works by A. C. Burton; D. A. McDonald, *Blood Flow in Arteries* (Arnold, London, 1960), which reviews use of certain dimensionless numbers in hemodynamics, particularly those of J. R. Womersley; and A. C. Guyton, *Am. J. Physiol.* **150**, 70 (1947). A clear distinction should be made between demonstrative models which illustrate certain specific features of a system and true models, from which measurements may be extrapolated to the natural prototype.
33. "Bionics Symposium: Living Prototypes—The Key to New Technology," *Wright-Patterson Air Force Base Rept. No. WADD 60-600* (1961).
34. *Monthly Index of Russian Accessions to the Library of Congress* (Government Printing Office, Washington, D.C.). A search was made for the years 1952–61. The well-known Soviet preoccupation with doctrinary Pavlovian theory has inhibited work on quantitative physiology of the type published in the *Journal of Applied Physiology* or *Medical Physics*, and also allometric studies. The third and most recent Soviet conference on mathematical methods in biology [see *Izv. Akad. Nauk SSSR Ser. Biol.* **27**, 151 (1962) (in Russian)] did not appear to include any discussion of physical biological similarity. Recent Soviet reports have dealt with purely informational cybernetic models.
35. J. Huxley, *Problems of Relative Growth* (Methuen, London, 1932).
36. E. F. Adolph, *Science* **109**, 579 (1949).
37. E. Zeuthen, *Quart. Rev. Biol.* **28**, 1 (1953).
38. F. M. Turrell, *Botan. Gaz.* **122**, 284 (1961).
39. H. D. Landahl, in *Aging and the Individual*, J. E. Birren, Ed. (Univ. Chicago Press, Chicago, 1959).
40. H. W. Smith, *Principles of Renal Physiology* (Oxford Univ. Press, New York, 1956).
41. F. Bergmann and S. Dikstein, *J. Physiol.* **145**, 14 (1959).
42. J. G. Defares and I. N. Sneddon, *The Mathematics of Medicine and Biology* (North-Holland, Amsterdam, 1960), pp. 529–33.
43. S. Roston and L. Leight, *J. Clin. Invest.* **38**, 777 (1959).
44. M. L. Crosfill and J. G. Widdicombe, *J. Physiol.* **158**, 1 (1961).
45. A. Klinkenberger and H. H. Mooy, *Chem. Eng. Progr.* **44**, 17 (1948).
46. A. B. Reznyakov, *Metod Podobiya* [Method of Similitude] (Academy of Sciences of the Kazakhstanian S.S.R., Alma-Ata, U.S.S.R., 1959) (in Russian).
47. G. K. D'yakonov, *Voprosy Teorii Podobiya v Oblasti Fiziko-Khimicheskikh Protsessov* [Applications of the Theory of Similitude in the Area of Physio-Chemical Processes] (Academy of Sciences of the U.S.S.R., Moscow, 1956) (in Russian).
48. I. Perel'shtein, *Kholodil'n. Tekhn.* **37**, 35 (1960) (in Russian). See also I. I. Novikov, *Nekotorye Vopr. Inzh. Fiz.* **1**, 43 (1957) (in Russian).
49. E. W. Sinnott, *Plant Morphogenesis* (McGraw-Hill, New York, 1960).
50. The work discussed in this article was completed while I was a special post-doctoral fellow of the National Institute of Neurological Diseases and Blindness, NIH, (grant No. BT-555, 2-3). I gratefully acknowledge the advice and assistance of H. Goheen and A. Lonseth (department of mathematics, Oregon State University); of H. D. Landahl and N. Rashevsky (University of Chicago); of D. E. Pickering and L. B. Lusted (Oregon Regional Primate Research Center); of I. W. Sizer and W. McCulloch (Massachusetts Institute of Technology); and of G. Birkhoff (Harvard).

News and Comment

Space Program: Congress Passes It Unanimously, But NASA Wonders About Durability of Support

The Senate, without asking any serious questions, gave its unanimous endorsement last week to the Administration's space program.

The action followed a similar display of unanimity in the House, where even H. R. Gross, the Iowa Republican who thinks budgets are for cutting, grudgingly went along with a $2 billion increase in NASA's budget, bringing it to $3.7 billion. Gross did add that "it would be my hope that if and when we do get to the moon we will find a goldmine up there because we will certainly need it." But neither he nor any of his colleagues on the floor showed an inclination to debate NASA's activities. In the Senate, William Proxmire, Democrat of Wisconsin, tried to stir up some debate about the space program, but the response was minimal. Two amendments offered by Proxmire—calling for a study of the space program's manpower situation and for more competition in space contracts—were promptly overwhelmed. The Senate then went on to give NASA virtually everything it requested. As in the House, a few items were shaved, but the effect will not extend to any activities that NASA deems even moderately important. If it changes its mind, it has assurances that both houses will review the cuts with sympathy.

