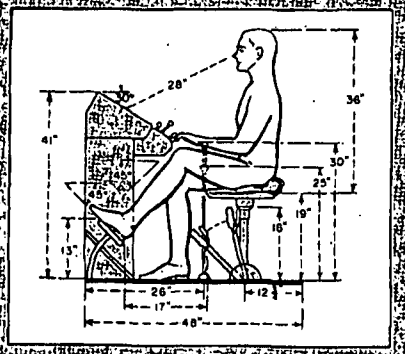
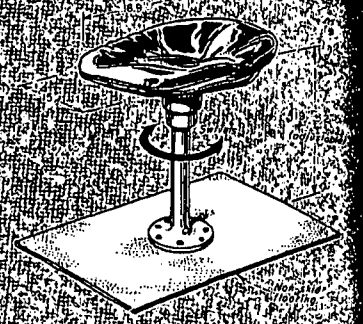
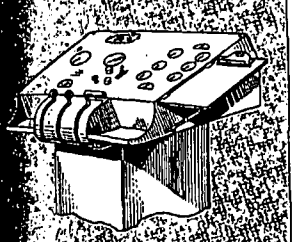
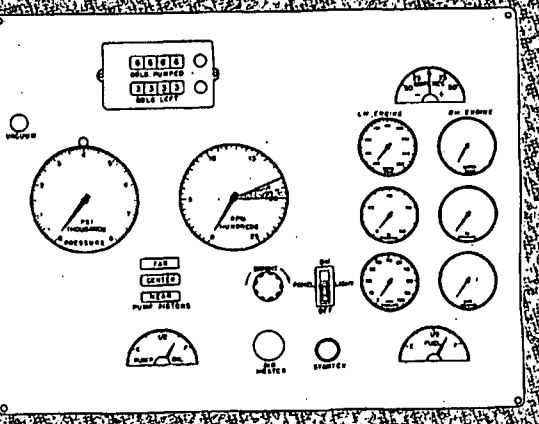




1 Centralizing controls and instruments at operating station contributes to equipment safety and operator comfort

2 Adequate seating for the operator working long periods is most often overlooked, must be a properly designed unit





3 Operator's console provides easy reading of instruments, view of work area

4 Instrument panel groups instruments in logical order, gives prominence to most important indicators. Dial faces and layout utilize human engineering principles

HUMAN ENGINEERING—An Aid to Instrument and Control Design

How effective are your arrangements for control panels and control room? This question, often causing heated arguments among plant designers, can be settled by objective tests, devised and run by industrial psychologists—'human' engineers

By DR B J COVNER, *Dunlap and Associates, Inc*

► TECHNICAL DEVELOPMENTS are changing our way of life. In factories we see trends toward automation of both manufacturing and clerical operations. Laboratories and industries make greater use of high-speed computing equipment. Airplanes fly faster and operate during weather conditions that grounded them only a decade or so ago. Power plants produce increasingly large amounts of energy with better and better reliability of service. Household chores have been *lightened by mechanization and electrification.*

A common denominator of all these developments is the more complicated machinery needed to do a job formerly done by man. The benefits depend on the ability of man to operate and control the machines. Unfortunately, unlike the machine, the human being has not been improving in basic ability. His capacities and limitations are about the same as they were thousands of years ago. When man remains an essential part of a mechanical system he becomes a stumbling block unless the system conforms to his limitations.

Human engineering, a composite science drawing from psychology, physiology, anthropology and engineering, aims to fit a mechanical system to man's ability. It is concerned with design of products, equipment, work-place layouts, and work processes, for optimum simplicity, ease, safety, and comfort of operation and maintenance, as well as optimum cost, value and investment.

These problems are neither new nor the private domain of the "human" engineer. Engineering managers must make decisions on them every day. The human-engineering specialist can develop additional data that will influence such decisions.

Control station. To show how the human engineer works in fitting a machine to the man, let's review what was done for a special type of pumping unit. This unit, mounted on a truck, pumps a sand and oil mixture at high pressures into oil wells to increase the porosity of the oil-bearing formation. To prevent damage to the well and to the unit itself, the operator must be alert constantly to the changing conditions. The unit runs 24 hours a day under virtually all weather conditions.

In the original design the instruments and controls were arranged so the operator was forced to stand in awkward positions and turn around 180 degrees in doing his work. About 20% of the time he had to divert his attention from important operating instruments. To minimize these conditions the controls and instruments were centralized, Fig. 1 to 4. While this is not a new idea, centralization still awaits application in many work situations. To design a centralized control station, without creating new problems for the operator or excessive costs for the manufacturer, presents quite a challenge.

In this control station the throttles, clutches and shift levers are grouped so the operator uses them without changing his position or taking his eyes off the main pressure gage. The seat is an important feature of the station. It is padded, adjustable in height and fully rotatable. The dimensions are based on anthropometric measurements of male adults. It is amazing how often adequate seating is omitted from work places. In many instances an operator controlling a million dollars worth of equipment will be provided with the crudest sort of hard, nonadjustable seat.

Nonskid flooring, Fig. 2, perforated for drainage of oil, mud and water, contributes to personnel safety. The operator is placed so that blowing heads or gaskets cannot hit him. Making the main pressure gage a relay, rather than a direct-reading gage carrying high-pressure fluid internally, reduces hazard to the operator. A detachable canopy and side curtains contribute to safety during inclement weather. This is often overlooked with equipment used outdoors.

Fig. 3 shows the operator's instrument console. The collapsible writing surface at the right edge facilitates keeping records. Control switch and knob are kept close to the associated instruments. The over-all tilt allows wide visibility without obstructing background objects or personnel.

Fig. 4 shows the instrument panel. Pump performance indicators are grouped at the left, engine instruments at the right. Features of the panel are: (1) pressure gage and tachometer in most prominent position (2) uniform zero position of all instruments (3) horizontal, rather than radial or tangential orientation of instrument letters and numerals (4) clockwise increase of *all* numbers and moving pointers (5) scales in units of five where practical, otherwise in units 10, 50, 100 (6) dial pointers of same or narrower width than markings, and not overlapping markings (7) all indicators clearly labeled (8) dial lettering with stroke length to width ratio of 6:1, height to width ratio of 1:1 (9) edge lighting to eliminate glare and hot spots, to increase legibility and to decrease operator fatigue and eye strain (10) rheostat to permit brightness control from 0.5 to 5.0 foot-lamberts on the dial faces as needed.

Instrument Panel. Another illustration of the services the human engineer can perform centers on Fig. 5 and 6. These rather simple electrical-distribution panels are used by an operator who has many other duties to perform, and has very little opportunity for practice. Results of incorrect operation would be serious, even though the number of actions at the panel would be few. The operator literally has to watch this panel out of the *corner* of one eye.

Certain limitations were evident in the old model, Fig. 5, so the owner requested proposals from different manufacturers based on Fig. 6. Some manufacturers proposed including a graphic feature consisting of transilluminated plastic strips connecting meter, light, switch and control knobs for each generator. They claimed that operating advantages more than compensated for the added cost. Other manufacturers claimed the opposite. Who was right?

The owner engaged a human-engi-