("1" is the option for paired comparison input data; "3" is the option for coordinates input.) You can make these changes with any ASCII file editor. If you don't have a favorite ASCII editor, you can use the EDWIN editor provided in the TOOLS directory. Then 1) change the "1" on the options line to "3"; remove the file names from the end of the runstream file, and append the coordinates to the runstream file.

Conversion of Coordinates

Note: *V55 cannot read coordinate files made by Microgal, Catpac, or Galnet without editing.* You will have to use your ASCII editor to delete the concept labels and standard errors (if any) from the coordinate file before input to V55. You will also have to edit the format statements on the header line. Galileo V5.5 expects to see, in columns 10-12,13-14 and 15-16, respectively, the number of concepts, the number of real dimensions, and the total number of dimensions in the solution. MICROGAL, CATPAC, and GALNET provide these numbers, but in columns 10-13, 14-16 and 17-19 respectively.

Similarly, *coordinate files made by V55 cannot be read by ASG or Galileo*PLOT. If you wish to plot coordinate files made by V55, you will have to append the concept labels to those files using your ASCII editor.* If you have also calculated standard errors using Galileo*MICROGAL, you can append these errors to the file following the concept labels. You will not, however, have to edit the header line, since PLOT and ASG can read the V55 formats. See the formatting requirements of Galileo*PLOT for more information on plotting formats.

Running Galileo*V5.5

After you have set up your runstream, you only need to say "V55" or choose option 12 **Run V55** from the Galileo menu) and the program will ask you where your runstream is. The program will then automatically execute, using the instructions in the runstream file. There will, of course, be no problems at all. (If you believe that, you are new to computing!)

V5.5 is an expert's program. You may have some trouble at first, but, if you take notes on what you are doing (and what has gone wrong) you will soon find it quite simple. And if you have difficulty, please call Terra.

Option 13: Screen Plot: Galileo*PLOT

I read coordinates made by Microgal, V55, or Galnet and plot them graphically on the screen. Only the first three dimensions are plotted. The first dimension is the horizontal axis, the second dimension is the vertical axis, and depth is the third dimension. Each concept is represented as a sphere whose size is a function of the uncertainty of measure. The radii of the spheres representing the concepts is one standard error. (Measurement of the uncertainty of location of the concepts depends on a complete measurement of all pairwise distances among the concepts.) Among the Galileo programs, only MICROGAL and V55 provide complete pair comparison measures, and only Microgal computes the standard errors from which these spheres are made. GALNET allows producing ordinary perceptual maps from object-attribute data. When standard errors cannot be calculated, radii are defaulted to a convenient number which allows easy visualization, but may underestimate or overestimate the actual error of measure. (I'll warn you when the errors are missing and I have to use the default radii.)

I correct for parallel perspective according to distance from the eyepoint, as does the human eye. This means that objects close to the viewer will appear much larger than those far from the viewer, just as they do in real life. (Put your thumb in front of your eye as you read the screen and you can see how this happens.)

You can interact with the plot. You can rotate the space up, down, left and right any arbitrary number of degrees. This is not as easy as it sounds, and rookies frequently become hopelessly lost after a few rotations. If this happens to you, just press **[F8] (RESET)**; no harm can be done by experimenting.

I'm also able to help you evaluate potential strategies. You provide me with a goal (that is, the position you want to take in the market place, or where you want to go). You also tell me what concept (product, candidate, etc.) you want to move to that position. Then you can suggest various combinations of other concepts, attributes, and the like, that you think might form an effective strategy for moving the desired concept to the desired position. I will tell you how far are from that position at the start, how close this strategy is capable of bringing you, and what percentage of the original distance this would be. (Zero, of course, would be a perfect strategy which could take you exactly to the position you wish to occupy.)

While the typical procedure is to move one concept to the position of another single concept (e.g., to move a product to the point where most people in the market can be found, or to another ideal point), I am able to evaluate strategies of any degree of complexity. You may try to move one concept to the middle of any number of others; or you may try to move several concepts toward one other, or several concepts to the center of several others. As with any other simulator, my accuracy depends on the tested strategy being fully implemented, and on the fact that outside forces such as competitor's strategies don't change the situation beyond my existing knowledge. No strategy can ever be perfectly implemented, and outside circumstances never stand still. A wise analyst will always assume each strategy will be somewhat less effective than its simulation. But it is appropriate to compare strategies to each other.

I currently don't support printing, but you can capture the PLOT image using a screen capture utility, and insert it into word processing documents in the standard way. The plot can then be printed with the document, using the print facility of your word processor. If you currently do not have a screen capture utility, contact your Terra representative who can help you select one that's right for your applications.

I'm a very powerful program, and have my own User Manual and Tutorial, which is included in the documentation. Please consult this document for further information about how to use me effectively.

Option 14: Run Oresme: Galileo*ORESME

I'm a self-organizing neural network like CATPAC. (we're related). I'm optimized for conversation, however. You can type words to me, and I respond with the words I associate with those words. What's more, I'm self-organizing, which means I can learn from the conversation and change the patterns of associations by paying attention to our conversations. I can also read . win matrices made by CATPAC, MICROGAL, GALNET and V55, so that all the patterns of association they learned are instantly available to me. (Don't you wish you could do that with YOUR relatives?)

This means that I can talk to you about some text CATPAC has read, and I'll know the things it discovered. You might think of me as a non-hierarchical clustering system. I read the word or words you give to me, and I find out what other words go with them; this set of words can be thought of as a cluster or category. But I don't assign each word into only one category, as does a hierarchical clustering scheme, and a word can belong to many categories for me, as for you. (Marketers find this helpful when they are trying to develop a product that can exist in, and compete in, several segments at once.)

Like Galileo*PLOT and Galileo* CATPAC, I'm a very powerful program and have my own manual, which you should consult for further information about how to use me effectively.

Option 15: Input Network Data: Galileo*NETIN

Perhaps the most important mathematical form in all multivariate analysis is the square matrix. I'm a simple utility that allows you to enter any arbitrary square matrix and normalize it in one or more useful ways. I'm called NETIN because the most general theoretical form that is used to describe such matrices is network. Each row or column of the network is called a node, and the cell entries represent the relationships (or connections or weights) among the nodes. I was created originally to deal with switching data, such as brand loyalty and the like.

There are two kinds of switching data: loyalty and source of sales. Loyalty data tells the percentage of users of brand x that switch to brands y, z, and so forth. Source of sales data tells the percentage of those who switch to brand x that come from brands y, z and so on. I can make either type for you, but it's up to you to know which kind you want.

