A Communications Primer (Transcript/Notes)

by Ray and Charles Eames, 1953; length: approx. 23mins

Communication, from the Latin *communicatio*.
1. Act or fact of communicating. As communication of smallpox, of a secret, or a power.
2. Intercourse by words, letters or messages, interchange of thoughts or opinions...

In the broadest aspects of communication, much work has recently been done to clarify theories and to make them workable. The era we are entering might well be characterized as an era of communication.

This film will touch, in the most elementary way, some aspects of the subject that are of daily concern to all of us. Here is Claude Shannon's diagram by which almost any communication process can be schematically represented.

The information source selects the desired message out of a set of possible messages, the transmitter changes the message into the signal, which is sent over the communications channel to the receiver where it is decoded back into the message and delivered to the destination. Every such system contains noise. Noise is a term used in the communications field to designate any outside force, which acts on the transmitted signal to vary it from the original. In this usage, noise does not necessarily mean sound. Reading is a form of communication where the word is the signal, the printed page the transmitter, light the channel, the eye the receiver. Here sound can act as noise and interfere with the message. But in some situations like reading on a train where the sound level is normally high, it is not the sound that interferes with the communication process, as much as the motion and the unpredictable quality of the light source. Quality of light and motion then becomes noise.

In radio, noise could be static. In television, noise is often the distortion of the picture through transmitting or receiving. In a typewritten message, the noise source could be in the quality of the ribbon or the keys - and we're all familiar with the carbon copies that keep getting progressively worse. If anything acts on the signal so as to bury it in an unpredictable and undesirable way in the communications system, it is noise.

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

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

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

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

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

This time, noise could originate in the transmitter or in sound vibrations that disturb the channel. Or it could be a nervous condition on the part of the receiver and it could change the message from I LOVE YOU to I HATE YOU. How do you combat it? One way is through redundancy - I LOVE YOU, I LOVE YOU, I LOVE YOU, I LOVE YOU. Another is increasing the power of the transmitter; this combats noise, as does the careful beaming of the signal, or duplicating the message via other signals.

Now let's consider amount of information communicated. The message SELL contained one bit or unit of information because it was a choice of two possible messages, BUY or

SELL. A choice of two gives one bit of information. This is the amount of information that one on-off circuit can handle at one time. It can be on or off.

Two bits of information is the amount two circuits can handle. There is a choice of four possible conditions: on-off, off-on, on-on, or off-off.

Three circuits can handle three bits, or a choice of eight possibilities. Four circuits, four bits, or 16 possibilities. Five bits, 32 possibilities. Six bits, 64. Amount of information increases as the logarithm of the number of choices.

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

Source, message, transmitter, channel, message, destination. You could imagine the message being music and the transmitted signal being tone, or it could be applied equally well to writing, or to smoke signals, or to hand signals. But let's take painting as another example of a signal transmitting a coded message.

Information source, mind and experience of painter. Message, his concept of a particular painting. Transmitter, his talent and technique. Signal, the painting itself. Receiver, all the eyes and nervous systems and previous conditionings of those who see the painting. Destination, their minds, their emotions, their experience.

Now in this case, the noise that tends to disrupt the signal can take many forms. It can be the quality of the light, or the color of the light, or the prejudices of the viewer, or the idiosyncrasies of the painter. But besides noise, there are other factors which can keep the information from reaching its destination intact. The background and conditioning of the receiving apparatus may so differ from that of the transmitter that it may be impossible for the receiver to pick up the signals without distortion.

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

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

Other high-level communication occurs in very different areas. A wave breaking on a beach brings a world of information about events far out at sea. It can tell of winds and storms, the distance and the intensity; it can locate reefs and islands and many things if you know the code.

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

The symbol - the abstracting of an idea, communication at once anonymous and personal. Personal because of the countless individuals that created its form, each one who in his turn added something good or who took something bad away. Anonymous because of the numbers of individuals involved and because of their consistent attitude. These are examples of communication of an idea through symbols.

But there can also be communication through symbols to an idea, as in the burnt offering or in the flame of a candle. The use of flame as a transmitter in the communications channel is probably as old as man's first fire. It stands for all the wonder and mystery of forces beyond man's knowledge.

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

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

The message being transmitted here may be unlimited in the range and subtlety of its ideas yet the method and the signal are such that they must be fed to the transmitter in a series of positive decisions. The system calls for the key to be either up or down. The code calls for a dot or a dash. The current flows, it ceases to flow, it flows. It is black or white. It is STOP or GO, on or off, one or none, go or no go, or black or white as in this small area from a half-tone reproduction in a magazine.

The press that printed it is capable of printing but one color of ink at a time, in this case black ink on white paper. In order to transmit the image, it had to be broken down to many points of decision, black or white. We know that such a limitation is not at all restricting if enough decisions are made. In this case, half a million decided points give a fair rendition, a million would be better.

Conventional printing of color is no different, except that with the added factor of color, four times the number of decisions have to be made, one set in yellow, one in red, in blue and in black.

