Transition Budget: Steady Growth for R&D

President Ford left office this week after submitting to Congress an R&D budget that bore his personal mark—sharp increases for military-related programs and some real growth in basic research, following nearly a decade of decline. Although President Carter will now propose amendments to some items in the budget, no substantial changes are expected in the nonmilitary R&D portion.

The proposed budget authority for total federal spending on research and development in fiscal year 1978 is $28.0 billion, up from $25.9 billion in fiscal 1977. This federal support represents 54 percent of the nation's total R&D spending. Roughly two-thirds of the increase would go to defense-related R&D, which would total $13.1 billion for fiscal 1978.

Federal spending for basic research is proposed to rise from $2.785 billion to $3.041 billion—an increase of 3 percent in purchasing power, once a 6 percent rate of inflation is accounted for. The federal government accounts for nearly 70 percent of the nation's support of basic research, and the purchasing power of even the new budget will remain substantially below the 1967 peak level.

In theory, of course, all this could change as the new administration takes over, but a lack of time and the inflexibility of the budget will prevent all but a few key changes. More than three-quarters of the present federal budget is officially designated "relatively uncontrollable"—meaning that it has already been committed to paying off the national debt or to meeting obligations from previous budgets. Thus, out of a total federal budget of $440 billion for fiscal 1978, the change of administration is expected to result in a change of only $5 to $10 billion.

The civilian R&D portion of the budget seems particularly unassailable. Most budget items are simply continuations of long-range programs, and this year's new additions seem firmly based. Funding of research to predict earthquakes and mitigate their effects, for example, is scheduled to double—a recommendation based on the report of a presidential science advisory committee. The Department of Agriculture plans to launch a new program of competitive grants to bring more scientists into work on crop productivity. And the Department of Transportation hopes to substantially increase research aimed at using satellites to upgrade air traffic control over the North Atlantic. None of the items has raised political hackles.

Under the proposed budget, the stepped-up drive on earthquake prediction would be spearheaded by the National Science Foundation and the U.S. Geological Survey, with each agency directing independent portions of the program. Last minute adjustments prevented NSF from requesting quite as much budget authority as previously estimated (SN: 1/8/77, p. 21), but the agency should still receive a hefty $110 million increase for a total budget of $889 million, including funds for building new facilities. Another special thrust of NSF will be to upgrade instrumentation at various American laboratories, following reports that other countries are pulling ahead in this important, though arcane, area.

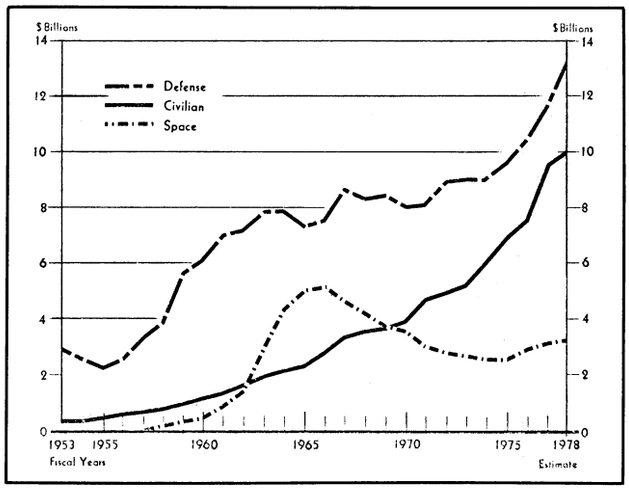
Support for basic research from the National Institutes of Health will decrease slightly after accounting for inflation. Cutbacks in general support to institutions will be matched with gains in support for specific research projects. These include funds for evaluation of potential carcinogens, development of safer technology for recombinant DNA experimentation, and training of 974 postdoctoral fellows.