Option 16: Forecast Trends: Galileo*FORECAST

I can project future sales and installed base from loyalty data. By loyalty data I mean a square products X products matrix whose entries give the percentage of those who use product x that switch to product y during the period the matrix represents. I also need to know the percentage of the entire installed base that is represented by each of the products in the matrix, the percentage of each of the products that is traded during the period, and the rate at which each product (or its users) goes out of service during the period. (A car which has gone to the junk yard, for example, can't be traded in.)

As you go through the program, I can help you with files, formats and the like. Just enter '?' whenever you don't know what to do next. By the way, NETIN is just the ticket for making the loyalty matrix I need. Tell NETIN that FORECAST sent you!

Option 17: Review a study: Galileo*READ

ELQM (The Electronic Questionnaire Maker) sets up the Galileo*CATS system, makes the files, and automatically controls access to data. If you need to review a particular study after you've set it up with ELQM, you need me. Just tell me the name of the directory on which the study resides and I'll find the relevant information and write it out on the screen for you. (If you have a favorite file editor, you can read the information file with that. The file is always called STUDY.DAT, and it resides on the study directory. Don't modify this file, however, since SPED depends on it to work properly.

Option 18: Modify exclude file: Galileo*EXCLUDE

Whenever CATPAC reads text, it automatically skips certain words that most people don't care to examine (such as a, the, if, because, and so on.) You may have some additional words in your text you'd like to ignore,or, you may want to remove some words from the exclude list. I help you add or delete words from the exclude list.

Option 19: Go to DOS

I'm actually not a program at all. When you choose me, I just suspend the Galileo system and return you to DOS. To return to Galileo Control, simply enter a blank line.

Option 20: Quit

Choose me and I shut down the Galileo system and relax. Phew!

Appendix 1: Tools

Your Galileo installation includes a directory called GALILEO\TOOLS. On this directory Terra has supplied three helpful DOS tools. First is a simple read only editor called **LOOK**. **LOOK** is a public-domain program which allows you to examine the contents of any file interactively. It is convenient since you can page up and down or scroll up, down, left and right in the file using the cursor control keys. You can also easily read the 132 column format files that V55 writes. And, since **LOOK** is a read only editor, you don't run the risk of altering important files.

To use **LOOK**, simply enter the command

LOOK [filename]

at the DOS prompt. To leave **LOOK**, press [ESC].

Also included is a very powerful ASCII editor, **EDWIN**. **EDWIN** is a public domain program which follows the formats of WORDSTAR, and can be very helpful in modifying files produced by V55 for use in the other Galileo programs and vice versa. **EDWIN** has complete online help, accessed by pressing **F2** once in the program. To start EDWIN, simply enter the command

EDWIN

at the DOS prompt. You can also enter a file directly with EDWIN by entering the command

EDWIN [filename] .

If you already have an ASCII editor you favor, you may use that instead of **EDWIN**. For more information on installing and using EDWIN, consult the documentation provided on the \GALILEO\TOOLS directory.

The last tool provided is called **UP**. Up lets you climb up your directory tree in only three keystrokes. If your default directory, for example, is GALILEO\DATA, then issuing the command

UP

at the DOS prompt will set your default directory to \GALILEO. Issuing the command again will move you to the root directory.

All three of these utilities are public domain software and are neither warranted nor supported by The Galileo Company, Terra Research and Computing or any of their agents. The are provided at no charge as a convenience for the user.

Note that authors of public domain software sometimes request voluntary payments from users for the use of their programs. No such payments have been made on your behalf by Terra, Galileo or any of their representatives.

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313 398 6236

Galileo*CATPAC:

User Manual and Tutorial

Rev. June, 1993

CATPAC COPYRIGHT 1990 BY JOSEPH WOELFEL

PLEASE DON'T LOSE THIS PAGE. IT CONTAINS THE REGISTRATION NUMBER YOU WILL NEED TO UPGRADE TO LATER RELEASES OF CATPAC.

Your Name ________________________

Your Registration Number ________________________

Version 3.0

IMPORTANT!

PLEASE READ CAREFULLY BEFORE USING THE SOFTWARE.

TERRA RESEARCH & COMPUTING COMPANY

TERMS OF LICENSE

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INTRODUCTION TO CATPAC

CATPAC™ is a self-organizing Artificial Neural Network that has been optimized for reading text. **CATPAC** is able to identify the most important words in a text and determine their patterns of similarity based on their associations in the text. From this information, it is able to tell you the main concepts dealt with in the text.

CATPAC does this by assigning a neuron to each major word in the text. It then runs a scanning window through the text. The neuron representing a word becomes active when that word appears in the window, and remains active as long as the word remains in the window. Up to *N* words can be in the window at once, where *N* is a parameter set by the user.

As in the human brain, the connections between neurons that are simultaneously active are strengthened following the law of classical conditioning. The pattern of weights or connections among neurons forms a representation within **CATPAC** of the associations among the words in the text. This pattern of weights represents complete information about the similarities among all the words in the text.

Technically, the pattern of connections among neurons is a complete paired comparison similarities matrix, and so lends itself to the most powerful and sophisticated of statistical analyses. Among these is the diameter method cluster analysis automatically performed by **CATPAC**.

CATPAC can automatically exclude from consideration any arbitrary list of words. A default list of articles, prepositions and the like, is contained in a file labeled EXCLUDE.DAT. You can add or delete words to this file by using the enclosed program EXCLUDE.EXE

CATPAC expects to find both EXCLUDE.DAT and EXCLUDE.EXE in a directory called C:\GALILEO\RUNNER. This directory is automatically created during installation. If you have not followed the standard installation instructions, you must create such a directory and copy all files with an .EXE extension, as well as the EXCLUDE.DAT file, to this directory.

You can create you own exclude files and we recommend that you do so. Every data set is different and there are some words you may wish to exclude in one but not another. To use an exclude file you have created, simply enter it's name in the Exclude file field.

We also recommend that you place the directory C:\GALILEO\RUNNER in your path. This will allow you to run CATPAC from any directory, simplify your analysis set-ups, and keep your raw data (and/or results) separate from your program files. If you are not sure how to edit the path statement contained in your AUTOEXEC.BAT file, consult your DOS manual.

INSTALLING CATPAC

- Place the diskette in the A: or B: drive.

- Type **INSTALL <diskette drive> <target drive>** and press Enter.

  For example to install the system on your C: drive with the diskette in the A: drive you would type:

  INSTALL A: C:

That's it. The install program will take care of everything.

