TECHNOLOGY

Impact of declining R&D investment

Investment in research and development, adjusted for inflation, has been declining in the United States since 1968 and the National Science Foundation recently predicted that such expenditures will take a progressively smaller share of the gross national product in the future (SN: 10/30/76, p. 278). What the impact may be was spelled out by General Electric Vice President Thomas A. Vanderslice in a talk to the Executives Club of Chicago.

Reduced Federal spending for R&D has hit universities the hardest, he says, which may mean a shortage of technically trained professionals in the future. Already the proportion of scientists, relative to the population, has been decreasing since the late 1960s in the United States—the only major industrial nation experiencing such a decline.

As America's competitive position is thus weakened, the biggest crunch may come in unemployment. The U.S. trade balance for products with low technical content shows a $16 billion annual deficit, while the balance for high-technology products shows a $25 billion annual surplus. "High technology companies appear to have a growth rate about double that of low technology companies and create jobs five times as fast," Vanderslice says, and within the next decade 18 million new jobs must be created.

Fins and mucus for boats?

One of the things ship designers talk about when they're "brainstorming" is how to make boats more like fish. As nautical vehicles, fish have two advantages never successfully duplicated by man: a coating of mucus that cuts down on drag, and fins, which are more efficient (properly used) than paddle-wheels or screw propellers.

For years scientists have experimented with slippery substances, like polyethylene oxide, to reduce drag. Power-devouring eddies are caught up in the long molecule threads and thus suppressed. But such nonadhesive, artificial slimes need to be constantly replenished.

Now researchers at Berlin Technical University's Institute of Measuring and Control Technology have found that fish mucus does not require constant replenishing through secretion. By studying the composition of adhesive mucus from a variety of fish, they hope to develop an artificial one for ships.

The Berlin scientists are also trying to develop a small, economical electric boat driven by fins. The main problem at present is to discover the best form and degree of elasticity for an artificial fin.

Solid photography

The newsletter INSIDE R&D of Sept. 22 reports that the Dynell Electronic Corp. of Melville, N.Y., is developing a system that will reproduce solid objects in three-dimensional form. By next year the company hopes to open a demonstration studio to produce busts of human heads quickly and cheaply.

The process involves taking a series of pictures with multiple cameras and masks, which produce a set of profiles that are converted to digital data and fed into a computer. The computer then drives cutting equipment that successively chisels out a series of planar sections, which are stacked to reproduce the original object.

In a related technique, the *appearance* of three dimensionality can be produced with a flat picture by passing transparent elements rapidly in front of it. These elements have varying thicknesses and act as lenses to make parts of the picture appear nearer or farther away.

SPACE SCIENCES

Closed ecology tested for space

Permanent colonies in space, earth-orbiting stations and manned flights to other planets all are possible applications for life-support systems that function as closed ecologies, providing air, water and food through a variety of mutually dependent biological systems. A recent Soviet test sustained three people for six months in a system that provided oxygen by recovery from atmospheric carbon dioxide, water from "photosynthetic regenerative process" and included the production of "a certain amount of grain and vegetables." The result, according to I.I. Gitelson and colleagues from the Soviet Academy of Sciences, "established beyond question that a small, steadily operating, essentially closed system of 'substance-turnover' involving man is quite feasible."

The experimental system, described at the recent annual meeting of the International Astronautical Federation in Anaheim, Calif., provided primarily "traditional food which was obtained in the nontraditional way." A problem in the actual application of such closed systems, according to the authors, is to provide "nontraditional foods," such as certain higher plant species not commonly used as food and biosynthetic products of unicellular organisms, which are better optimized for efficient ecosystems of finite size. All known food ingredients can be reproduced by microbial synthesis, the authors maintain, but not all of the results can be properly digested, due to the limited ability of human intestinal systems to hydrolize the peptide bonds. But research into this limitation, they suggest, may enable products of microbial synthesis to be added to the closed-ecosystem diet.

Another problem for future study is that a small, closed ecosystem is far more susceptible than a large, natural one to instabilities induced either by genetic changes in the main links of the system due to mutation and selection processes or externally by invasion of foreign elements that alter the biosynthetic processes. Also, the researchers point out, "division of accompanying microbial flora and viruses may greatly contribute to destabilization of the system. Experiments lasting to six months did not show any significant changes in the test environment caused by bacterial infection, but a balance of accompanying microbial flora was not achieved either."

There are many other problems to be overcome, such as protecting the system from contamination by waste products, but, the authors aver, the answers are worth pursuing for earthbound as well as outer-space purposes. They may well become critically relevant, in fact, if they can contribute to the protection of the terrestrial ecosystem from its dominant inhabitants' own industrial wastes.

Scooping space fuel from the air

The proposed project of building a network of large, power-generating satellites in orbit would be a formidable task indeed, spanning several decades and involving numerous construction operations in space. An economical way of providing fuel for the vast project, according to Rudolf H. Reichel of Analytical Methods, Inc., in Bellevue, Wash., might be to simply scoop it up from the atmosphere using a series of huge, orbiting cones. The cones, 35 meters long and 10 meters in diameter, would collect the air and store it primarily as liquid oxygen and nitrogen for transfer by another vehicle to the construction sites in higher orbits.

The transfer tanker would use some of the liquid oxygen as its own propellant, while ferrying the rest to a larger propellant-storage "farm." Tugs would then transfer the fuel for other uses, including sending the completed satellites out to their final, geosynchronous orbits.