include objects in different stages of evolution." (Halley is considered a much "fresher" comet, having made fewer trips around the sun.)

It would be possible to accomplish many of the dual mission's objectives with two separately launched spacecraft, said Cornell's Joseph Veverka, who headed the NASA Comet Science Working Group, but "there is no justifiable reason for choosing such an approach. It offers no technical or scientific advantage. It does delay the expenditure of $15 million in FY 1981 funds [a revision of NASA's $20 million request], but ... we will have escalated the cost of carrying out the desired comet exploration program by at least $250 million." Existing approximate figures suggest that about $200 million of this would be for the second spacecraft, $40 million for its launching by the shuttle and $10 million for an additional upper-stage booster engine.

It is quite possible, Cameron and Veverka both believe, that NASA could start the development of SEPS with less than its initial $20 million request. A still more constraining option open to Congress would be to approve a budget bill giving NASA the option of reprograming some of its existing funds — if it could spare any. Next week, similar issues are likely to reemerge at a hearing on the Senate side.

The dual-comet mission, however, may face other problems as well. On the flight past Halley, the spacecraft is to jettison a probe that would go all the way to Halley's nucleus, but some sources are now worried that the European Space Agency, which was to have built the probe, may be about to back out of the deal in the face of the overall mission uncertainty. More recently, on the other hand, there have been signs that an individual European country may take on the job. But even if SEPS and the probe survive, NASA will next year have to battle for funds for the main mission spacecraft itself. □

The space race in manufacturing

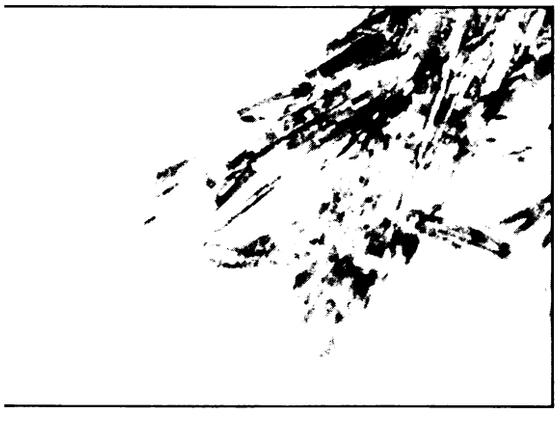
The Space Race once referred to the competition for getting something — anything — from the earth into orbit around it. It meant sending animals, then humans, then being first to the moon, and more recently it has covered orbiting weapons and the scientific prizes of planetary space probes. Already underway, however, are the preliminary heats of a race for yet another prize: the economic, technological and political gains from manufacturing in space. Whether the ultimate goals be space colonies, solar power satellites, better microcircuits or medical advances, the contestants are on their way. But the Comptroller General of the United States has just warned, in a report to the Senate Subcommittee on Science, Technology and Space, that America is already starting to look a bit winded.

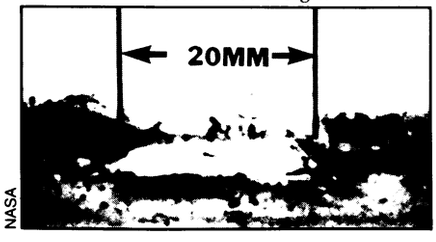
After consulting "nearly 100 scientists, program managers, economists, industrialists and government officials ... in this country and in Europe," the report concludes that "only limited success can be expected in the next 20 years due to low funding and limited backing by the Administration and the Congress."

The report identifies four central problem areas:

- A need for greater U.S. industry participation, currently hobbled by such issues as government restrictions on the use of government-held patents.
- Technology transfer to the private sector, for which present programs must be revamped to emphasize commercial potential.
- Basic research in materials science, which will require greater government investment if industry is later to consider high, long-term investment. "Current funding levels," says the report, "assure very slow progress."
- International cooperation. "The U.S.' conservative approach does not compare favorably to the specific, long-term plans of ... the European Space Agency ... nor to the plans of the Soviet Union and Japan."

"Whether the United States is to maintain its world leadership role in materials science as well as other areas of space development depends largely upon events of the next 15 to 20 years," the document notes. "The opportunity to be the world leader in space is still available if we choose to exercise this option." □





NASA

Future space products could include large semiconductors such as the GeS crystal (below), made on Skylab, compared to earth-bound versions one-eighth its size.

