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Experimenting with PICTUREPHONE

What specific features will customers want most in a service that provides a new dimension in telephoning—the use of sight as well as sound? World's Fair visitors are helping Bell Laboratories engineers to find out

Developing PICTUREPHONE Service

Arthur D. Hall, *Head, Television*
Engineering Department, Bell Telephone Laboratories

IMAGINE, IF YOU WILL, a service which permits you to have a face-to-face conversation with a person who may be many miles away—a telephone conversation in which you can see every expression of the distant person. Think for a moment what this might mean in terms of a "reunion" with a friend or relative in a faraway city. Consider the advantage of being able to show or be shown an object difficult to describe in words and consider, too, the possibility of a person with a hearing defect being able to read the lips of the person at the other end of the line.

These are just a few of the intriguing prospects of PICTUREPHONE service which was demonstrated for the first time on April 20 with a transcontinental call between Bell System exhibits at the New York World's Fair and Disneyland. Visitors to the Bell System exhibits at the New York World's Fair and at Disneyland are trying it out now. It features a simultaneous telephone conversation and picture, both of which are switched through conventional telephone central office equipment.

Those who try PICTUREPHONE service will have a novel personal experience. For the first time they will encounter a new dimension in telephoning—the ability to use the sense of sight as well as of hearing. But at the World's Fair, the PICTUREPHONE system is far more than a novelty. Its purpose is not entertainment alone. It is actually a part of a carefully planned experiment designed by Bell Laboratories' engineers to make this new concept as useful and valuable as possible to customers at the time when it can be offered commercially.

The basic idea is not new. Indeed, if you are a science fiction fan you may be somewhat surprised to learn that PICTUREPHONE service is just now an accomplished fact. As far as the pages of fiction are concerned it has been a familiar prop for some time. Certainly in the Bell Laboratories it has been a subject of experiments and development work for many years. From the technical point of view we know, today, how to provide such a service. Indeed, the present setup at the World's Fair is evidence that it is quite possible without going beyond today's technology.

What Will Customers Need and Want?

Nevertheless, before a complete system can be successfully designed and built there is much more that we need to know. All of the potential uses of the PICTUREPHONE service depend on which specific characteristics and capabilities are built into a system. Before we can determine these, we need to know what potential customers will need and want from such a system after the novelty has worn off.

Such information is basic of course. In fact, customers' needs largely determine the fundamental technical and economic requirements of any system. But in a service as new as PICTUREPHONE, an understanding of the customer's point of view is essential. What specific uses will a customer consider most important? What quality of picture will best serve these uses? Which features will he prefer and what controls will he need to activate them? How often would the typical customer use PICTUREPHONE service, at what times of day and for how long? We need detailed answers to such questions as these so that systems engineers can make realistic assumptions about what compromise a customer would make if he had to choose between a system's features, its performance, and its cost.

This kind of information is now being compiled in a program of studies and experiments. A vital part of this program consists of observing how people use and react to experimental systems complete

L. A. Meacham at his desk at Bell Laboratories talks with and views author A. D. Hall on experimental PICTUREPHONE *set. Both engineers helped develop the visual telephone system.*

with PICTUREPHONE sets, transmission and switching facilities.

Fortunately, many devices and techniques currently in use are readily adaptable to experimental PICTUREPHONE systems. Solid-state electronics makes possible PICTUREPHONE sets that are small and highly reliable; that operate on low power and that produce good pictures without studio lighting.

A Two-Part Experiment

Our experimental program has two parts. One system has been operating between Bell Laboratories' Murray Hill and Holmdel Laboratories for the past two months. A number of PICTUREPHONE sets, divided between the two locations, have been connected by ordinary unshielded pairs of conductors in telephone cables to switching centers. Trunks between the two locations use a microwave radio link and a baseband repeatered line. Bell Laboratories engineers taking part in the experiment have been using this system in their daily business.

The second system is the one in operation at the World's Fair. This consists of seven sets in individual booths and another set used by an attendant. All sets are con-

CHRONOLOGY OF VIDEOPHONE RESEARCH

Related Research on Television Transmission Over Communications Lines

April 7, 1927—The first public demonstration in the United States of the transmission of television over telephone facilities took place at Bell Telephone Laboratories, New York City, between Walter S. Gifford, president of American Telephone and Telegraph Company, and Secretary of Commerce Herbert Hoover in Washington, D.C. At that time Mr. Gifford's remarks included the following: "The principles underlying television, which are related to the principles involved in electrical transmission of speech, have been known for a long time but today we shall demonstrate its successful achievement. The elaborateness of the equipment required by the very nature of the undertaking precludes any present possibility of television being available in homes and offices generally. What its practical use may be I shall leave to your imagination. I am confident, however, that in many ways and in due time it will be found to add substantially to human comfort and happiness.

