

## 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

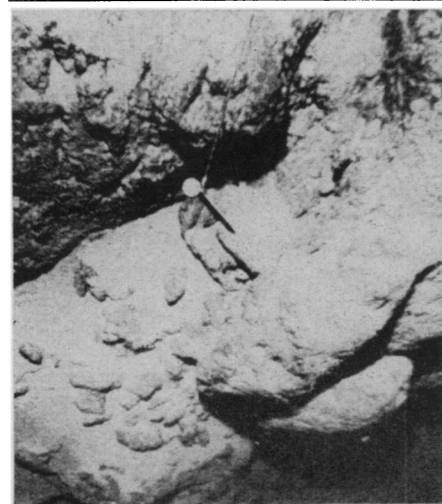
Penthrane, efficiently pass through silicone rubber tubes by osmosis, enter the blood in small doses and relieve pain without inducing sleep.

**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

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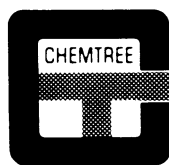
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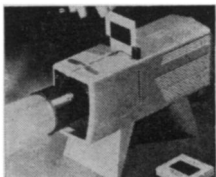
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rides about 25 or 30 feet off the ocean floor. The sled carries magnetometers and sonars, to identify metallic objects, and cameras to photograph whatever is found.

The supposed Scorpion fragments were found and photographed in about 10,000 feet of water, well below the depth at which pressure would have crushed the submarine.

The initial photographs from Mizar have been flown to the United States. Navy spokesmen say they will be analyzed to determine exactly what they do show and then turned over to the official board investigating the cause of the disaster; the board has been reconvened at Norfolk in light of the findings. After the board has examined the pictures for evidence, security considerations

will determine whether they will be released to the public.

Security reasons also preclude publication of the exact location of the wreck, at least while there is still something to be found there.

**The next step** in the Scorpion search will be to send down a deep diving submersible, probably the Trieste, in an effort to bring up some of the fragments. The Navy has under development free deep submersibles that can cruise at great depths to perform search and rescue missions, but they have been having budget trouble. The general technique is therefore still what it has been for many years past: trawling with instruments and then dropping a deep diving capsule to fetch up what is found

**OVERDONE**

**Diet drugs accused in court test**

Vera Ashley, a 36-year-old Maryland housewife, drove her daughter to school on May 25, 1964. On the way home she suddenly slumped over the wheel of the car and died. Her death has been blamed, in court, on diet pills.

Mrs. Ashley's doctors, Charles J. Savarese and Wilfred H. Ehrmantraut, are charged with malpractice—giving her overstrong doses of an obesity drug that has since been taken off the market. The trial, which may last as long as four weeks, is believed to be the first civil suit involving the controversial pills. Mrs. Ashley's estate is suing for \$1.5 million in damages on behalf of her two surviving children.

Mrs. Ashley, who was five feet four inches tall and once weighed 202 pounds, reportedly wanted to lose weight to win back her estranged husband. Her doctors prescribed Neo-Barine, a potent drug containing a thyroid hormone called thyroxin.

**Excessive doses**, her estate's lawyers claim, caused a condition known as thyrotoxicosis which led to heart failure.

Attorneys, and some medical witnesses, for Drs. Savarese and Ehrmantraut dispute the cause of death, laying it to a virus.

Regardless of the outcome of this case, researchers present strong evidence condemning weight-losing pills laden with thyroid hormones and other potent agents including digitalis, a heart drug, diuretics for loss of fluids, and laxatives.

In the United States some 5,000 doctors engaged exclusively in treating the obese, prescribing, and often selling, at least \$60 million worth of brightly colored pills a year.

The consensus of the medical profession, voiced by the American Medical Association, is that pills won't work,

and may kill you. At least 60 deaths have been attributed to diet pills, though the figure may be staggeringly higher.

**As a result**, this year, Senator Philip Hart (D-Mich.), introduced a bill forbidding physicians to sell what they prescribe. It died in this session of Congress but will be reintroduced next year.

Thyroid hormones supposedly cause weight loss by speeding the body's metabolism, so that food is burned up rapidly. But, says Dr. Harry C. Shirkey of Samford University, Birmingham, Ala., they often simply increase appetite, inducing an even greater food intake than before. The hormones, in effect, stoke a furnace for which the body is the fuel, and dangerously stimulate the heart.

**Digitalis**, another diet drug, is designed for heart patients. One of the early effects of toxic doses is loss of appetite. A later effect is death. Though used in small doses in diet pills (30 milligrams of digitalis leaf), it is notorious for its tendency to accumulate in the body—a likely probability for fat patients who take pills indiscriminately.

Diuretics, physicians argue, should be given only to persons with kidney disease or other diseases associated with high fluid retention. Fat patients, they say, seldom just have too much water in their bodies. Likewise, there is no rational basis for use of laxatives in diet pills. "Obviously," Dr. Shirkey says, "it is not difficult to administer enough laxative to hasten the passage of ingested foods through the gastrointestinal canal so that most of it is not absorbed." But, he points out, vitamins and essential body chemicals are lost as well as weight. The result: a thinner person with metabolic disturbances.