Equipment Design and "Human" Limitations

To the Editor:—Recently (ANESTHESIOLOGY 32:87, 1970), Dr. Ditzler commented on a previous communication by Dr. Rendell-Baker (ANESTHESIOLOGY 31:194, 1969) describing some near-catastrophes caused by the unsuspected presence of two sets of valves that were crossed. Both authors recognized that these difficulties arose in spite of supervision by two fully qualified anesthesiologists, but they emphasized different aspects. Dr. Rendell-Baker accepted that most of us are subject to mistakes and proposed steps of an engineering nature to forestall similar incidents. Dr. Ditzler did not disagree, but the gist of his communication was a plea for a thorough check of equipment as a more basic safeguard. Actually, Dr. Rendell-Baker did not carry his point far enough. It is not so much that we are subject to mistakes, but we are also limited by human anatomy, physiology, and particularly, psychology.

I think Dr. Ditzler will agree that the persistent attention he demands must go beyond the ritual of checking our equipment. We should want to assure ourselves that this equipment can really serve its function. He advocated greater vigilance. This is a key word of a new multidisciplinary science which analyzes patterns of man–machine interface in order to adjust mechanical devices to the limitations of human nature. This new science, which "fits the job to the worker" has been called "Human Engineering," "Human Factor," or "Ergonomics," among others. It came into its own during World War II, when it was realized that the efficiency of an airplane varied with human responses and there was a need for preliminary analysis of the control systems as related to the variability of these responses. As early as 1947, data implicated the layout of controls as a major factor in some airplane crashes attributed to "pilot errors."[1]

My own interest in this question grew out of some difficulties with oxygen supply caused by an ambiguity in the design of the pressure gauge. The "full" reading (1,800–2,000 pounds) is almost opposite the "empty" position, and the indicator needle is double-ended (fig. 1*A*). An operator under stress may fail to distinguish between the two poles of the pointer—and be under the illusion that the tank is full, when it is actually empty (fig. 1*B*). The small size of the dial makes the scale spacing too narrow; this makes it difficult to recognize some relatively large changes, and one is apt to leave much gas in an "empty" tank.

We should implement a basic principle of display and "use the simplest design to supply the necessary information." It is essential to know the approximate content of the tank, but not the fine gradations. A 180-degree scale would offer certain advantages; it could avoid any reversal error, and could also be distorted by partial projection to give greater weight to the lower end of the scale (fig. 2).

Other aspects of our equipment can benefit from similar consideration,[2] but it is particularly in the layout that ergonomic considerations are important. One must look at the

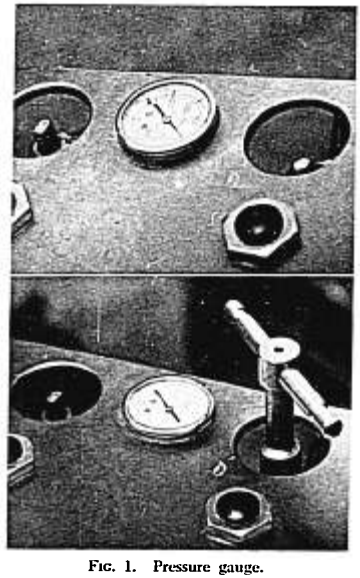

FIG. 1. Pressure gauge.

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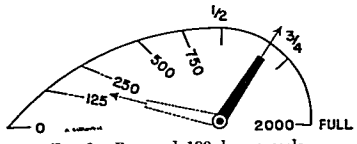

FIG. 2. Proposed 180-degree scale.

administration of an anesthetic as a work situation and our swivel chair as part of a workbench. Because of the extent of our field of observation and the number of independent pieces of our equipment, it is impossible to arrange them together on a single dashboard, as in a car, but dials should be of a size and location such that they "look" at the operator instead of the operator's looking for them. Specifically, the pressure gauges and flowmeter should be close enough together so that they can receive simultaneous attention.

Ergonomic principles are particularly important when pieces of equipment manufactured by various companies are used alternately. One can look again to aircraft for an example. The incidence of serious accidents could be related to the shift of pilots from one plane to another, with different control layouts in the cockpits of the two planes. As a consequence, "great care is taken to standardize the positions of controls to avoid the potential disastrous effect of negative transfer"; negative transfer implies that the execution of a specific maneuver may be influenced or even overridden by previously established patterns. Anesthesiologists may get annoyed when they have to interchange equipment of different manufacturers, but each manufacturer will continue to produce its own design, until there is a re-evaluation of responsibilities and recognition of the importance of ergonomic principles.

It is time for the anesthesiologist to realize that human perception and reaction can influence the effectiveness of his equipment, and to recognize that appropriate guidelines from behavioral sciences can assure the most fundamental form of safeguard.[2] The crucial consideration is not that a particular operator is more astute or more familiar with the equipment, but that our equipment should be built as an extension of our nervous system and appendages, so that it can be totally at our command. Human components in a man–machine system, by their very nature, are far from constant. We must make sure that the price for the health of the patient is not paid by the well-being of the anesthesiologist. It is fundamentally a matter of properly adjusted equipment.

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REFERENCES

1. Fitts PM, Jones E: Psychological aspects of instrument display. Analysis of 270 "pilot error" experiences in reading and interpreting aircraft instruments. U.S.A.F., Air Command, Wright Patterson A. F. Base Rep. #TSEAA-694-12A, 1947
2. Blum LL: Safety factors of anesthesia equipment and the components of man–machine interface (Introduction into ergonomics). Proc III, Europ Congr Anesth, Prague, 1970 (in publication)
3. Kendler HH: Basic Psychology. Design of Controls. New York, Appleton–Century–Crofts, 1963 p 653

Obstetrics

VASOPRESSORS IN OBSTETRICS Metaraminol was used to correct spinal hypotension in eleven pregnant ewes near term. Uterine blood flow, which had decreased 45 per cent, was returned to within 10 per cent of control values by metaraminol. Infusion of the drug improved fetal P_{O_2} and P_{CO_2} slightly, indicating better placental perfusion, but did not check progressive metabolic acidosis of the fetus as reflected by continued declines in fetal *p*H and base excess. Metaraminol ranks between ephedrine and methoxamine in its effectiveness in correcting fetal deterioration due to spinal hypotension. (*Shnider, S., DeLorimier, A., and Steffenson, J.: Vasopressors in Obstetrics. III. Fetal Effects of Metaraminol Infusion during Obstetric Spinal Hypotension, Amer. J. Obstet. Gynec. 108: 1017 (Dec.) 1970.*)

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