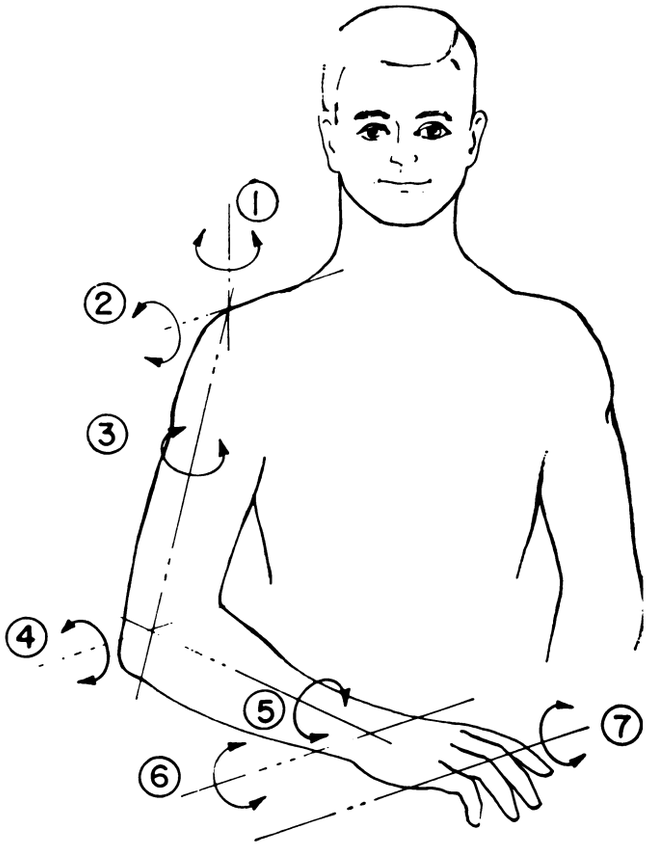
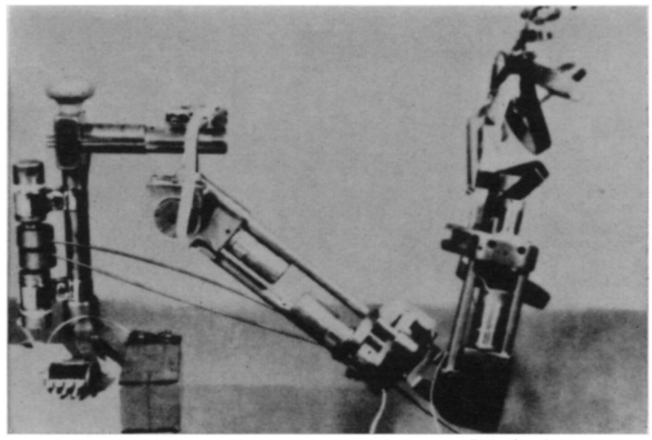


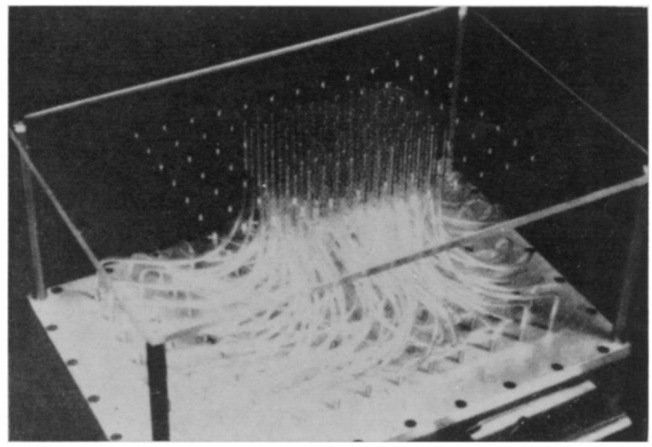
Rancho Los Amigos

All of the arm motions a mechanical arm can perform.



Rancho Los Amigos

A manipulator to be used in the NASA/AEC humanoid.



Stanford University

Magnified tactile device that fits on a human finger.

Homo mechanicus

Created by man in his own likeness, the humanoid sets the stage for the robot

by Edward Gross

Since 1923, when the Czech, Karel Capek, introduced the word robot to the world in his play "Rossum's Universal Robots," the idea has come to represent the last stage in a mechanical evolutionary process that started in the industrial revolution and has reached the point of automation. Created by man in his own image, a perfect robot would obey every command, automatically relieving man of tasks menial and burdens impossible.

But if automation is the latest step and a thinking robot the ultimate goal, a stage between the two is the humanoid.

