



The greatest technical accomplishment in the world may go unused if it is not designed with people in mind. Thus, the parts of the Picturephone system that people will use directly have been designed to be attractive, easy to operate, reliable, and versatile.

Getting the Picture

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PEOPLE'S REACTIONS to PICTUREPHONE® service will be based largely on the unit that displays the picture, along with accompanying controls and other items in the customer's home or office. Is the equipment attractive? Functional? Reliable? Is it easy to use? Is the picture good? Coming up with the right answers to these and similar questions has been a major concern at Bell Labs as the Picturephone system has evolved.

The "right answers" means, first of all, that the picture itself must be clear and sharp and must stay that way without a lot of tuning adjustments. The equipment must be easy to operate. The camera must adapt readily to a variety of picture subjects, backgrounds, and lighting conditions. At the same time, the set must be versatile enough to meet diverse needs such as showing sketches or objects, changing the field of view, or allowing the person using it to turn off the camera if he doesn't want to be seen. The user should be able to select any of these modes easily and conveniently, with little need for thought or chance of error. Finally, the set, like all Bell System equipment, must be designed for a long life of trouble-free service under the hazards of everyday use.

These objectives, and the knowledge gained from study and experimentation over the past 10 years (see *The Evolution of Picturephone Service*, RECORD, October 1968), have helped shape technical possibilities and customer preferences

into a successful Picturephone system. In 1965, a significant milestone in the evolution of Picturephone service was the beginning of product trials, using what was called the "Mod I" Picturephone set. The results of these trials were then used to develop the latest and completely new Picturephone set, known as the Mod II.

The Mod II set consists of a picture display unit (containing the camera, picture tube, and loudspeaker), a control unit (containing the control buttons and knobs and a microphone), a 12-button TOUCH-TONE® telephone, and a service unit (containing the power supply, logic circuits, and transmission equalizing circuits). The first three units are color-coordinated and intended to fit in as harmoniously as possible with any decor, since they will almost always be in plain sight. The service unit is intended to be installed out of sight and can be up to 85 feet away from the other three.

The display unit is mounted on a sculptured ring stand and can be turned almost all the way around (340 degrees) on the stand. Since the ring stand has a "non-skid" base, the unit is not easily pushed or pulled off the surface on which it rests. However, when the unit

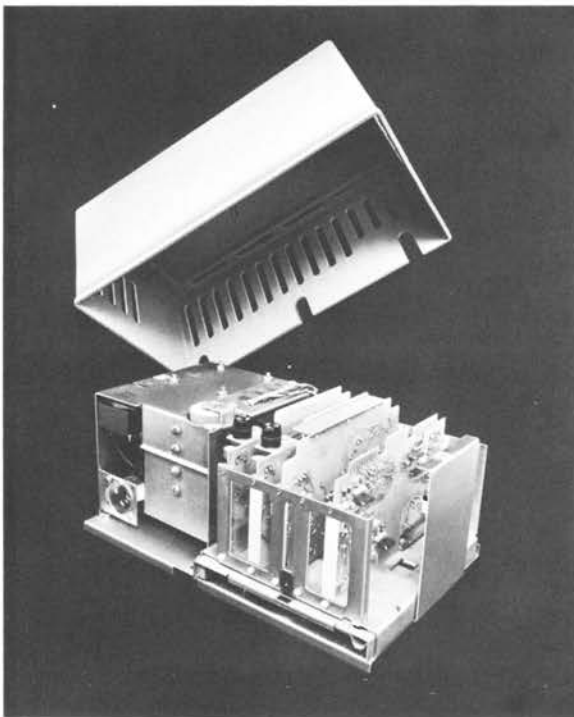


is tilted close to the point of tipping over, the non-skid material, which covers only part of the base, lifts away from the surface and the unit slides instead of falling on its side. All of the video circuits, the camera and picture tubes, and the speaker are in the display unit. The area around the face of the picture tube has a mat black finish, which is ringed by a band of chrome that serves as a transition to any of the many available shell colors.