Nuclear waste policy unveiled by Carter

Admitting that "past governmental efforts to manage radioactive wastes have not been technically adequate," President Jimmy Carter outlined for Congress on Tuesday Feb. 12 his plans for the nation's first "comprehensive" radioactive-waste management program. Born out of recommendations by a 14-agency federal review group (SN: 3/24/79, p. 183), the plan seeks generic solutions for the permanent disposal of all types of wastes from all types of sources. A draft of the plan detailing specific goals, research programs and timetables should be available for public and congressional review by year's end.

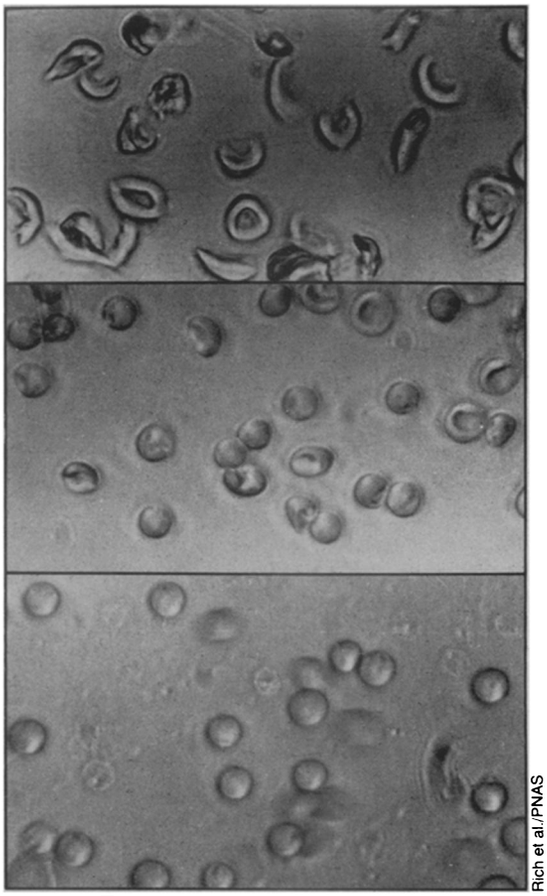
Among the more controversial aspects of the Carter proposal is termination of WIPP — the Waste Isolation Pilot Plant (SN: 7/21/79, p. 47) that was to have housed high-level radioactive transuranic wastes generated by the Defense Department. Though WIPP's underground salt caverns in Carlsbad, N.M., may provide adequate safety, its military role would have made it exempt from licensing requirements set by the Nuclear Regulatory Commission — something the President says runs counter to his policy. The Carlsbad site will remain a candidate, however, along with 10 or more others as a possible dump for high-level commercial wastes.

And in an attempt to stem growing local opposition to proposed waste sites, Carter has established a State Planning Council. It will permit local input on siting, licensing and management issues via a 14-member advisory panel to Congress and the Executive Department. □

Benzyl esters as a desickling drug

The crisis in sickle cell anemia arises when a person's abnormal hemoglobin molecules take on a sickled shape after giving up oxygen to tissues. As a result, the red blood cells housing the hemoglobin molecules become sickled as well and clog blood vessels, causing excruciating pain and tissue damage. There are several tactics one can take to prevent such crises: Keep hemoglobin molecules from sickling, keep red blood cells from sickling, or both. The problem is to find an antisickling drug, particularly one that attacks at the molecular level, which has minimal toxicity for the rest of the body and which is easy and inexpensive to give. Now a class of compounds called benzyl esters of amino acids looks as if it might fulfill these requirements at least on the basis of test-tube and animal studies.

In 1977, Alexander Rich of Massachusetts Institute of Technology in Cambridge, Mass., and his colleagues



Rich et al./PNAS

Top to bottom: sickle cells; normal cells; cells treated with benzyl esters.

found that if they put certain small proteins (peptides) into red blood cells from sickle cell patients, the peptides would keep the red blood cells from sickling. But it took fairly heavy concentrations of peptides to penetrate red blood cells. Rich and his colleagues have since tested derivatives of the peptides and found them to be just as effective as the peptides but able to get into red blood cells easier. They report in the January PROCEEDINGS OF THE NATIONAL ACADEMY OF SCIENCES that peptide derivatives called amino acid benzyl esters do the trick nicely — apparently by binding to sickled hemoglobin molecules, by modifying the membranes of sickled red cells, or both.