The following directories will be created:

\GALILEO\RUNNER	Contains the executable programs
\GALILEO\HELP	Contains the help files
\GALILEO\DOC	Contains all available Galileo Documentation in WordPerfect 5.0 format
\GALILEO\DATA	Contains sample data sets
\GALILEO\TOOLS	Contains a text editor and several utility programs

RUNNING CATPAC

You will need at least 530k of free ram to run Catpac. If you experience difficulty running the program, chances are you will have to free up some memory. The best way to rectify a memory problem (if you have a 386 or better processor) is to install a memory manager like QEMM. This program is inexpensive and will give you up to 630k of ram to run programs with. Another approach would be to create a 'vanilla' boot diskette that has the bare minimum of TSR's and device drivers in Autoexec.bat and Config.sys. If you are unfamiliar with these files or are unsure how to make a boot diskette, refer to your DOS manual or resident Techie.

There are 3 ways to access **CATPAC**:

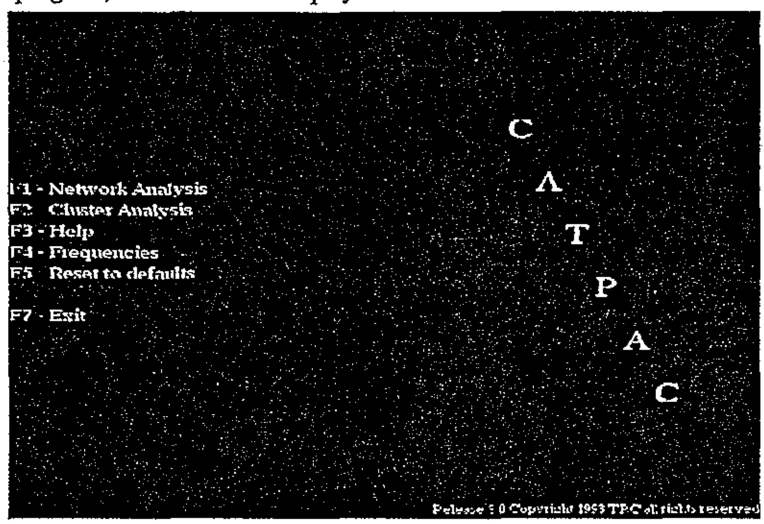
(1) Type the word **GALILEO** and a menu will appear on the screen. You would then select the number which corresponds to **CATPAC**. If you have <u>not</u> edited your path to include **\GALILEO\RUNNER**, you must first change to C:\GALILEO\RUNNER prior to typing **GALILEO**.

(2) If you have placed C:\GALILEO\RUNNER in your path, you can simply type **CATPAC**

(3) If you have not edited your path, you must first change to the directory C:\GALILEO\RUNNER and then type **CATPAC**

If you have not installed a memory manager or have a 286 machine and are having difficulty running the program try either method 2 or 3. These methods require less memory because they do not use the menu interface.

Once you call up the program, **CATPAC** will display a menu screen like the one below. To make a selection, press the function key that corresponds to the operation you wish to preform. You can choose one of three types of analysis, Help, or Reset to defaults. Each of these options is explained below.



2 CATPAC main menu

SCREEN CONTROL

Each analysis screen has a number of fields that require information to run (see figure 3). You move from field to field using the arrow or tab keys.

Once you have entered all the information, press **F10** to run the job. If you wish to bail out and go back to the Main Menu, press **F7**.

One nice feature of **CATPAC** is the ability to do multiple runs with the same settings. If you decide to analyze 10 data sets each with the same settings you need enter the settings but once. You need only change the Data file and File descriptor field (or output file fields for a Frequency or Cluster analysis).

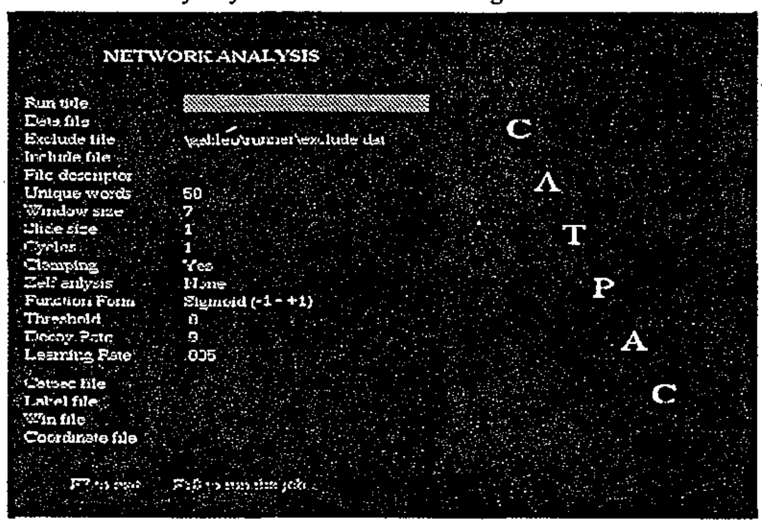
NETWORK ANALYSIS

This is the premier analysis offered by **CATPAC**, accept no substitutes. If you want to perform a Cluster analysis based upon simple word co-occurrences, you would have typed **F2**. Essentially, this was way all cluster analyses were performed before the development of artificial neural networks like **CATPAC**.

You, however, choose to conduct a more advanced form of relational analysis, a Network Analysis, so you pressed **F1**. In a Network analysis CATPAC will generate square matrix of numbers which summarizes the connection strength between unique words. How catpac performs this analysis is discussed in detail below as we explain the fields specific to a Network analysis.

> **Be aware that if you want to produce a perceptual (or brand) map, you must choose a Network analysis.**

If you Press F1 to do a Network analysis you will see the following screen:



3 **CATPAC** Network analysis screen

Some of the fields for a Network analysis are also offered for a Cluster analysis and a Frequency run so we'll explain them here. Many of the fields are supplied with default values and file names that we have found to work best with a wide variety of runs. You are encouraged to change them at your whim to experiment with different settings. Every data set is different and what works for one may not work for another.

Run title

CATPAC is asking you for a title, which will be printed as a banner on your output file. Your title is limited to forty characters (including spaces).

Data file

CATPAC needs to know the exact path to your data. You must specify: the drive, the directory and the name of the file which contains the text you wish to analyze. If you are running **CATPAC** from the directory where your data are stored, you can simply type the name of the file which contains your data.

Remember, **CATPAC** can only read an ASCII file. Sometimes, people make the error of exiting their word processor without (first) converting the file to ASCII. Don't make this mistake!