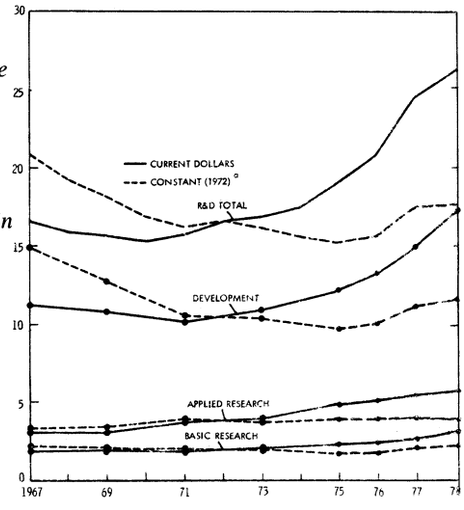
The Energy Research and Development Administration will continue to support high-energy physics, including upgrading the Bevalac facility at Lawrence Berkeley Laboratory and continuing construction of the positron-electron project (PEP) at Stanford. ERDA also proposes to develop nuclear power sources for future spacecraft.

What may happen to the military portion of the R&D budget remains uncertain, in view of President Carter's earlier opposition to some key elements, such as the B-1 bomber. A protracted fight in Congress now seems likely, and should center on the following items: The B-1 bomber, said to be capable of penetrating Soviet air defenses; the M-X intercontinental ballistic missile, designed to survive a nuclear attack and become a main-

R&D BY AGENCY (MILLIONS)

DEPARTMENT OR AGENCY	OBLIGATIONS 1977 estimate	1978 estimate
Defense—Military functions	11,132	12,317
Energy Research and Development Administration	3,610	4,064
National Aeronautics and Space Administration	3,800	3,833
Health, Education and Welfare	2,910	2,976
National Science Foundation	693	766
Agriculture	530	579
Interior	349	355
Transportation	367	359
Environmental Protection Agency	311	266
Commerce	247	250
Nuclear Regulatory Commission	122	148
Veterans Administration	116	118
Housing and Urban Development	55	60
Agency for International Development	27	42
Justice	45	36
Labor	35	36
Smithsonian	31	32
Tennessee Valley Authority	32	31
All other	49	54
Subtotal (conduct of R&D)	**24,461**	**26,322**
Subtotal (construction of facilities)	**1,455**	**1,636**
Total	**25,916**	**27,958**





Most federal agencies show increased R&D budgets for 1978 (table above). Military R&D still dominates federal research spending (chart at left). Most areas of R&D have fallen off since 1967, in terms of constant, uninflated dollars (dashed lines in chart at right), though current-dollar costs have risen steadily (solid lines).

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stay of defense in the 1980s; the versatile cruise missile, which can be launched from land, sea or air; the Trident submarine and its associated missiles, capable of longer range; and supersecret space-based systems.

One particularly puzzling aspect of the transition process for the scientific community has been the lack, so far, of a Carter appointee for science adviser. By law this adviser must be consulted on the R&D budget, so any amendments to the present proposals—including those involving military R&D—fall within his domain. Carter has promised to submit his list of budget amendments to Congress by Feb. 15, and he will be in an awkward position if those involving research were formulated without the science adviser's sanction. □

ERDA budget: From coal to fusion

Coal. Great long trains of it used to come down from the hills to the cities of the coastal and Great Lakes plains. It was and is the United States' most abundant fossil fuel, and as such it is first in the hearts and minds and the fiscal 1978 budget of the U.S. Energy Research and Development Administration, half a billion dollars worth of first.

In spite of the promise of alternate technologies, "new fuels" in ERDA's budgetese, ERDA believes that even when the millenium comes (in about 25 years) the United States will still depend heavily on fossil fuels for its energy needs. With natural gas getting scarce and OPEC pricing petroleum out of the market, that leaves coal. In fiscal 1978 ERDA is asking for authority to spend $598 million on fossil fuel research, an increase of 24 percent over 1977.

Most of this money will go for coal research, not a little of it to take the soot out, much of it for new ways of coal gasification. That too will bring a smile to those with memories because it was coal gas (not the increasingly scarce natural gas) that flowed through the pipes of the first gaslight companies. A more modern fossil option is seeking ways to get something burnable out of oil shale. In spite of recent grumbling that it will never get out of the ground, ERDA proposes to continue to research it.