"It is our constant aim to furnish this country with the most complete telephone service possible. In connection with that aim, we endeavor to develop all forms of communication that might be supplemental to the telephone. With that in view, we shall continue our work on television, which although not

1927. *First public demonstration of TV over telephone facilities took place.*

directly a part of telephone communication, is closely allied to it."

Later, Mr. Gifford added, "As it is now, it is a giant mechanism which takes up nearly half a room. . . . Of course, it will be a long time before the ordinary telephones will be provided with devices for television. A great deal of work must be done on them to make it practicable to use them in our system. But we will some day, I have no doubt".

1929-1931—A similar system, the first two-way television transmission system, was set up and operated between the American Telephone and Telegraph Company headquarters at 195 Broadway and Bell Telephone Laboratories at 463 West Street, New York City. This system was in operation for two years and included the transmission of outdoor scenes, color television, and motion picture films.

Television-Telephone Research

1935-1938—A television-telephone service was operated by the German Post Office between video-telephone centers in four cities: Berlin, Leipsig, Nuremburg, and Hamburg. To make a video call, the public made appointments in advance to be at the centers at pre-arranged times. Operators made the connections manually with plug-in jacks. The picture sets were large. Signals were transmitted over coaxial cables.

1955—Kay Laboratories of San Diego, California and Pacific Telephone and Telegraph Company (Bell System) demonstrated a two-station video-telephone system over a distance of one mile.

1956-1963—Bell Laboratories devised a system plan, developed and tested an automatically switched, experimental system between two Bell Laboratories locations, 25 miles apart.

1963—Reports were received from Italy and Japan of slow-scan video-telephone experiments. Russia reported a public video-telephone service using regular TV network facilities during nonbroadcast hours.

1963—Pye Telecommunications, Ltd. exhibited a television telephone at the Business Efficiency Exhibition held in London. The set included a 19" screen, a loudspeaker and a miniature television camera. This was used with a desk unit incorporating a loudspeaking telephone. Up to ten extensions could be used in the system.

1964—PICTUREPHONE service demonstrated to the public at the New York World's Fair. The first transcontinental call is made April 20 by William L. Laurence (below) science consultant to the New York World's Fair from the Fair to Donald Shaffer managing editor of the Anaheim, Calif. **Bulletin** at Disneyland.

1964. *First transcontinental* PICTUREPHONE *call between World's Fair and Disneyland.*

nected to a switching system that permits a visitor to call an attendant or a visitor at another station.

We were faced with a very considerable problem in constructing these systems: how do you arrive at even temporary requirements that would reflect what customers might want in a PICTUREPHONE system before there is any experience to draw on? In other words, how do you anticipate the answers to the very questions the experiment is set up to help determine? The telephone was a known factor; the accompanying picture was not. We solved this problem in part through the design of a variable-parameter picture system that can develop millions of different sets of picture characteristics.

A TV Laboratory

This flexible system is used in a special laboratory set up to carry out subjective tests on television pictures. The laboratory consists of two television-viewing studios and a control room containing two variable-parameter systems. Each system has a camera, a control panel, transmission path filters and two television receivers. Each has a dual set of controls—called "red" and "green" parameters—which can be used to prepare two different sets of pictures.

A person taking part in the experiment can view the red pictures while a second set is being prepared with the green. By throwing a switch, the operator of the system can change immediately from one set of pictures to the other to facilitate pair comparison and make other subjective measurements.

The system is variable over a wide range of picture parameters (size, frame rate, bandwidth, etc.). Contrast, brightness and spot wobble (a technique for softening a picture that has too prominent a line structure) can also be varied over wide ranges. The viewing conditions of the studio can also be altered. For example, the lighting system can be used to produce a wide range of spatial and spectral effects. This flexibility has great value in studies of such problems as glare, picture tube surface treatment to reduce washout from ambient light and reflection from the background. Because the transmission paths of the systems are quite free of impairments, known amounts of signal impairments can be introduced in order to determine acceptable levels of noise, interference and echoes for various picture standards. A laboratory of this kind offers a wide range of possibilities. Experiments may range from quite simple and straightforward ones to the most complex.

The experimental PICTUREPHONE systems were developed around picture parameters tentatively selected on the basis of information gained with the variable-parameter system. Among the major parameters selected were a bandwidth of about 500 kc; a picture four-and-three-eighths inches wide and five-and-three-quarters high and a viewing distance of 36 inches. Of these, the most important is the bandwidth. Although it is much less than the four megacycles of commercial television, it provides a very acceptable head and shoulders view of a caller if the other parameters are carefully chosen. It also helps to achieve economy because it simplifies using baseband transmission over ordinary cable pairs. Another advantage is that this bandwidth is free of interference from the radio broadcast band of 550 to 1500 kc.