The picture tube face, which is 5 by 5.5 inches, displays a picture constructed in the same way as that on a home TV set. That is, it displays 30 frames a second using odd-even line interlace to give 60 fields a second, thereby yielding an acceptable "flicker" rate. A complete frame consists of about 250 visible interlaced lines, and horizontal and vertical resolution are essentially equal.

A near-perfect interlaced picture is provided in the camera by an integrated digital synchronizing generator, which is probably the most unusual circuit in the station set (see *Devices—The Hardware of Progress*, in this issue). The

The customer service unit contains the low-voltage power supply, the control circuits, and the station set equalizer, where required. The unit is usually not in view at an office or home, and can be placed up to 85 feet away from the other units.



synchronizing generator promises to yield significant cost savings in the production version of the Picturephone set.

Beyond the quality of the picture itself, other factors played an important part in the design of the display unit. For example, the camera is placed above the picture tube to make the eye contact angle as small as possible. This is significant because, while the camera is looking at the subject, the subject is looking at the picture tube. The apparent "looking away" is annoying to the viewer unless the angle is small. The least annoyance occurs when the subject appears to be looking slightly down, which is frequently the case in normal conversation. Locating the camera just above the picture tube creates this effect.

The best position for the camera has proved to be about 12 inches above the desk top so that its field of view is essentially straight ahead. Here the camera gets the most natural-looking, least distorted view of the subject, keeping him on camera while allowing some movement, and (hopefully) not picking up too many ceiling lights.

The lens in the camera has an aperture of $f/2.8$, with a viewing angle of about 53 degrees. It is normally focused for a distance of about 3 feet from the set. This distance can easily be changed, however, by moving the button above the lens to the left or "20" position, changing the focal distance to a field centered about 20 feet from the set.

An automatic iris adjusts the lens opening for ambient lighting conditions. The iris is of a unique friction-free design, and is controlled by peak averaging of the video signal. Omitted from these measurements, however, are the upper and lower quarters of the picture, where ceiling lights and white shirts could unduly influence the camera setting. When the iris has opened completely (at a scene brightness of about 12 foot-lamberts) an automatic gain control circuit in the camera amplifier takes over control of the signal level, although with increasing noise as the light level decreases. In good light, with a small opening of the iris, the camera has an increased depth of field. This effect is exactly the same as with an ordinary photographic camera, where a large "f" number allows both near and far objects to be in sharp focus.

In addition to the camera, the display unit also contains a loudspeaker. Since the voice coming through the speaker is normally that of the person in the picture, it is appropriate that the loudspeaker be located as close as possible to the picture. However, since the loudness of the voice is best controlled by the listener, the "VOLUME"

control knob is located on the separate control unit, which is normally at his fingertips.

The "ON" button, of course, turns the set on. But, during a conversation, if the viewer desires to mute his microphone, he again presses and holds the "ON" button. This allows him to talk to someone else in the room without being heard by the person at the other end of the line. To resume conversation over his Picturephone set, he simply releases the button.