We like to use the extension .TXT to denote an ASCII file. That way, when we see this extension on a file, we know **CATPAC** can read it.

Exclude file

CATPAC will let you use any EXCLUDE file you wish. If the one we sent you (EXCLUDE.DAT) meets your needs, simply skip this field to accept the default EXCLUDE file. Alternatively, if you want to use another EXCLUDE file you have created for a special purpose, type the name of this file. Again, if this file is <u>not</u> in your current directory, be sure to specify its exact path. Make sure you Exclude file is in ASCII and has only one work on each line.

Include file

Just as you can exclude certain words from an analysis, you can include others. After stripping, some words you may wish to analyze may be dropped from the data set. If you wish to analyze these words anyway place them in an ASCII file in the same format as your Exclude file and enter the file name here.

A second use for the Include file is for a Zelf-analysis (named after the famous Rudolph Zelf, from Vienna). If you choose to do a Zelf-analysis the Include file contains words that may reference respondents in the text. E.G. "I", "Me", "MY", a name, or any specific identifier you used in you data collection (do not specify your Id number in this file - CATPAC will associate the Id number with the self references automatically).

File descriptor

This prompt is asking you for the filename you want **CATPAC** to use to as a prefix when labelling your output files. You may use any name you wish (up to 8 characters). When you are doing a network run CATPAC will automatically create several files using the filename you entered and supply an extension for each: a labels file (**.LBL**), an output file (**.CAT**), a weighted input network file (**.WIN**), and a coordinate file (**.CRD**). The labels file contains the unique words **CATPAC** identified in the analysis, while the output file contains the basic **CATPAC** outputs -- i.e., the word counts, alphabetic listing and cluster analysis. The weight input network contains the connection strengths between nodes and the coordinate file is used by **PLOT** to make a perceptual map. It contains the coordinate loadings of each unique word on a 3 dimensional set of axes. The more ambitious can actually draw their own map (by hand) using the x, y, and z coordinates listed in this file.

For example, if you were analyzing a text file that contained information about cars, you might use the filename CARS, and **CATPAC** would create the following files: **CARS.LBL** and **CARS.CAT**, **CARS.WIN**, and **CARS.CRD**. These file names are displayed automatically at the bottom of the Network analysis screen

Unique words

At this field, **CATPAC** is asking you how many words you want to carefully study. Most of the time, you will only want to use only the top fifteen, or twenty, or 30 unique words. This version of **CATPAC** can perform higher-order analyses on as many as 150 words. If you need to study more than 150 words, call TERRA; we have another version of the program that can read more words, but you will need special instructions, and perhaps, a faster machine.

CATPAC identifies unique words in the following manner. First, the program looks at every word that occurs once or more, and then checks to see if the number of such words is greater than the number of unique words you specified. If it is, **CATPAC** will study every word that occurs twice or more; and then check to see if the number of such words is still greater than the number you requested. If it is, **CATPAC** will study those that occur three or more times, and so on, until it finally obtains the number of unique words you specified.

Many times, **CATPAC** will provide you with fewer unique words than the number requested. When this happens, it means that there were several words which occurred with the same frequency as the nth unique word and, if included, the number of unique words identified would have exceeded the number you requested. Hence, to avoid giving you more than what you ask for, **CATPAC** deletes all of these words, leaving you with fewer unique words.

A very good reason to conduct a FREQUENCY RUN (see below) prior to doing any other analysis is to examine the frequency with which the words you wish to study occur in the text. Doing this will help you determine exactly how many words you should specify at this prompt. The process is simple. Using the descending frequency list on your initial FREQUENCY RUN, examine the rank-order position of all words you want to include in your analysis. Find the rank-order position of the last word you want to include in the analysis, and specify that as the number of unique words you want **CATPAC** to study.

Remember, if there are other words which occur with the same frequency (as the last word you want to include) you must count-down to the rank-order position of the last word (with the same frequency) and specify that number as the number of unique words you wish to study.

Window size (or -1)

CATPAC works by passing a moving window of size *n* through your file. If you were to enter a window size of 7 (a good guess to start with in most cases), **CATPAC** would read your text seven words at a time. So, for example, if you were to specify a window size of 7, and a slide size of 1, CATPAC would read words 1 through 7, then words 2 through 8, then words 3 through 9, and so on.

Any time a word is in the window, the neuron representing this word becomes active. Connections among active neurons are strengthened, so words that occur close to each other in the text tend to become associated in **CATPAC**'s memory.

If you enter -1 instead, **CATPAC** abandons the moving window, and looks for -1's in your data file. These must occur in columns 1 and 2, and all the text that lies between these delimiters is considered a case.

If you use the moving window model, you do not need any -1's in your file, and **CATPAC** will make its own cases automatically using the window size you specified. Further, having -1's in your data file will not adversely effect your run if your choose to read your file using a moving window.

Slide size

This prompt is asking you how you would like the moving window to "slide" through the text. The number you select dictates how many words the window will skip prior to reading the text. You may select any increment you like. For example, if you chose a window of 5, and a slide size of 1, **CATPAC** would read words 1 through 5, 2 through 6, etc. If you chose a window of 5 and a slide of 2, **CATPAC** would read words 1 through 5, then 3 through 7, etc. Slide sizes larger than 1 are most often used when you have a very large text file from which you want to draw "samples". This is a new field, so feel free to experiment.

If you entered -1 for window size (case by case analysis) this field is ignored.

Cycles

CATPAC's network analysis procedure works in the following manner.

When words are present in the scanning window, the neurons assigned to those words are active, and the connection among all active neurons is strengthened. But the activation of any neuron travels along the pathways or connections among neurons, and can in turn activate still other neurons whose associated words may not be in the window. These neurons can, in turn, activate still other neurons, and so on.

In an actual (biological) neural network, these processes go on in parallel and in real time, so that the signal coming into the network is spreading at different rates of speed throughout the network, and neurons are becoming active and inactive at different times. (This process of delay is called *hysteresis*.)

In a serial computer like yours, however, this is extremely difficult process to model, and so the network is updated periodically all at once. Each update is called a cycle.

Letting **CATPAC** cycle two or three times allows second and third order relationships among the words to be considered.

Very little cycling (or none at all as in the simple co-occurrence model) tends to find only very superficial associations. Too much thinking, however, is not always a good thing, since **CATPAC** can tend to see things as all pretty much alike if its allowed to cycle too many times.

> Some analysts with a warped sense of humor like to refer to this problem as "The Buddhist Monk" syndrome, since, after sufficient contemplation, it appears that all things are one.