After Rich and his co-workers determined that amino acid benzyl esters were able to prevent sickling of sickle cell patients' red cells, they compared the ability of various esters to produce the effect. They found that esters from amino acids with a high degree of hydrophobicity (aversion to water) were especially potent. They tested the esters on normal red blood cells' membranes to make sure that the esters did not damage them. Then they injected one of the most promising esters into mice and, as they hoped, it showed low toxicity. On the basis of all this data, they concluded: "Benzyl esters of hydrophobic amino acids and related compounds may prove to be useful in the treatment of sickle cell disease." □

R(3.17) or the color chemistry of quarks

Once upon a time the quark theory seemed like a fairly simple way of explaining the properties of nearly all the subatomic particles of physics. The particles were divided into two broad classes, the baryons, which are made of three quarks, and the mesons, which are made of two. Three varieties or "flavors" of quark, called up, down and strange, managed to serve to constitute all the particles known in various permutations.

Nothing in life stays simple. Theorists now see a need for six flavors of quark — charm, bottom and top have been added. This introduces new physical properties and increases the number of possible quark permutations. But until now the dual classification into baryons and mesons had held. Nobody had seen a single particle that had more than three quarks in it.

Evidence for just such a thing, a five-quark particle, may now have been found at the CERN laboratory in Geneva, according to a report at the recent meeting of the American Physical Society by Gerald A. Smith of Michigan State University. The finding was by a collaboration of physicists from Michigan State, the Universities of Birmingham, Cambridge, Glasgow and Paris, and CERN.

One of the recent complexities of quark theory is the attempt to study the behavior of quarks and their interrelationships inside particles. In such a quark dynamic study, one in which K mesons (a strange and an up quark) were struck against protons (two ups and a down), a particle appeared that gave indications of containing three strange quarks. Ordinary quark theory does not permit that combination.

A possible explanation of this unusual particle, which is being tentatively called R(3.17) is a "three-baryon resonance," a fleeting state in which three baryons are very temporarily stuck together. Its mass, 3.17 billion electron-volts, goes well with that supposition. The more exciting explanation is that the R(3.17) is a five-quark baryon, precursor of a whole new genus. Five-quark baryons (they have as yet no more distinctive technical name) are not part of the ordinary quark theory but are predicted by an extension called color chemistry. (Color is the name of the force that holds quarks together.) This is "chemistry" because the geometry of the configurations formed by the quarks is important. Smith suggests that R(3.17) consists of "two distinct clusters of two and three quarks respectively connected as on the ends of a dumbbell and rotating about its center with high velocity," a direct analogy to a molecule. If R(3.17) is a five-quark baryon, others should begin to appear. □

Pot: Off the streets, into the drugstores

In a move reminiscent of a pre-game pep rally, the government met with pharmaceutical companies Jan. 18 to whip up enthusiasm for Delta-9-Tetrahydrocannabinol (THC), the active ingredient in marijuana. The government's rallying cheer? Take THC to the marketplace!

Since then the National Institute on Drug Abuse and the Food and Drug Administration have met a second time with one of ten companies that attended the January session and plan similar meetings with four other drug companies that also have shown interest in marketing THC. Although government-sponsored sessions on potentially marketable drugs are not unusual, the history behind THC and the fact that several pharmaceutical companies now have shown interest in developing it weave an interesting tale.

Before it became an illegal substance in the 1930s, marijuana had been used in a number of medical preparations. But it was not until a young cancer patient noticed less nausea and vomiting, a side-effect of chemotherapy, after smoking street marijuana that interest was revived in marijuana as medicine. Researchers applied to FDA for grants to investigate the anti-nausea phenomenon and began experimenting with NIDA-supplied THC. Scientists have also found THC to be an effective treatment for glaucoma and the spasms associated with multiple sclerosis.

Still, from an economic viewpoint, the three potential applications of THC comprise only a "small market," causing drug companies to think twice about the high-risk investment of developing THC, explains Edward Tocus, a pharmacologist for the FDA's bureau of drugs. Furthermore, "THC has a reputation that some companies just don't want to mess with," Tocus says, referring to the social stigma attached to marijuana. Also, drug companies traditionally have shunned THC because of the red tape and security involved in researching a Schedule I drug — a substance classified as having high abuse potential and no redeeming medical value. Other deterrents include marijuana's notorious euphoria, the problem of encapsulating the resinous, sticky THC and the fact that THC is unevenly absorbed by the body when taken orally. Finally, although marketing processes can be patented, THC as a composition of matter cannot be patented.

Despite THC's complicating attributes, Robert Willette, chief of NIDA's research technology branch, believes THC already has passed through enough flaming laboratory hoops. Stephen E. Sallan and coworkers of Sidney Farber Cancer Institute