

the numbers and dial markings and mark off this range by heavy lines on the dial circumference. The operator then merely notes whether his pointer is within, above, below, or moving in a particular direction with regard to this range. This type of instrument is termed a *qualitative display*. A group of dials of this type may be arranged in a pattern to show at a glance which of several instruments may be malfunctioning. For this purpose they should be arranged in rows or columns so that their normal operating range is similar (see Figure 7).²⁴ The third and con-

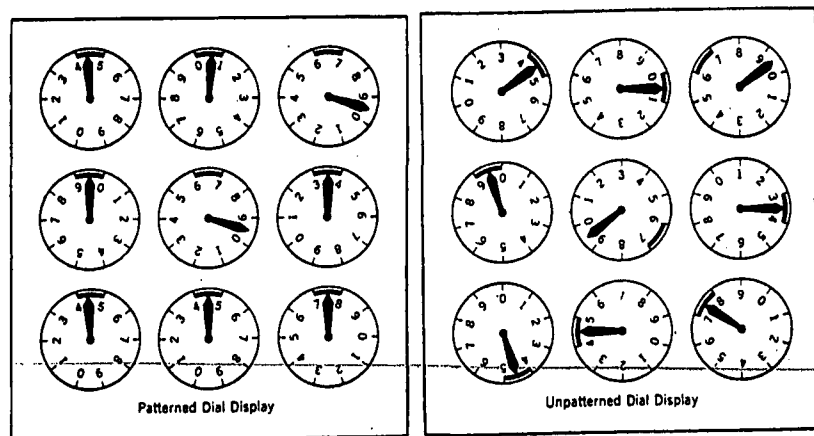


Figure 7. Patterned and unpatterned dial displays. Dials that are only required to indicate whether or not a certain activity is within a normal operating range may often be grouped together in a patterned display in which the normal pointer readings are oriented in the same direction. A quick glance can then determine which of many activities has departed from normal, as in the display at the left. In the unpatterned display at the right a much more time-consuming examination is necessary. (From Chapanis *et al.*²⁴)

ventional type of indicator is called a *quantitative display*. Here the worker finds a numerical figure when he reads the display, as in speedometers or rpm indicators. This type of instrument can give not only the direction but the rate of change as well. In many cases a quantitative indicator could be replaced by one of the other types. This sort of redesign should be one of the first considerations in the human engineering of visual displays.²⁵ When quantitative displays are used, however, they may consist of either a moving pointer with a fixed scale or a moving scale with a fixed pointer. For general purposes the former is most advantageous.⁴⁶

²⁴ C. A. Baker and W. F. Grether, Visual presentation of information, WADC Tech. Rept. 64-160, Wright Air Development Center, Wright-Patterson Air Force Base, Ohio, 1954.

4. Principles of Display Design

In addition to general factors involving the visibility of objects within the working area, sufficient research has been done within the field of visual display design to warrant some fairly specific recommendations. The areas of research include shape, size, type of scale markings, distance between markings, type of pointer, direction of increase on scale, and the design of multirevolution instruments. Some of the more important findings are summarized below.

a. Shape of Dial. The five most commonly used dial shapes have been experimentally tested for accuracy of reading by Sleight. All were equated in terms of size and shape of numerals, illumination, and so forth, so that any differences in reading accuracy may be presumed to be primarily due to shape. The shape found to give the fewest reading errors in this test was the open window type of direct reading counter. Mistakes were made in only 0.5 per cent of the readings. The next most accurate dial, although very much inferior to the open window type, was the round or circular type; 10.9 per cent of errors were observed with this display. Following, in order of mistakes, were the semicircular dial, 16.6 per cent; the horizontal, 27.5 per cent; and finally the vertical shape with 35.5 per cent errors.⁴⁷

The marked superiority of the direct reading counter is evident only under conditions of rapid viewing during short exposure. Where the viewing time may be lengthened, the number of errors observed in the other types of dials would be very substantially reduced. Also, for check reading in a group of instruments (see page 87) the moving pointer type of display is definitely superior.

b. Size of Dial. The optimum size of the dial is, of course, related to the viewing distance. For a distance of 30 inches between the display and the eyes of the operator, it has been found that a dial 3 inches in diameter can be read faster and with fewer errors than dials of smaller size. The diameter must be increased for distances above 30 inches and decreased for those below 30 inches.^{48,49} An additional variable, however, is the number of scale markings or indices that must be used. Table 5 shows the minimum dial diameters under varying conditions. No dial should be less than 1 inch in diameter regardless of the circumstances.⁵⁰

c. Scale Markings and Numberings. The ease of quantitative dial reading is significantly affected by scale markings and numberings. The common practice of making the numbered division marks longer than the halfway marks is good. For rapid readings, the fewer the marks the better. When accuracy is desired as

⁴⁷ J. A. Sleight, The effect of instrument dial shape on legibility, *J. Applied Psychol.*, 32, 170-183 (1948).

⁴⁸ W. F. Grether, The design of instruments for ease of reading. Paper presented before the Soc. Automotive Engrs. National Aeronautic and Air Transport Meeting, April, 1948.

⁴⁹ W. E. Kappauf and W. M. Smith, Design of instrument scales for maximum legibility: A preliminary experiment on dial size and graduation, *Memorandum Rept. No. MCREXD-49-10*, USAF, Air Materiel Command, July 12, 1948.

⁵⁰ W. E. Woodson, *Human Engineering Guide for Equipment Designers*, University of California Press, Berkeley, 1954.