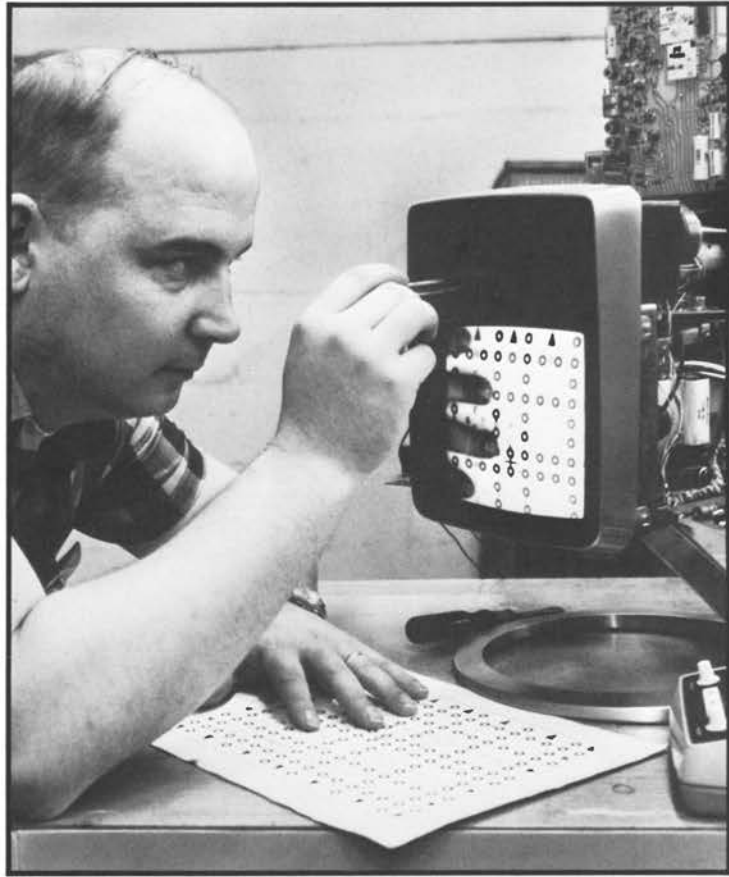
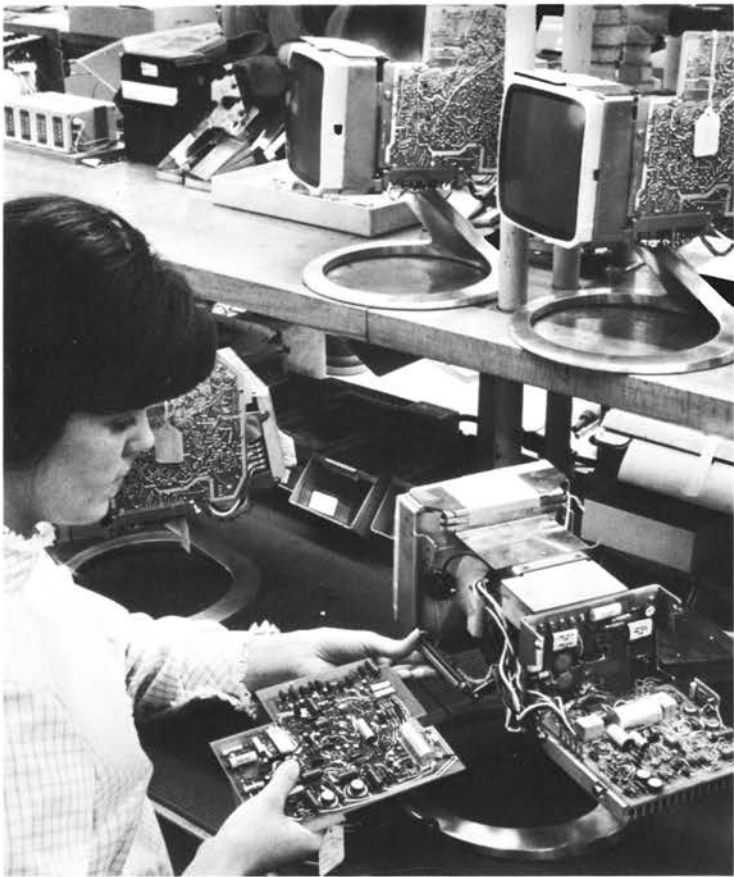
Although the user will normally stay reasonably centered on camera without giving the matter any attention, he can check his position by pressing the "MONITOR" button on the control unit and viewing his own picture. Pressing the "MONITOR" button a second time returns the picture of the person at the other end of the line. If at any time the user does not want to be seen (a frequent concern of housewives), he (or she) can press the "DISABLE" button and a distinctive bar pattern will be substituted for the picture. As with the "MONITOR" button, pressing the "DISABLE" button a second time returns the picture.

