COLOUR TELEVISION IN MEDICAL TEACHING

How to demonstrate surgical operations in such a way that they can be followed closely by large numbers of students is a problem of some antiquity in medical teaching. A significant step was taken towards its solution when advances in television engineering made it possible to project bright pictures of considerable dimensions. When the Philips projection system \(^1\) was introduced, its utility for medical teaching was quickly recognized. The system was demonstrated in the University Hospital at Leyden in February 1949, when an operation was followed on the television projection screen by more than 200 spectators \(^2\).

With the advent of colour television it has become possible to add colour information to the projected picture. The fact that this helps the spectators to understand what they see is illustrated in fig. 1, which shows the same surgical object in black-and-white and in colour.

Another important development in the last ten years has been the improvement of the variable-focus lens, or "zoom" lens. With this instrument the size of the field of view can be continuously varied, so that both general views and close-ups can be televised without shifting the camera.

These considerations induced the University of Marseilles to acquire for its Faculty of Medicine a closed-circuit colour-television system capable of projecting a very large picture \((2.70 \times 3.60 \text{ m})\). The installation, which was put into operation in October 1958, is briefly described below.

A diagram of the layout is given in fig. 2. In the operating theatre A the television camera is attached to the lamp above the operating table (see also fig. 3). The camera "sees" the brightly lit object (luminous intensity 20 000 to 30 000 lux) reflected in a flat mirror, which is mounted obliquely on the lamp and so coupled to it that if the lamp is turned the camera continues to see the illuminated field (fig. 2).

The camera contains three photoconductive


Fig. 1. A coloured picture of a surgical object shows details far more clearly than a monochrome one.
Fig. 2. Layout of the closed-circuit colour television system installed in the Department of Medicine at the University of Marseille (the following photographs all relate to this installation).

A. Operating theatre containing operating table 1, lamp 2, colour-television camera 3, mirror 4, microphone 5, headphone with microphone 6, monochrome monitor 7, loudspeaker 8.

B. Control room containing racks I, II, III. Rack I includes a monitor 9, an oscilloscope 10 and a panel II containing the controls for adjusting the camera lens system (focus, focal length, aperture; these can also be controlled from the operating theatre). In Rack II, 12 delivers a test signal and 13 the scanning currents and correction signals for the camera. Rack III contains a 70 W amplifier 14 and two 2 W amplifiers 15 and 16. Loudspeaker 17 enables the control-room operator to listen-in on both sound channels. 18 is the voltage stabilizer (5 kVA).

C. Lecture theatre with colour-television projector 19, projection screen 20, loudspeaker columns 21 and microphone 22.

Fig. 3. The operating theatre. The lamp 2 (numbering as in fig. 2) and the colour camera 3 are mounted on a bracket. The lamp carries the tilted mirror 4, to the back of which a microphone 5 is fixed. Right, the picture monitor 7 and loudspeaker 8. None of the equipment obstructs the surgeons.
camera tubes 3). Dichroic mirrors and filters transmit the red, green and blue components of the incident light to their respective camera tubes 4).

The lens system ("Pan Cinor", made by S.O.M. Berthiot) has a continuously variable focal length of 42 to 170 mm, corresponding to a field of view of 30 to 7.5 cm diameter on the operating table. Focussing, zooming (changing the focal length) and adjustment of the diaphragm of the lens is done by remote control either from the operating theatre or from the control room. A feature of the lens system is that there is enough space between the last lens and the camera tubes for the dichroic mirrors and filters.

The operating theatre further contains a monochrome picture monitor (this could also be a colour picture monitor), on which the three primary-colour pictures can be checked separately or in combination.

As fig. 3 shows, none of the parts of the installation obstruct the surgeons.

The three primary-colour signals are transmitted by cable via the control room — which we shall discuss presently — to the lecture theatre (C in fig. 2). The projection system installed here (figs. 4 and 5) is of a type already dealt with at length in this Review 2). It consists of three primary-colour projectors side by side, each incorporating a Schmidt optical system and a projection tube giving red, green and blue light, respectively. As described in

Fig. 4. The colour-television projector in the lecture theatre. The primary-colour projectors (red, green, blue) are mounted side by side 6).


4) P. M. van Alphen, Applications of the interference of light in thin films, Philips tech. Rev. 19, 59-67, 1957/58 (No. 2); see especially p. 65 et seq.

5) T. Poorter and F. W. de Vrijer, The projection of colour-television pictures, Philips tech. Rev. 19, 338-355, 1957/58 (No. 12); see especially figs. 20, 21 and 22.

Fig. 5. The control desk for the colour-television projector. The picture on the screen measures $2.70 \times 3.60$ m and has a highlight luminance of 14 cd/m².
Fig. 6. The three racks in the control room (cf. fig. 2). The wall on the left is the rear wall of the lecture theatre. The operator can see the projected picture through the window.

article 5), the three primary-colour images are brought into superposition on the projection screen partly by mechanical means (the outside projectors are pointed slightly inwards) and partly by electrical means (correction signals are added to the scanning currents). Effective measures are taken to provide protection against the X-rays generated in the projection tubes, which operate at 50 kV.

The picture on the screen (fig. 5) — beaded screen with a gain factor of about 2.5 — measures 2.70 × 3.60 m and has a highlight luminance of 14 cd/m². When the smallest field of view is used the projected image of a 7.5 cm object fills the whole screen height; this represents a linear magnification of about 36 ×. The size, definition, brightness and contrast of the projected picture are such that each spectator in the 300-seat lecture theatre can follow every detail of the operation. The result would still be amply satisfactory in a lecture theatre seating 500.

The control room (B in fig. 2) is equipped with three racks as shown in fig. 6. Rack I contains a picture monitor similar to that in the operating theatre, and an oscilloscope for checking the amplitude and waveform of the three primary-colour signals.

Rack II supplies the scanning currents and correction signals for the camera tubes (the picture is scanned on the 625 line system). This rack also contains the circuits generating the synchronizing signals for the camera and the colour projector, and a test signal for checking the colour projector distinct from the camera.

Rack III contains the amplifiers for the sound installation, viz. one 70 W amplifier and two 2W amplifiers. The first operates two loudspeaker columns, which are mounted at either side of the projection screen, and over which the commentary from the operating room is given. A limiter circuit in the amplifier prevents distortion if the speaker should approach too close to the microphone (which is attached to the back of the mirror); this allows the speaker appreciable freedom of movement in relation to the microphone. One of the 2W amplifiers serves the intercommunication system of headphones and microphones between the operating theatre, the control room and the projectionist. The other 2W amplifier connects a microphone in the lecture theatre to a loudspeaker in the operating theatre. A loudspeaker in the control room enables the operator stationed there to listen-in on this channel as well as on the 70W-amplifier channel.

The whole installation is powered from the mains via a 5 kVA voltage stabilizer.

It is evident that the usefulness of this installation is not confined to instruction in surgery. Dentistry, anatomy, autopsies, sterilization technique, etc., can similarly be demonstrated to large audiences, not only for the teaching of medical students but also for the training courses provided in hospitals for the nursing staff.

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