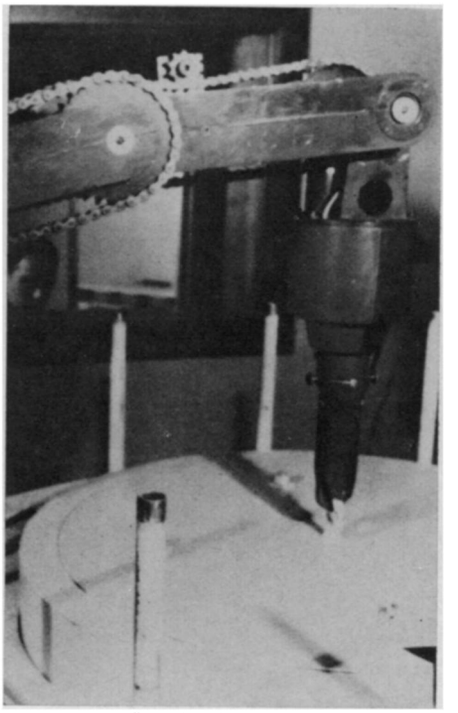
Human in form, these creatures, even when completed, will not be ready for true robothood in the fullest sense of the word because man will still be at their controls. But there will be an intermediary: a computer. That intermediary makes the humanoid different from the now-common remote manipulator.

The first humanoid will be finished in early 1969 in a joint project by the Atomic Energy Commission and the National Aeronautics and Space Administration. This humanoid, a term applied by Edwin G. Johnsen, chief of the equipment and facilities branch of the space nuclear propulsion office of the AEC and NASA, is designed for work in extreme or dangerous environments. The humanoid, christened SAM (Self-propelled Anthropomorphic Manipulator), is equipped with artificial arms, TV camera and sound pickup and is intended to retrieve highly radioactive materials and rescue people in a contaminated area. Mounted on a flat-bed vehicle, it uses a teletype machine for communication between man and its computer and is steered and controlled by microwave radio. Laser guidance, which will transmit more information in a tighter package, is contemplated for later.

The Navy is also considering using a humanoid to disarm explosives. Among other applications are the testing of rockets during operation and the initial exploration of a planet. Case Western Reserve University is trying to work out techniques for these so-called teleoperators to disassemble a nuclear reactor core, which is made up of thousands of individual fuel elements.

A humanoid's justification is its ability to improve man's senses, or add new ones, and then do his bidding. Its human features allow the operator to identify with it and thereby operate it more easily. It can be built to see via television, detect heat through thermal sensors, feel shape with tactile devices and transmit these sensations to the operator. Humanoids exceed humans in ultraviolet and infrared sensitivity and

. . . robots and computers



Case Western Reserve University

Computer-controlled arm at work.

in magnifying images, areas where people have been shortchanged. Thus humanoids augment and extend man. The speed and precision of their responses is also superior to man's.

The major problem still to be overcome in humanoid development is communication: communication between the operator and the computer and between the computer and the humanoid. In each case—human, computer and humanoid—a different language is spoken (verbal, mathematical and electrical), which requires translation.

At the University of Santa Clara, Dr. Richard Dorf and his group are devising a man-computer language to avoid the lengthy teletype method SAM requires. They hope ultimately to resolve the communication problem to the simple pushing of a button. This group is also working on a way to predict where a humanoid teleoperator will be if it maintains a course, and get this information to the operator.

Man usually tells where and when, while the computer handles the how. Dr. Dorf is concerned with how much of the where and when can be turned over to the computer.

Dr. Dorf, however, feels that we're still a long way off from the robot takeover envisioned by Capek in his play. "Our work is still embryonic," he says. "Robots are not even rolling, much less taking over."

The reason for putting man in the picture at all is that he is still better than any machine in goal seeking, de-

cision making, pattern recognition and adapting to new situations—another way of saying that the creation of artificial intelligence is not advanced enough to bring computers up to man's level.

Researchers at Stanford University and the Massachusetts Institute of Technology, however, are working on this problem too; they are looking beyond humanoids to the robot. Both research groups have a TV-arm apparatus advanced to where it can recognize three-dimensional objects, some of them partially obscured, and sort them out according to size. Next to recognizing different objects, the most difficult problem is deciding on the order of doing things, a crucial matter in assembly work.

In their artificial intelligence research, Dr. Charles Rosen's group at the Stanford Research Institute is dealing with the added problem of mobility. The researchers there are developing a computer program to enable a wheeled automaton to perceive the real world and move about in it while planning and executing tasks.

The development of future teleoperators depends on major technical advances. One such advance is the development of digital computers with large capacity disk-type memories enabling the teleoperator to use a number of tools simultaneously. Theoretically, 20 humanoids could work out of one computer, although in actuality the number would be less. Add to this the simultaneous use of tools, and a tremendous increase in work efficiency is possible.

Thus, because of the computer, humanoids are a radical breakthrough in machine operations. Because the computer enables a man to control and direct more than one teleoperator, he is actually multiplying rather than merely extending himself.

Another advance requiring further development is in the area of sensor devices that feed back information about the weight, strength, appearance, heat, size and texture of objects—an area being developed for all kinds of remote manipulating systems (SN: 3/9/68, p. 238). Still another area is in advanced guidance and control systems to keep a teleoperator hovering in a stationary position or guide it around obstacles.

For a while to come, then, humanoids will be the big thing in teleoperator equipment because they are halfway between totally automated machines and totally independent robots.

Ultimately, however, in the engineers' great scheme of mechanical evolution, the humanoid will be phased out for The Compleat Robot. ◇