Clamping

When a word is found in the window, its neuron is activated. But it can become de-activated again as the network goes through its normal processes, just as you (yourself) see things, become aware of them, and then forget them. (If you never forgot, your mind would become so cluttered with images in only a few minutes that you could not go on with life).

When you choose to clamp the nodes (another word for *neuron*), you prevent them from turning off again. It's like writing yourself a note and holding it in front of you so you must always pay attention to the words in the note.

Zelf-analysis

A self-analysis will allow you to identify self-references based on predetermined id's within your data set. These points will be plotted as cloud using plot. This option allows you to determine the rough boundary and location of the self-point of the text.

There are two ways to do a self-analysis. For either you have to include as the first line of each case an id number that begins with either * or +. Method I, locate by id, simply associates the Id number of any given case with the case. Method II, locate by self-reference, will essentially replace any self-referent referred to in your Include file with the id and treat that id as a node. Since method II forces a repetition of the id, this will lead to stronger associations between the self point and the text, if the text is sufficiently "rich" in self-reference. If there are no or few self-references, the Id method ought to be used.

To do a self-analysis, press Enter on the self-analysis field. You will be given a pop-up menu of choices. Using the arrow keys, choose the method you wish and press Enter again. Remember, if you choose to do a self-analysis, your Include file becomes a self-reference file.

Network parameters

CATPAC can simulate four different kinds of neurons (functional forms), and the overall performance of **CATPAC** depends on three parameters (threshold, decay rate, and learning rate). The most generally useful neuron and some reasonable values for the three general parameters have been chosen as defaults in **CATPAC**. But you can change them if you wish, and none of these neuron types or parameters are sacred, even those selected by Terra as defaults. You might well find **CATPAC** performs better for some tasks with a different choice of neurons and/or default parameters. In order to change any defaults, just tab to the field of choice and enter a different value.

Function form

This option allows you to try different transfer functions. A true chiphead would jump at the chance to play with these. You can choose from four: a logistic varying between 0 and +1, a logistic varying between -1 and +1, a hyperbolic tangent function varying between -1 and +1, and a linear function varying between -1 and +1. Some writers speculate that different functions are better for different kinds of task, but no one knows for sure at this time.

The default threshold is 0.0. If you choose the logistic function that varies between 0 and 1, the threshold will automatically be set to .5. If you'd like to experiment with different transfer functions, press enter at this field and you will get a menu of the four forms, arrow to the function of your choice and press enter.

> Note: A Chiphead is a person with an exceptional commitment to computing. If you plan to do basic research on various transfer functions, you are one.

Threshold

Each neuron in **CATPAC** is either turned on by being in the moving window, or else receives inputs from other neurons to which it is connected. These inputs are transformed by a *transfer function.*

After the inputs to any neuron have been transformed by the transfer function, they are summed, and, if they exceed a given threshold, that neuron is activated; otherwise it remains inactive.

The default threshold for the three transfer functions that vary between ± 1 is 0.0, and .5 for the logistic varying between 0 and +1. By lowering the threshold, you make it more likely for neurons to become activated; by raising the threshold, you make it less likely for neurons to become activated.

Decay rate

When you see an object, neurons which represent that object are activated. When the object is gone, the neurons (fortunately) turn off again. (If they didn't, you'd be seeing everything you ever saw all the time.) The decay rate specifies how quickly the neurons return to their rest condition (0.0) after being activated. The default rate is .9, which means that each neuron, if not reactivated, will lose 90% of its activation each cycle. Raising the rate makes them turn off faster; lowering the rate means they are likely to stay on longer.

Learning rate

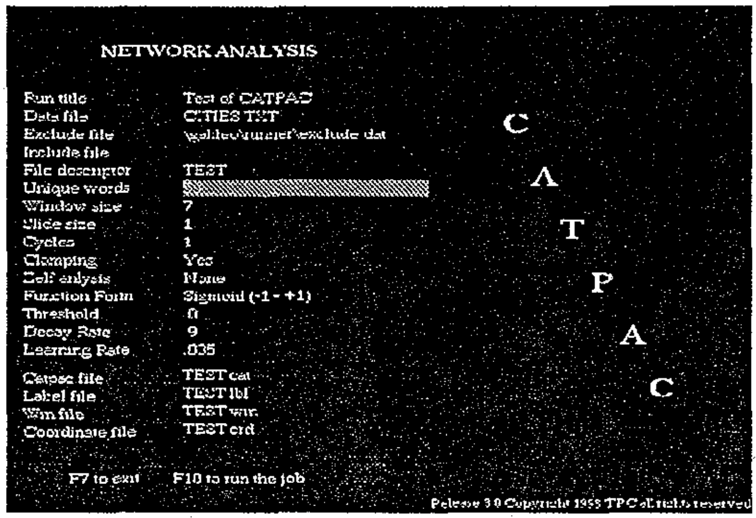
When neurons behave similarly, the strength of the connection between them is strengthened. The learning rate is how much they are strengthened in each cycle. Default is .001. Increasing this rate makes **CATPAC** learn faster. Faster is not always better, though, since too high of a rate can make **CATPAC** oscillate back and forth as new information is read. No one knows the optimum rate, or even if there is an optimum rate, so feel free to experiment.

Output files

As explained above **CATPAC** automatically produces its out files for a Network analysis. These four fields: **Catpac file, Label file, Win file, and Coordinate file** merely display the names of these files based on the File descriptor you entered. These fields can only be altered by changing the contents of the File descriptor field.

COMPLETED SCREEN

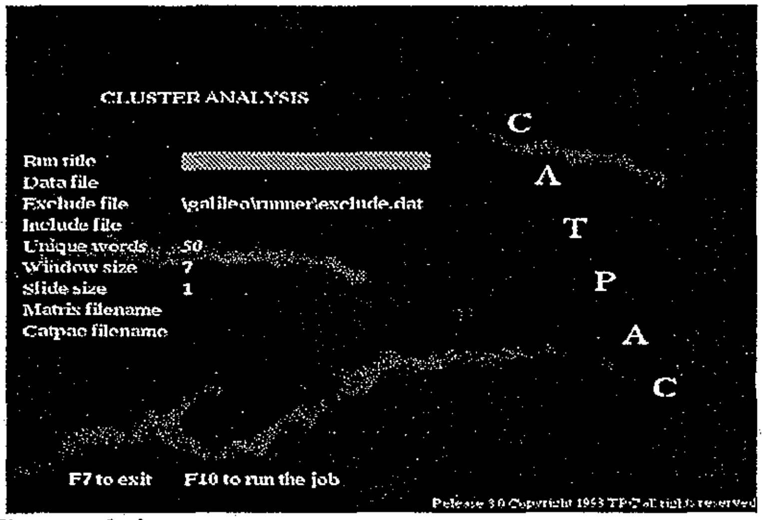
A completed Network analysis screen might look like this:



4 Completed Network screen

CLUSTER ANALYSIS

To do a Cluster analysis, press **F2** at the Main Menu. The cluster analysis will appear:



5 Cluster analysis screen

Many of the fields for a Cluster analysis are identical to those for a Network analysis. The main differences are a lack of network parameters and how you enter the output file names.

