Electronic systems — 2

Background to a communications course

by P. R. Darrington

Communication between people, between machines and between machines and people is at the core of our society. Without communication, life would not be possible; indeed, without the communicating link of the DNA molecule, there would be no life.

In the somewhat more confined area of an electronic systems course, our concern is more specific and the two main subjects of interest are audio and visual communication. Both have arisen because the needs of people far outstrip their capabilities. People need to communicate with each other at a distance, or by "delayed action": information must sometimes be recorded for later use or the communicator requires that his message be modified in some way, perhaps to make it more entertaining.

The language that this kind of discussion is conducted in sometimes obscures the fact that these requirements can give rise to familiar objects. A "recorded, delayed visual communication" is better known as a photograph and "an electromagnetically-transmitted, melodic/visual stimulus" is not easily recognized as Top of the Pops. Such descriptions could be called breakdowns in communication and are fatuous, but can often be seen in print. We will try to avoid them.

Communication between people is at the centre of the subject and can be effected by the use of newspapers, town criers, posters, films, radio, records, tape and television. Our concern is with the last four, as the intention is to use electronics to illustrate systems in action in society, electronics being a prolific user of systems of all kinds.

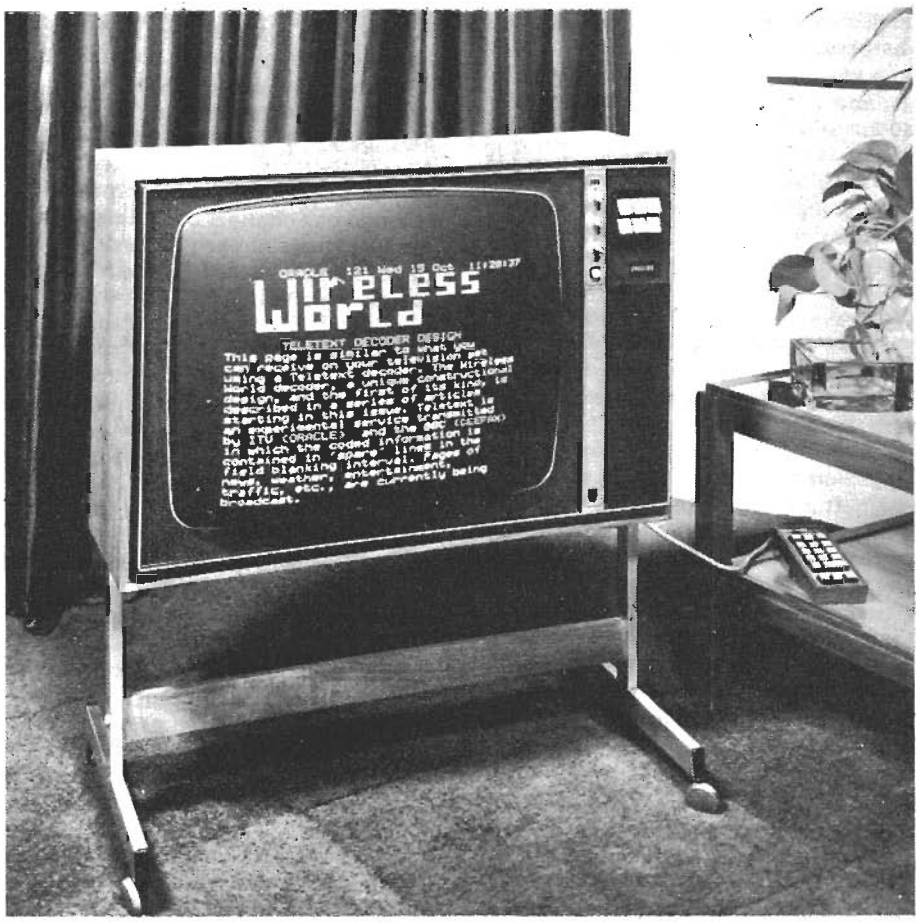
Aural communication

The easiest way to communicate aurally is to open one's mouth and bellow. However deep-chested the bellower, this method has a limited range and electronics, in the form of radio, is employed to enable the message to travel almost any distance from a few yards to millions of miles. The original sound is carried by the wave-motion of the air — a short-range mechanism. By impressing the low-frequency sound waves via a mechanical-to-electrical transducer onto a high-frequency radio wave, which does not suffer the rapid attenuation of an airborne wave, the message travels further. At the receiving end of the communication channel, the low-frequency sound is recovered and made audible by another transducer, this time electrical-to-mechanical — the loudspeaker or headphone.

Notice that the radio wave itself was not the message. Each cycle of the original radio wave is identical to any other and, as the probability of one being like the last is maximum and the recipient is aware of this, no information is carried. To reduce this probability, the sound wave changes, or modulates, the cycles of the radio wave. The message is then in the differences between cycles. This matter of modulation is crucial.