Two of the more exotic new-fuel options, solar and geothermal energy, are also getting good licks. Solar heating and cooling research actually looks as if it's down 48 percent to a budget authority of $45 million, but that's because last year Congress gave ERDA $41 million extra for this item that the agency hasn't spent yet. Solar production of electricity used to be the cry of a few lonely professors harping in the wilderness. Now the wilderness (the Mojave Desert, specifically) is going to get a 10-megawatt-electric demonstration plant to be built in cooperation with the city of Los Angeles and Southern California Edison. Another item under the rubric "Solar electric and other" is research on crops grown for fuel, that is, forestry among other things. "Solar electric and other" asks for $260 million, an increase of 27 percent. Geothermal gets $88 million, a 60 percent increase.

A great deal of ERDA's interest is of course focused on nuclear fission, the one new technology that is already paying off. The biggest single item here is the liquid-metal fast breeder reactor program, for which $855 million is asked, a 25 percent increase. Of this, $230 million is to continue construction of the Clinch River breeder reactor in Tennessee.

An important question in fission operations is the fuel cycle: enriching fuel or breeding it, recycling it, and safely getting rid of waste. The authority request for this is $636 million, a 57 percent increase. A lot of the money is intended for development of new enrichment methods such as the centrifuge process. Waste management gets $125 million, and ERDA hopes to use it to demonstrate safe disposal technology by 1978 and have a demonstration repository in full operation by 1985.

Thermonuclear fusion is still in the experimental state and not expected to produce usable energy until after the turn of the millenium. For it, $513 million is asked, a 23 percent increase. The money will be used to pursue both of the promising approaches to controlled fusion, magnetic confinement and pellet implosion by laser light. Construction of new facilities of both kinds is envisioned, especially the Tokamak Fusion Test Reactor connected with Princeton University.

Last but not least comes basic research for which $385 million is asked, a 14 percent increase that should be pleasing after years during which Oliver Twist was hardly ever allowed to ask for more. There are two categories here, $198 million for environmental studies and $162 million for basic energy research. That last item includes the physics of subatomic particles, for which ERDA is the chief government sponsor. In that are two new major pieces of equipment: continuation of the Proton-Electron Project, a high-energy colliding beam facility at Stanford University, for which starting money was provided in fiscal 1977, and a start on a national synchrotron light facility. Synchrotron light, a high-energy, narrowly directed light produced by accelerated particles, is useful for probing many material structures both physical and biological.

Together with these specific items, administrative expenses and other categories of activity bring ERDA's total budget authority request for fiscal 1978 to $7.841 billion, an increase of $1.452 billion or 23 percent over fiscal 1977. □

NASA: New starts but no post-Viking

Four major new projects are included in the outgoing administration's proposed budget for the National Aeronautics and Space Administration, but conspicuously absent is any mission to follow up Project Viking in the 1981 "launch window" to Mars.

The requested $4.02 billion authorization, up about 7.9 percent from fiscal 1977, "continues the policy of fiscal restraint that has characterized NASA budgets in recent years," in the words of NASA Administrator James C. Fletcher. Nonetheless, it includes the following new programs:

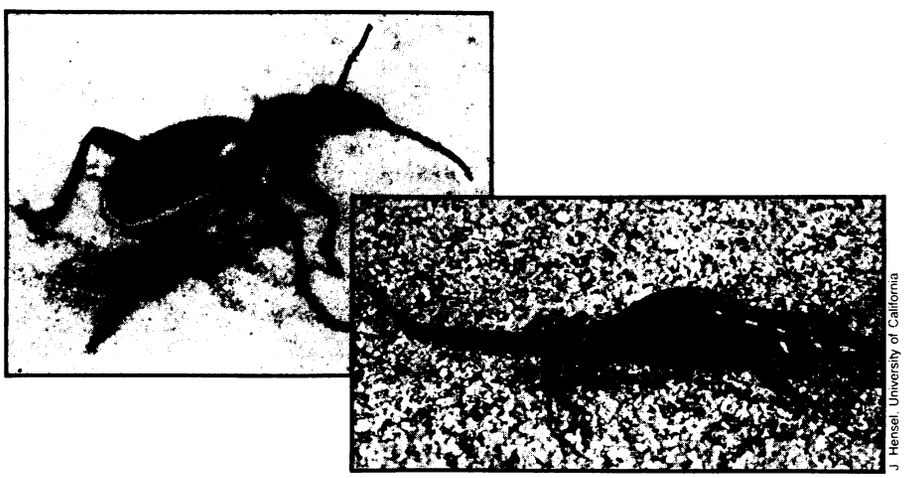
- The Space Telescope, which lost the adjective "large" from its title two years ago when cost-cutters trimmed its design from a 3.0-meter reflector to 2.4. To be left in orbit and periodically serviced by the space shuttle, the instrument promises, according to Fletcher, "a 350-fold increase in the volume of space accessible to astronomers." The off-again-on-again program was saved in part by belated support from the astronomical community.
- The Jupiter Orbiter and Probe (JOP), planned for a 1981 launching, designed to circle the planet for a year and send an instrumented capsule as deeply as possible into the Jovian atmosphere.
- Landsat D, fourth in the earth-resources monitoring series and first to embody a device now under development known as the Thematic Mapper, which will return data on selected surface features rather than just bulk multispectral information. Landsat D will also be the second satellite to be based on NASA's Multi-Mission Modular Spacecraft (MMMS) design, intended to cut costs by using standardized component modules that can be replaced from the space shuttle by simply unplugging them and plugging in new ones.
- A Search and Rescue Satellite System, to be developed in collaboration with the Canadian government and perhaps others, in which special transponders for air and sea distress messages will be merged with existing or planned satellites.

A proposed Lunar Polar Orbiter was trimmed from the funding request by the Office of Management and Budget; NASA hopes to start it next year. The deletion of a program to follow Viking in 1981, however, was a decision, says Fletcher, of both OMB and NASA. A 1981 flight would have required using the existing backup Viking spacecraft, presumably with new scientific instruments and perhaps with treads or wheels to make it a "rover," but with no backup of its own in case the one spacecraft failed. The leftover Viking could still be an option for the 1984 opportunity, Fletcher says, but he implies that a more likely decision

will be to "spend the money and do it right" with two new spacecraft. From a scientific standpoint, an informal polling of researchers reveals differing viewpoints about whether it is better to take advantage of Viking's momentum by shooting for the earlier date, or to wait and take advantage of Viking's data-packed return.

Being considered for future space missions are a pair of low-thrust, long-term propulsion systems—solar electric propulsion and solar sails—envisioned for such goals as a long, velocity-matched flyby of Halley's comet. Neither is included in the fiscal 1978 budget request, but both are being studied at Jet Propulsion Laboratory under recently reprogrammed fiscal 1977 funds for a possible decision in August. The request does, however, include funds to begin production of the third, fourth and fifth space shuttle orbiter stages. □

A lizard in beetle's clothing



J. Hensel, University of California

Survival of the mimic: Juvenile lizard imitates Anthia bettle in color and gait.

Volkswagen isn't the only imitator of the lowly beetle. Juvenile lizards of the species *Eremias lugubris* in southern Africa walk stiffly and jerkily with arched backs in an apparent attempt to imitate a neighboring insect. And researchers now have evidence that the lizards' mimicry is successful.

According to an important hypothesis of evolutionary theory, palatable and unprotected individuals can gain protection from predators by imitating an unpalatable or well-armed species. "The resemblance of juvenile *E. lugubris* to oogpister beetles represents not only the first substantive case of mimicry involving a quadrupedal lizard, but also, to the best of our knowledge, the first case of a terrestrial vertebrate mimicking an invertebrate," say zoologists Raymond B. Huey of the University of California at Berkeley and Eric R. Pianka of the University of Texas.