Matrix file

Cursor down to the Matrix file field and enter the name of a file to store your co-occurrences. If you enter a file name at this field, **CATPAC** will output a file that contains a list of word co-occurrences it encountered within the window-size you specified. CATPAC will list every co-occurrence, and tell you how many times it encountered each co-occurrence. If you leave this field blank **CATPAC** will not produce this output.

Catpac file

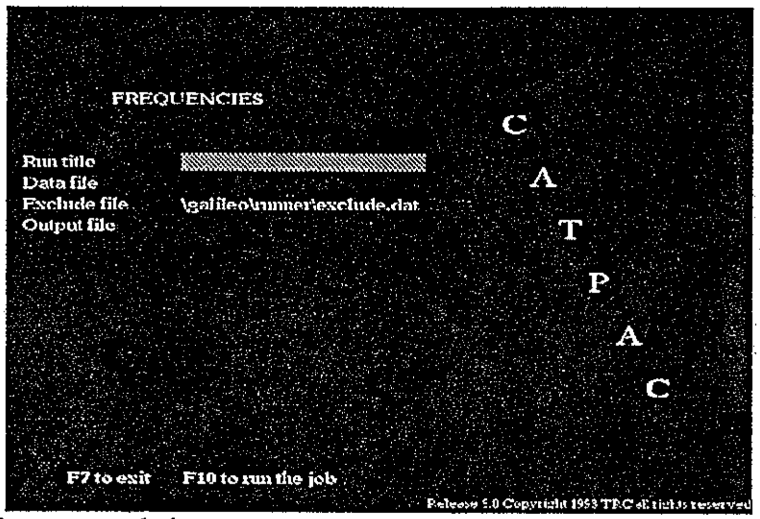
You must enter a file name for this field. This is the same output mentioned above (.CAT) and is the standard output for **CATPAC**. You may call it anything you like, but we suggest you use the .CAT extension. If you leave this field blank, **CATPAC** will not run and will prompt you for a file name.

FREQUENCY ANALYSIS

CATPAC has the capability to read every word in your file and list these words in descending order of frequency, as well as in alphabetical order. A FREQUENCY RUN is typically used by analysts to help them "clean" their data prior to performing advanced analyses. A FREQUENCY RUN can help you find typographical errors, synonyms, plurals, pro-nouns, and other such words that you may want to recode using a word processing program (or a text editor) prior to proceeding with further analyses.

If you want to perform a Frequency analysis, type **F1** at the main menu. Here is the screen you'll see:

This is a very simple screen. Most of the information requested is explained above. You must supply an output file name for your frequencies. Cursor to the **Output file** field and enter a file name to store this output on.



6 Frequency analysis screen

HELP

You may get help at any time by pressing **F3**. There are two ways to get help. If you press F3 from the main menu, you will be given the option to press any other function key for help on any of CATPAC's main operations. When you are done with help on the main menu, press F7 as the screen indicates.

If you are filling out any specific analysis screen, press F3 on any field and you will get a brief explanation of what the field is and what kind of information it is looking for.

RESET TO DEFAULTS

If you have altered any of CATPAC's default settings and wish to return to these values, press **F5** and CATPAC will reset all changed parameters to the ones supplied with the program.

INPUT TO CATPAC

CATPAC can read any text file that has been converted to ASCII. Some examples of text files people have studied using **CATPAC** include: answers to open-end survey questions, focus group transcripts, newspaper and magazine articles down-loaded from a data base, comments left on a customer telephone hot-line, and restaurant/hotel/airline comment cards.

When preparing data for a **CATPAC** analysis, keep in mind that while **CATPAC** is quite an amazing technology, it is still quite primitive. In as much, if you are studying focus group transcripts for example, you should probably first parse the file into discrete topic-specific sections, rather than have **CATPAC** try to study a file that spans 10-15 topics.

Figure 1 shows a text derived from some interviews where people were asked to describe the difference between a select set of pizza restaurants. Asking people to describe the difference between products is usually a good method, since they then usually report attributes which make a difference, instead of attributes which all the products might share.

The reader will note that this particular text file is not very long or of very high quality. Hopefully, your data set will be a little better!

```
     I like pizza, hot and fresh. I like quick delivery, like
Domino's gives, but I need quality like pizzahut. Little Caesar's
is inexpensive, but I guess pizzahut has quality. Domino's
delivers, but Domino's is expensive. Little Caesar's is
inexpensive, and you get two at Little Caesar's. Little Caesar's
two for one deal is inexpensive. I like good flavor, like pizzahut,
but I guess Domino's is faster. Sometimes you want it faster, and
Domino's is faster. If you want good flavor, Pizzahut is for you,
but if you want it inexpensive, Little Caesar's is the best. It's
good, Little Caesar's is good, but Pizza Hut is good too. Domino's
is not as good, but fast. Domino's is fast.  I think Domino's has
fast delivery, and Domino's fast delivery means a lot to me.
Pizzahut's quality is important, but it's not worth it; Little
Caesar's two for one is really good. Two for one? Little Caesar's
is the two for one place. Pizzahut quality sets it apart, but
Little Caesar's is inexpensive. Pizzahut is expensive. But of
course Domino's fast delivery can be important. When you want fast
delivery, Domino's is the fast delivery place.     For inexpensive
pizza, Little Caesar's is most inexpensive of all. Inexpensive
little caesar's is the place for two for one: little caesar's two
for one. Little Caesar's is inexpensive.
```

Figure 1 PIZZA INTERVIEWS

CATPAC OUTPUTS

Getting **CATPAC** to analyze these interviews is very simple. In this case, we asked **CATPAC** to cycle once, and to identify no more than 20 unique words. We set the window size to 5, no other values were re-set. The results are shown in Figures 2 and 3.