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

Men have long known the theory on which complex problems of many factors can be solved, but the number of decisions, the calculations necessary were prodigious. Not until the recent development of the electronic calculator could these areas be touched. The problem became one of communication between man and machine, between machine and machine, between machine and man. The cards are punched or not punched, light passes or stops, and by this binary system, information is fed to the machine. In a moment, we will hear sounds, which are an actual product of a huge calculator. The frequencies are made audible to check its functioning and, in a way, feel its pulse. Here it is.

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

As flowing as the human movements may seem, they are actually the product of these countless yes/no decisions communicated with great speed to and from all parts of the body. The channel is the nervous system. Each nerve is made up of hundreds of fibers. The decision is the impulse of a single nerve fiber, an all-out event, a trigger process which is set off like an explosion when the stimulus exceeds the ignition point. The dot in the half-tone, the hole in the tape - each is a separate fire/no-fire signal, but together they add up to a smooth, sometimes incredibly complex action that often seems more vague than decisive. Yet many things that we accept as undecided vagaries would be, if we could bring our focus in sharp, decisive individual units. It is the responsibility of selecting and relating parts that makes possible a whole, which itself has unity.

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

These elements of a communications system act together as one great tool, and though the tool may perform a most complex task, it will never relieve the man of his responsibility, no matter where it occurs, no matter what the technique: Communication means the responsibility of decision, all the way down the line.

[Credits and acknowledgements]

The Information Machine (Transcript/Notes)

Or: Creative Man and the Data Processor, IBM; Made by Charles and Ray Eames, 1957; length: approx. 10mins

Since the time when man began to control the environment, he has been plagued by his limited ability to speculate: His failure to accurately predict the effect of a proposed action.

This is the result of his not being able to consider and relate all the factors in a problem. Evidence of this inability can be seen in the persistence of a certain kind of myth involving three wishes. In a frantic effort to reap immediate reward, the first wish is often not too wise. The second usually tends to over-correct. Our hero can consider himself lucky if after the last wish he ends up just where he started.

But there were men whose wishes were not only prudent, but had a habit of coming true. These man -and women - were artists and had certain characteristics in common. They were seldom bored with anything. They were constantly building up stores of information in active memory banks. When confronted with a specific need, they would call on these memory banks for information, which they would run through, sort out, and relate to the problem at hand. These men could speculate and could predict.

They were artists - artists in many fields: architecture, mechanics, medicine, science, politics, and the art of relating factors. It is often not a conscious art and the degree to which it is operative can tend to make one normal, bright, super bright or genius.

Numbers were used to count. But soon they were also being used as abstract symbols for states of being. Values were given to mass, speed, inertia and the forces of gravity. Such measurement was an enormous help to creative thinking. Man was learning to numerically relate and to predict.

Theories were developed by which the many factors in a problem could be numerically related. But the magnitude of the calculations necessary made many such theories impractical. In the last century the complications of our society have been compounding themselves and it began to look as though the science of numerical relationships could never catch up.

For a long time in the world of numbers man has been developing tools to help him handle increasing amounts of data. Something has now emerged that might make even our most elegant theories workable. The recent acceleration has been fantastic. The electronic calculator has already become a tool upon which much of our daily activities depend. A tool which has broadened the range of man's concepts and intuition, much the way other tools have broadened man's range of communications, man's range of travel or the phenomenal range of his control over environment.

With the computer, as with any tool, the concept and direction must come from the man. The task that is set and the data that is given must be man's decision and his responsibility.

This is information. The proper use of it can bring a new dignity to mankind. Properly related, it can maintain a balance between man's needs and his resources. In many aspects, these are information machines capable of storing, processing and relating a vast quantity of information. They process information so it can be made meaningful at the human scale.

Computers are generally used in any of three ways: First: As a control or balance. Second: As a function of design. Third: As a simulation or model of life, where we can see the effect before taking the action.

As a control or balance, the calculator keeps our complicated systems functioning. It determines the logistics of raw materials, its inventory and flow, history and performance of tools, and of personnel, production rates and quality, public utilities rates and flow, cost accounting, payrolls, billing, and all the ramifications of insurance, and, in addition, presents the broadest possible basis for making decisions.

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

Perhaps the most challenging use of the computer is the simulation of real situations. If, for example, a machine is properly programmed, and is provided with sufficient numerical data concerning a chemical plant, then the computer begins to take on the functions of a working mathematical model of that chemical plant in which it is possible to determine the probable effects of many possible courses of action.

Today there are working mathematical models of railroad systems, rocket engines, complete reactors and whole living communities. The calculator is helping to define society's most complicated problems. It is a tool for turning inspiration into fruitful prediction. As an information machine, it has done much to broaden the base of our growing concepts.

But the real miracle is the promise that there will also be room for those smallest details that have been the basis for man's most rewarding wishes. This is a story of a technique in the service of mankind.

[Credits and acknowledgements]