The oogpister beetle is well equipped to discourage attackers. The beetle can eject a pungent fluid of formic acid and assorted other acids and aldehydes.

The juvenile lizards are certainly in need of protection, being palatable and relatively defenseless. Against the pale sand, a lizard's jet-black skin with white broken stripes makes it an obvious target for birds, snakes, foxes and jackals. Paradoxically, because it is conspicuous and looks like a noxious beetle, predators avoid the lizard.

In their field study, funded in part by the National Geographic Society, Huey and Pianka observed that the lizards changed to adult coloration, pale red-tan, when they reached body lengths of 40 to 50 millimeters. That length is about the maximum size of an oogpister beetle. At the same time, the lizards' foraging movements also changed. Adults move with lateral undulations, typical of most lizards, instead of the stiff juvenile gait.

The lizards and beetles meet various criteria for successful mimicry. The lizards are fewer in number than the beetles, are active only during times of day and year when the beetles are active and live only in areas also populated by the beetles.

"These noxious beetles are thus ideal models; juvenile lizards have apparently converged on them both in behavior and morphology," the researchers write in the Jan. 14 SCIENCE. "Indeed, on occasion we have initially mistaken juvenile lizards for oogpisters."

But does the disguise work against the lizards' natural enemies? "We cannot measure predation rates directly, but the frequency of broken tails can be used to index relative intensity of predation," say Huey and Pianka. They found that of all the related lizard species in the southern Kalahari, *E. lugubris* has the lowest frequency of broken tails.

This indirect evidence, they explain, is one of the few nonmanipulative examples supporting the hypothesis that natural selection promotes mimicry of species with stronger actual defenses. □

Female hormones and birth defects

In 1971, there was a disturbing scientific discovery—that the synthetic estrogen DES (diethylstilbestrol), a medication used for threatened miscarriage, could cause vaginal cancer in female offspring many years later. Then from 1973 to last year, other equally unsettling reports started to surface—that use of not only DES but also other estrogens and progesterones during pregnancy could lead to cardiovascular defects in offspring.

Now those initial reports, based on small numbers of subjects, have been confirmed in a much larger study. It is reported in the Jan. 13 NEW ENGLAND JOURNAL OF MEDICINE by Olli P. Heinonen, Dennis Slone, Richard R. Monson, Ernest B. Hook and Samuel Shapiro of Boston University Medical Center, Harvard School of Public Health and Albany Medical College.

The group conducted a study of 50,282 pregnant women at 12 American hospitals between 1958 and 1965. They obtained extensive information about which estrogens and progesterones the women were exposed to during early pregnancy, either through prescriptions for threatened miscarriage or other pregnancy problems or through inadvertent use of oral contraceptives after they were pregnant. The investigators found that these agents were used by 1,042 of their subjects. Of them, 438 (42 percent) used both estrogens and progesterones (278 from oral contraceptives), 176 (17 percent) used estrogens exclusively, and 428 (41 percent) used progesterones exclusively. All the subjects' offspring were examined for congenital heart disease without prior knowledge of which ones' mothers had been exposed to hormones during pregnancy. This way observer bias was unlikely.

Out of 50,282 total pregnancies, 19 children with heart defects were born to 1,042 women who received female hormones during early pregnancy (18.2 per 1,000). Among 49,240 children not exposed to these agents, there were 385 with cardiovascular malformations (7.8 per 1,000). In other words, women who took the hormones were twice as likely as other women to have babies with heart defects.

When the researchers separated out prenatal exposure to specific hormones, they found that the risk was 2.1 times as great as normally expected for combined estrogen and progesterone use, 1.4 times for estrogen only and 1.5 times for progesterone only. For oral contraceptives, which was a subgroup of combined exposure, the risk was highest of all—2.4 times as great. However, the data on the separate effects of estrogen and progesterone were inadequate to be statistically significant. "The separate and combined roles of estrogenic and progestational