ADOLESCENT DISCIPLINE

Engineering the body

Television commercials that show a sick man's liver and lights as just so much plumbing have a valid scientific base. Researchers who look on human beings as if they were simply mechanical systems are discovering important treatments for various illnesses.

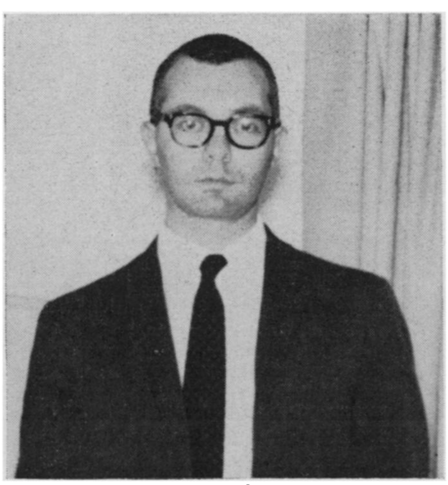
Biomedical engineers, pioneers in an adolescent discipline, are approaching the body as an integrated system that is best described according to such principles as negative feedback, thermodynamics and transport phenomena.

A heart drug, for example, affects not a single piece of tissue but the entire, dynamic cardiovascular transport system. Biomedical engineers want to know about that system at work, responding to stress and strain.

Determining potassium levels in isolated bits of kidney tissue, while a traditional type of physiological research, they declare, tells little about how the renal system operates. They want to find out, so they are approaching physiology with the tools and laws of physicists, mathematicians and engineers.

"The computer," remarks Dr. David Rutstein of Harvard Medical School, "will do to medical researchers what the printing press did to medieval monks who passed their days illuminating manuscripts. It will force them out of their monastic role and bring them face-to-face with the challenge of technology."

Meeting under the auspices of the National Academy of Engineering, biomedical engineers who gathered in Washington at the end of last month stressed their view of medicine as a service industry, insisting that if health care and medical research are going to cope with the future, doctors and engineers will have to pool their talents.



Case Western Reserve

Gann: Look to mathematical models.

Engineering beachheads must be established in medical and health care institutions, they assert. This must be done not just to deal with problems of computerizing patient care, but to lead the way in revamping biological research. The body, they say, must be approached as a whole rather than a combination of parts.

Physiological systems are too complicated to be analyzed without the aid of a computer; the sheer bulk of data accumulated from series of experiments on animals can at times be almost impossible to put in order. A mathematical model, designed to both describe and predict behavior of a living system, may offer solutions, according to Dr. Donald Gann, director of biomedical engineering at Case Western Reserve University in Cleveland. The approach is through systems analysis, in which mathematical models of systems are built, and the effects of certain stimuli upon their behavior are calculated.

Homeostasis is a case in point. The underlying premise of homeostasis is that certain physiological features, such as body temperature, blood volume and blood sugar, are always maintained within quite narrow limits by intricate mechanisms or subsystems. For example, exposure to cold increases sympathetic nervous activity to limit blood flow through the skin and to increase secretion of thyroid hormone which in turn speeds metabolism. Both actions limit the drop in body temperature.

Similarly, if one mechanism acts to reduce the body's volume of fluid, another mechanism comes into play to restore it. But the same subsystems that control blood volume also control blood sugar levels, so that, in the process of restoring blood volume, blood sugar goes up. This calls the insulin system into play to lower it again.

Verbal description of such complex interactions, Dr. Gann says, are too cumbersome and imprecise to be useful to research. Hence the promise of engineering approaches which find an engineering analogue to a biological system.

The combination of medical and engineering science also promises new, nonnarcotic relief for chronic pain. Terminal cancer patients and severely burned children who require anesthesia during daily bandage changes, will be among beneficiaries of research reported by Dr. M. Judah Folkman of Harvard University.

In animal studies he has shown that anesthetics, particularly one called Penthrane, efficiently pass through silicone rubber tubes by osmosis, enter the blood in small doses and relieve pain without inducing sleep.

In human beings a silicone tube could be inserted in the wrist much as it is now in kidney patients who undergo dialysis. An anesthetic gas, put into the tube as needed, would permeate the tube wall and enter the blood.

The advantage of such a method, Dr. Folkman points out, is that the same dose of anesthetic delivers the same degree of pain relief time after time, and is not addictive as are narcotics. An engineering firm, the Abcor Company in Boston, is working with him to perfect the design of the tubes.

SCORPION

Fragments at 10,000 feet

Navy

The sea floor by Mizar's camera.

If the ocean's surface is a trackless wilderness, its depths are a jungle, lightless and unexplored. In those depths, at a spot some 400 miles southwest of the Azores, the U.S. Navy's oceanographic ship Mizar has photographed debris on the ocean bottom that the Navy believes to be fragments of the Scorpion. The nuclear submarine was last heard from on May 21 (SN: 6/15, p. 565) as she was under way to Norfolk.

The location of the wreckage seems to rule out one suggested cause of the disaster—collisions with a seamount. With submarines now going down thousands of feet the danger of their hitting uncharted heights is a worry.

Mizar has been in the search since it began May 27. She has been searching Scorpion's possible track, and had she not found this debris, would have continued, after a pause during bad winter weather, all the way across the ocean, possibly for another 30 months.

The technique is to crisscross the area dragging a submerged sled that