Run Summary

Figure 2 shows the most basic output of **CATPAC**. It consists of a summary of the parameters selected, and a frequency count of the main words found in the text. It shows that there were 115 total words in the text, and that 17 unique words were found. There were 138 windows in the analysis, and 21 lines of text.

```
CATPAC_PC  v3.00

                        05/25/93        09:29:40

TITLE:      Pizza interviews
DATA FILE:  PIZZA.TXT
```

TOTAL WORDS	115	THRESHOLD	.000
TOTAL UNIQUE WORDS	17	RESTORING FORCE	.100
TOTAL WINDOWS	138	CYCLES	1
TOTAL LINES	21	FUNCTION	Sigmoid (-1 - +1)
WINDOW SIZE	5	CLAMPING	Yes
SLIDE SIZE	1		

DESCENDING FREQUENCY LIST

WORD	FREQ	PCNT	CASE FREQ	CASE PCNT
LITTLE	13	11.3	58	42.0
CAESAR	13	11.3	57	41.3
DOMINO	11	9.6	46	33.3
INEXPENSIVE	9	7.8	37	26.8
PIZZAHUT	7	6.1	35	25.4
TWO	7	6.1	32	23.2
GOOD	7	6.1	28	20.3
FAST	7	6.1	26	18.8
LIKE	6	5.2	21	15.2
DELIVERY	6	5.2	26	18.8
YOU	6	5.2	26	18.8
ONE	6	5.2	27	19.6
QUALITY	4	3.5	20	14.5
WANT	4	3.5	20	14.5
PIZZA	3	2.6	12	8.7
FASTER	3	2.6	11	8.0
PLACE	3	2.6	15	10.9

ALPHABETICALLY SORTED LIST

WORD	FREQ	PCNT	CASE FREQ	CASE PCNT
CAESAR	13	11.3	57	41.3
DELIVERY	6	5.2	26	18.8
DOMINO	11	9.6	46	33.3
FAST	7	6.1	26	18.8
FASTER	3	2.6	11	8.0
GOOD	7	6.1	28	20.3
INEXPENSIVE	9	7.8	37	26.8
LIKE	6	5.2	21	15.2
LITTLE	13	11.3	58	42.0
ONE	6	5.2	27	19.6
PIZZA	3	2.6	12	8.7
PIZZAHUT	7	6.1	35	25.4
PLACE	3	2.6	15	10.9
QUALITY	4	3.5	20	14.5
TWO	7	6.1	32	23.2
WANT	4	3.5	20	14.5
YOU	6	5.2	26	18.8

Figure 2 CATPAC WORD COUNTS

The left-most columns present the major words in descending order of frequency of occurrence. They show that "Little" was the most frequently occurring word, that it occurred 13 times, which was 11.3% of all occurrences. "Little" appeared in 58 or 42.0% of the scanned windows. This last figure is referred to in the output as a "CASE FREQ" and indicates the number of times a given word appears in a case. If you had delimited each response with a -1 and done a case-by-case analysis, The "CASE FREQ" would indicate the number of respondents to mention each word. The words "pizza" "faster" and "place" occurred least often, three times each. **CATPAC** didn't consider any words that occurred fewer than three times, since that would have resulted in the identification of more than the 20 unique words we requested.

The right-most columns give exactly the same information as the left-most columns, except the unique words are now listed in alphabetical order for easy look-up.

Dendogram

Figure 3 shows the output from the hierarchical cluster analysis. These pictures are called "dendograms,", and they look a bit like the skyline of a city seen from afar. The "buildings" underneath the words show which words cluster together.

As can be seen in Figure 3, this cluster analysis reflects the information contained in the text quite well. The words "little" and "caesar" cluster very sharply together as we would expect. "Domino" and "Fast" cluster very closely, and the word "delivery" joins this cluster at a slightly lower level (Domino's specializes in fast delivery). Similarly, "Pizzahut", "quality", and like form a third cluster.

As we move downward through the diagram, each of the clusters grows larger, including more and more terms. Eventually, the first cluster includes "Domino," "fast," "delivery," "you," along with the subcluster "you", "want", and "faster." Little Caesar ends up in a cluster which includes "little" "caesar", "inexpensive," and "place" with the subcluster "two" and "one" (Little Ceaser offers two for one pizzas).

PIZZA CLUSTER ANALYSIS

DIAMETER METHOD

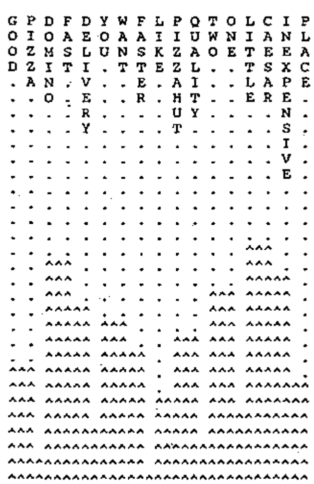


Figure 3 CLUSTER ANALYSIS DENDOGRAM

Weight input networks (.WIN file)

As we've said, CATPAC works by finding the connections among a set of neurons which stand for the main words in the text. This network of interconnected neurons is the main product of CATPAC's thinking, and it is stored in a file with the suffix *.WIN*. This matrix is not of much use by itself, but it contains all the information CATPAC has learned about the text, and can serve as an input to other programs, including ORESME™. ORESME simulates the processes a neural network carries out when it receives inputs of various kinds of information, and can give an interesting simulation of how individuals or groups of people might respond to different messages.

Since the .WIN matrix is in a standard ASCII format with its format statement in front of the data, it may be input into a variety of standard statistical and mathematical analyses software packages.

Coordinates (the .CRD file)

When you request a network analysis, CATPAC will also produce a file of spatial coordinates which has the same generic name as the other files produced by CATPAC, but which ends in the extension *.CRD*. This file contains information which can be used to generate a pictorial representation of the word associations CATPAC discovered during its analysis of the text.

The .CRD file contains the coordinates of the words on the basis of which plots can be made. To make a perceptual map the user must call up the program PLOT (which is also provided with your software) and type this file name with the .CRD extension after the F1 prompt. This .CRD file provides the basis for a wide variety of analysis of CATPAC data, including perceptual maps, development of marketing and advertising strategies, and tracking of perceptual change.