Small PICTUREPHONE *unit held by J. A. Mazzeo of B.T.L. is made possible by use of transistors, other miniature components.*

Visitors at New York World's Fair are now trying the experimental PICTUREPHONE *system installed there.*

Design Objectives

The general objectives of the PICTUREPHONE design included an attractively styled set, that would be small enough to be used on a desk or table top and with as few controls as possible to make it easy to use. It also had to be low in power consumption and heat dissipation, reliable, and stable in its performance. These demands were satisfied through a design that uses solid-state devices exclusively except for the pick-up and display tubes.

The set consists of three equipment packages: a display unit, a control unit and a power supply. The first two are in reach of the user; the power supply is out of sight. The largest of the packages is the display unit which contains a picture tube, camera, the scanning, synchronization and other video circuits and a loudspeaker. The control unit has a telephone handset, a Speakerphone and a set of TOUCH-TONE telephone push buttons.

One objective of the experiment is to observe the relative use given to the telephone handset and the Speakerphone. The audio line connects through relays to the PICTUREPHONE switching system as well as to the standard telephone switching systems so that both conventional telephone and Speakerphone services are provided on the same instrument. The user controls the system with push buttons and makes calls by means of the TOUCH-TONE telephone set.

There are push buttons to select either of two modes of viewing: one-way video in which the user receives an incoming picture but does not transmit his own, and two-way video. Another push button controls a "self-view" feature that allows the user to see himself on his own viewing screen. This feature helps him to position himself with respect to the focus and field-of-view of the camera lens. A lamp is provided for use if room lighting is poor. It can be switched on and off manually or be set to light automatically when the set is turned on. Novel circuits used in it do make important contributions to economy.

Gathering Data

One of the methods used to gather data on the system is a telemetry connection between the PICTUREPHONE sets and the computation centers at the Murray Hill and Holmdel Laboratories. Extra contacts on the control unit relays in the sets are wired over cables to the computation center. Data over these lines causes cards in the computation center to be punched as a record of a change of status for any set. Cards are punched when:

- A telephone begins to ring or stops ringing.
- A PICTUREPHONE set begins to ring or stops ringing.
- The main telephone goes off-hook when it has been idle, or goes on-hook after completing a call.

The following modes of using the sets are also recorded by card punchings:

- Whether the call is a PICTUREPHONE call or a regular telephone call.
- Whether the Speakerphone or the handset is used.
- Whether two-way or one-way video is used.
- Whether or not the self-viewing feature is used.
- Whether the lamp is on or off or arranged to light automatically.

The punched cards record the date of any of these actions and the time of day to the nearest millisecond. This exact record will facilitate correlation of all the punched cards when the experiment is completed. By comparing cards from both locations, it will be possible to study the use of the service in detail.

Rounding out this part of the experimental program, a digital computer has been programmed to accept the cards from the telemetry system and to derive statistical information from them such as:

- The mean and standard deviation of the number of off-hooks a day.
- The mean and standard deviation of the number of uses of the various service features (self-view, one-way or two-way video, etc.).
- The mean and standard deviation of conversation time, ringing time, and signaling time.
- The mean and standard deviation of the per cent of off-hook time in which the Speakerphone is used.

The telemetry data will be analyzed weekly until the statistics become stabilized. It should then be possible to draw some conclusions as to how the users of the system have reacted to it. Various circuit options will be introduced during the experiment and pertinent statistics collected to assess how they are used. Interviews with the users will complement the telemetry analysis. When the data from the analysis and the interviews become stabilized, the sample of users being studied can be changed.

Getting Users' Reactions

A sample of the World's Fair visitors who use the PICTUREPHONE system there will be asked for their initial reactions to the system. Because a large number of people will have an opportunity to use this system, differing attitudes after one experience may be studied exhaustively. Viewing conditions may be changed to obtain an even wider range of first-use reactions.

Reactions to any communications system, however, will change markedly after a long period of daily use. This, of course, is a fact that motivated the Murray Hill-Holmdel system. Between information gathered on both experimental systems, it will be possible to assess the response of several samples of users. Thus, the data from both systems should complement each other effectively.

At this point it is still too early to predict when we will be able to offer PICTUREPHONE service to all our customers. Charles M. Mapes, assistant chief engineer of A.T.&T., explained to the press at the time of the first transcontinental PICTUREPHONE call that, ". . . Much further development work remains to be done before it will be possible to offer PICTUREPHONE service to the general public for residence and ordinary business use. . . . On the other hand . . . a large company might find situations where communication by PICTUREPHONE might be attractive . . . and you might visualize a situation . . . where customers would come to a central location to make calls between family groups in distant cities. We are making studies of situations where PICTUREPHONE service might be justified . . . and would expect to come up with some kind of a limited trial commercial offering . . . within the next few months."

Dummy figure at right below is shown being used by Bell Laboratories Engineer Philip T. Porter in one of earlier experiments with the visual telephone system.