"SIZE" and "HEIGHT" controls are real contributions to the versatility of the Picturephone set. They permit the user to "zoom" his camera, changing the field of view by more than 2 to 1 in area, and to adjust the effective height at which the camera is pointed. Both functions are controlled from the control unit, without involving any mechanical movement of lenses or camera assembly. The adjustments are made possible by the silicon target in the camera, because the silicon target doesn't "burn-in" a memory of the area scanned by the electron beam.

The image on the camera target is always that of a field 26 inches high by 28.6 inches wide about 3 feet in front of the set. When the size control is turned to its upper extreme, the entire target is scanned, giving a "wide-angle" field of view. When the size control is set at the lower extreme, only a portion of the target, corresponding to a field 16 inches by 17.6 inches at the 3-foot distance, is scanned. While this narrow-angle field is considered the normal position, resolution may be traded for greater field of view either to allow the user to move around more in front of the camera or to accommodate more than one person on camera (see A "Solid-State"

Using the SIZE and HEIGHT controls on the control unit, a person making a Picturephone call can adjust his (or her) own image without moving the display unit itself. The HEIGHT control moves the image up (top, at right) or down. The SIZE control moves the image away, in effect, or brings it closer, electronically. A camera iris automatically adjusts the lens aperture to compensate for any differences in light intensity.





Electron Tube for the Picturephone Set, RECORD, June 1967).

For any setting less than the widest angle, the user can, by adjusting the HEIGHT control, move the reduced raster to scan the top or bottom portions of the image. Although a mechanical tilt adjustment allows an installer to compensate for desk and chair heights, the user can later adjust the set for his own height by using the electronic height control.

While Picturephone service is intended primarily for face-to-face conversation, visual communication sometimes entails showing drawings, documents, or other physical objects. This can be awkward if the customer has to hold things up in front of the camera. Therefore, the set is designed so the user can point the camera down at the surface on which the set rests and still keep the picture tube in view. This is done with a mirror swivel-mounted in the display unit. It can be brought in front of the camera by moving the button above the camera lens to the "1" position. The field of view of the camera when the mirror is out is 5 inches by 5.5 inches, with the top of the field at the edge of the ring stand. Moving the mirror into position also shortens the focal distance of the lens to one foot, reverses the camera sweep to correct for the mirror image, and locks the camera in the narrow-angle mode. The resolution at this distance is adequate for simple sketches, photographs, and the like. Typed text is of marginal legibility, and the 5x5.5-inch field does not, of course, encompass an 8.5x11-inch typed page.

Inside the plastic shell of the display unit, a heat shield at the front of the camera and a copper heat sink keep the camera from getting too hot. Both the shield and the heat sink are necessary since the right place for the camera from a human-factors standpoint turns out to be the worst possible place from a heat standpoint. An aluminum heat sink at the rear of the display unit holds the power transistors for the sweep drives and the power supply for the cathode-ray

heater. Top and bottom vents at the rear of the shell provide chimney action for cooling this heat sink.

The high-voltage power supply is encapsulated directly in front of the aluminum heat sink. When the shell is removed, an interlock at the rear of the unit disables the high-voltage power supply. A strategically placed shield on the receiver reduces interference between the transmit and receive sections of the set. Controlling this interference between the high-voltage drive pulses for the cathode-ray tube and the low signal level at the camera output was the most difficult problem in assembling the circuits into a unit.

The low-voltage power supply and the control circuits (as well as an equalizer where required) are contained in the service unit, which uses commercial power. Since no standby battery is provided, failure of commercial power removes the video portion of Picturephone service (but does not affect the voice portion).

The Picturephone equipment that the Bell System's customers will use has been designed with close attention to human factors, to simulate as closely as possible the free and natural communication of face-to-face conversation. A modest graphics capability is included, and adjustments that people will have to make are limited to those they are most likely to want. The Mod II set is expected to serve well as Picturephone service becomes commercially available over the next few years.



Picturephone display units being assembled and tested at Western Electric's Indianapolis plant. Among the many operations: mounting the picture tube and frame assembly on the ring stand (top left), checking circuit boards visually (top right), placing them in the display unit (bottom left), and finally, testing for picture alignment.