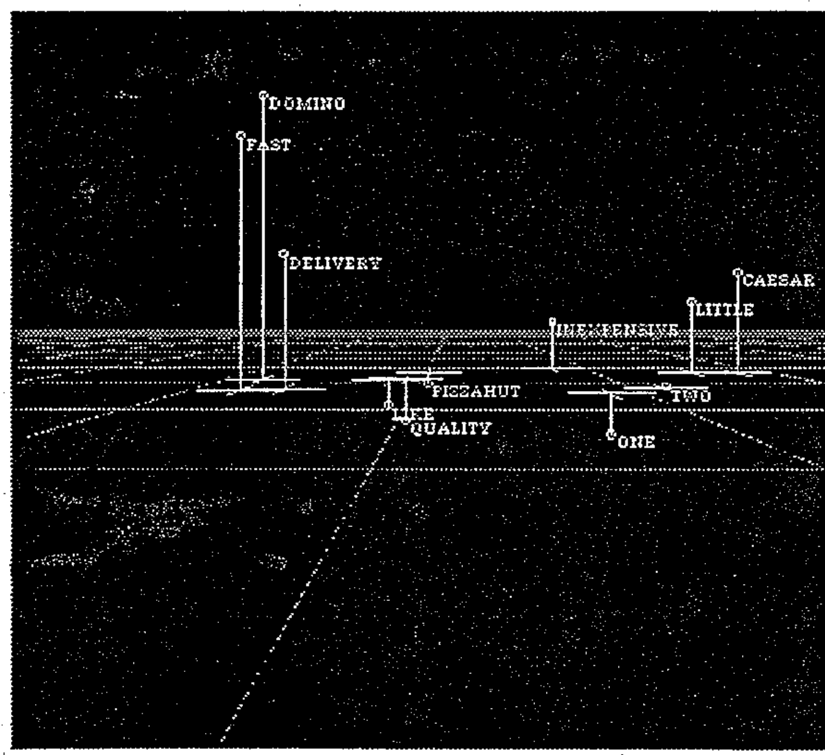


Figure 4 Galileo Map of Pizza Interviews

Figure 4 shows how the same clusters portrayed in the dendogram above, this time in the form of a perceptual map. To make the plot more readable, we used an option in PLOT that allows the user to remove concepts from the display. In this case we retain only the words in the major clusters.

Notice at the top of the plot the three concepts DOMINO'S, FAST, and DELIVERY. To the right and lower, LITTLE, CEASER, INEXPENSIVE, ONE and TWO. Right in the center are the terms PIZZAHUT, QUALITY, and LIKE.

This perceptual map provides not only an alternative way to represent the same results as the dendogram, but it allows for a wide range of special analyses.

Figure 5 shows the same perceptual map in 2 dimensions.

For a detailed description of these features, refer to the Galileo*PLOT manual provided with your diskette.

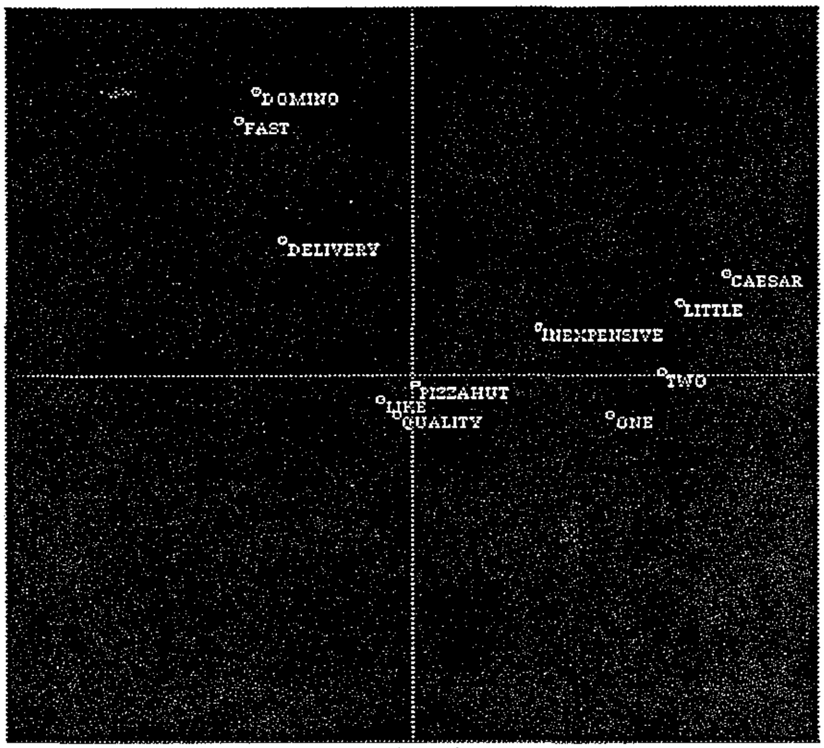


Figure 5 2-dimensional map of pizza interviews

SOME FINAL REMARKS

CATPAC represents a new generation of artificial neural software that can do things older computer software couldn't. In this manual we've tried to acquaint you with some of the new possibilities this technology makes available. But neural technology is so new that not even the development community has a good understanding of what's possible yet. Your best strategy is to spend time with the program and experiment. If you have any problems, please call your Terra representative.

Appendix 1: Tools

Your Galileo installation includes a directory called GALILEO\TOOLS. On this directory Terra has supplied three helpful DOS tools. First is a simple read only editor called **LOOK**. **LOOK** is a public-domain program which allows you to examine the contents of any file interactively. It is convenient since you can page up and down or scroll up, down, left and right in the file using the cursor control keys. You can also easily read the 132 column format files that V55 writes. And, since **LOOK** is a read only editor, you don't run the risk of altering important files.

To use **LOOK**, simply enter the command

LOOK [filename]

at the DOS prompt. To leave **LOOK**, press [ESC].

Also included is a very powerful ASCII editor, **EDWIN**. **EDWIN** is a public domain program which follows the formats of WORDSTAR, and can be very helpful in modifying files produced by V55 for use in the other Galileo programs and vice versa. **EDWIN** has complete online help, accessed by pressing **F2** once in the program. To start EDWIN, simply enter the command

EDWIN

at the DOS prompt. You can also enter a file directly with EDWIN by entering the command

EDWIN [filename] .

If you already have an ASCII editor you favor, you may use that instead of **EDWIN**. For more information on installing and using EDWIN, consult the documentation provided on the \GALILEO\TOOLS directory.

The last tool provided is called **UP**. Up lets you climb up your directory tree in only three keystrokes. If your default directory, for example, is GALILEO\DATA, then issuing the command

UP

at the DOS prompt will set your default directory to \GALILEO. Issuing the command again will move you to the root directory.

All three of these utilities are public domain software and are neither warranted nor supported by The Galileo Company, Terra Research and Computing or any of their agents. The are provided at no charge as a convenience for the user.

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