As in any aspect of communication, control or measurement, the transducers mentioned above are also crucial. They are the boundary between the familiar acts of talking, listening or seeing and the world of electronic activity which cannot be tested by any of our senses. If they are inefficient, as loudspeakers are, we spend too much on driving them and if they distort we lose some of the message.

Stored aural communication (oh, really!) is the domain of the disc or the tape, although one does sometimes wonder if a recording of, say, Vera Lynn singing a World War II song is really communication. If one has heard the record played a hundred times, the



A Philips television receiver, adapted to receive and display Teletext information. The system is capable of displaying several hundred "pages" of news and data. Photograph taken by the Independent Broadcasting Authority at their research centre.

probability that, on the 101st playing, it will be different is fairly low. Where, then, is the message? Storage, however, is the aim of the high-fidelity class of equipment. Discs and tape have their pro's and con's, concerned with ease of handling, vulnerability to damage and wear, and physical size. There is also the matter of access time — not, perhaps, as important domestically as in a computer service bureau, but a factor to note, nevertheless. When one is at the wrong end of a C-120 cassette, discs can take on a new appeal.

The problem of noise (defined here as unwanted sound) is a thorny one, particularly with tape. Recording materials, both for discs and tape, are responsible for background noise which is reproduced as though it were part of the original sound. It constitutes an error which, in most cases, is not serious but merely irritating. When information is transmitted digitally, each small piece of information frequently being denoted by the presence or absence of a signal, a noise signal can fake the presence of a legitimate signal and cause a lot of trouble. All information-carrying chennels suffer from noise to a greater or lesser degree, but in the domestic, music-playing environment, the tape-recording process is more vulnerable than disc. Hence the appearance of the name of the inventor of a noise-reducing process on many cassettes and cassette recorders — Dolby.

Distortion in the waveshape of a signal is, again, always present, and can be considered a form of noise, because it often consists of added harmonics — unwanted sound. In a telephone system, distortion is not considered very important (unless one is in the habit of dialling a disc) but in a high-quality audio system, a very small amount indeed is unacceptable. Some of this is no doubt due to the peculiar genius of advertising copy-writers (one can listen to a heavily-distorting car radio without suffering) but it seems to be a fact that amounts of distortion which are imperceptible visually on an oscilloscope are easily discerned when listened to.

For many years, the audio amplifier has been subjected to intense examination by circuit designers, with the intention of reducing the amount of distortion contributed by this link in the chain. It is now down to around 0.005% in the top-class units. And yet the other elements in the audio system can contribute much larger amounts — a tape deck up to 2%; a loudspeaker about the same. It is as though a rare wine in a golden goblet were decanted through an old sock and drunk through a mouthful of black pudding.

The virtually distortionless and noiseless reproduction of music from one loudspeaker is not, of course, considered good enough now. In the last two or three decades, stereophonic reproduction has been adopted as standard and surround-sound is almost upon us (assuming that the manufacturers ever decide which kind to make). Hearing mechanisms and the psychology of hearing are relevant subjects for study in this business of multichannel sound. Surround-sound reproduction is not always intended to give the listener the impression of being in a concert hall, listening to music from the platform. If the music is recorded in a studio and is mainly synthetic, the listener is quite likely to be among the players. The surround-sound effect is being used not to convey the literal truth, but the truth in a modified form.

Visual communication

Electronics come into their own here for remote viewing and storage. Perhaps the most spectacular televisual communication is that between a space capsule and Houston, Texas — communication in a very real sense. In its more mundane sphere, the science is perhaps not quite so communicative; the predictability of a weekly American detective film reduces the information content to a low level.

In industrial applications, a television channel will become part of a feedback loop. It can be used to observe the effect of a control and to display it to the controller, who is thereby protected from a possibly hazardous working area.

The amount of information required to reproduce an acceptable picture is large (between 300000 and 800000 elements). This immediately rules out any idea of transmitting a picture by means of a "one-to-one" photocell/lamp connexion for each element. Such a channel in cable form would be grotesquely expensive in copper and very bulky. This "parallel" method of transmission is therefore abandoned and a "sequential" approach adopted, wherein one channel is modulated with the brightness of each element in turn, by scanning the scene. At the receiver, a similar scan is "in step" with that at the transmitter. The scanning of a picture is used in television at high speeds for real-time viewing or at much lower speeds for facsimile and amateur use (slow-scan television – s.s.t.v.).

Recently, the exploitation of transmitted television signals has been increased by the Teletext experiment, which may become a permanent service. The previously unused sections of a television wave, blanked lines between scans, are now used to carry coded information. The code can be used by a domestic receiver to instruct a local "character generator" to display letters, numbers and graphic characters, forming a page of information on entertainment, news, weather forecasts, news flashes, financial reports and the like.

In the next article, the use of modulation techniques for signal transmission will be discussed.