Having scored a pair of shutouts on Capitol Hill—as it has in every post-Sputnik year—the space program would seem to have no political clouds in its future. But among persons associated with the program, in and out of Congress, more and more thought is being given to the question of the substance and durability of public and, ultimately, congressional support for the national space effort.

When portrayed in terms of competition with the Soviets, the space effort is assured of public and congressional support, especially since the mortification caused by Sputnik is embedded in the American mind. But the Administration is eager to convince the public that space developments are valuable in themselves and deserve to be supported at a high level of expenditure, regardless of what the Soviets are up to. Just what the future holds in the East-West space competition is something of which no one can be certain; the Administration, however, wishes to make certain that in the unlikely event of a decline in the cold war motivation, the public will be sufficiently enamored of space activities to give support to the continuance of a large-scale program.

Toward this end, the Administration has gone to great lengths to depict the space program as a great national undertaking that is leading to readily discernible benefits such as weather forecasting and satellite communications; indirect benefits, including technologies adaptable to nonspace activities; and, finally, a grand adventure in which all citizens can vicariously participate.

The difficulties involved in winning support for the program outside of a cold-war context are enormous, however, because, while the bill grows bigger each year, the benefits that are easily visible to the general public are few in number. The success of Telstar last week helps convince every television viewer that he has something to gain from space research, but such easily recognizable dividends from space are actually few in number.

One result is that the Administration and its space lieutenants in Congress have undertaken a campaign to convince the public that the "fallout" (or, as it is more discreetly referred to, the "spin-off") from space research is of such great value in nonspace fields as to justify whatever expenditures may be involved. Pronouncements to this effect are becoming fairly commonplace and sometimes are of a euphoric character that suggests a bit too much protesting. (One entry in this educa-

tional effort is a booklet published by the Science and Astronautics Committee, NASA's guardian angel in the House, which concludes, among other things, that "space exploration will ultimately play an important role" in "at least five major categories," to wit: "(i) Bursting population. (ii) Acute water shortage. (iii) Soil erosion and disappearance. (iv) Too much leisure. (v) Intensified nationalism." The pamphlet points out that national security is a direct product of the nation's space effort, but that space activity will also provide: "a strengthened national economy, new jobs and job categories, better living, fresh consumer goods, improved education, increased health, stimulated business enterprise and a host of long-range values which may ultimately make the immediate benefits pale into relative insignificance." The committee added that "the greatest, finest benefits to come from our adventure into space are yet unseen.")

Relative Cost

The theme that you are getting your money's worth even if you do not realize it is accompanied in many speeches by the assertion that the space effort, in relative terms, is not costly. In a recent address, Edward Welsh, executive secretary of the National Aeronautics and Space Council, said the money spent last year on space "is in the neighborhood of 10 percent of what the official figures show the people of this country are spending on recreation and also equals about one half of one percent of our gross national product. Next year," he continued, "we expect to spend about $3.8 billion. I do not suggest it, but if each adult in the United States saved the price of one martini each week, the total saved would come close to equaling the cost of all our space projects. On the other hand, if no one cuts down on such consumption, the federal taxes on alcoholic beverages this year could approximate the cost of our national space programs for this year and for last year as well."

While the administration has been seeking to convince the public that the space effort is neither beyond the nation's means nor as unproductive for terrestrial needs as it might appear, it has also been chopping at the argument that too much remains to be done on earth before man goes into space. The rebuttal offered is a political one: Congress will appropriate money for space in whatever amounts the Administration requests, but it is niggardly in supplying money for education and welfare purposes. "We did not spend enough money on those worthwhile purposes even before we had a space program, and there is no assurance that sufficient sums would be spent even if we didn't now have a space program," Welsh stated in that same address. "In none of these cases where we are not doing enough," he continued, "is the failure to accomplish due to our space expenditures or to the lack of resources in this great country. Rather, prejudices and various forms of self-interest often act to prevent sufficient money from flowing where it would do the country the most good. A vigorous space program will increase our wealth and our ability to improve our standard of living and hence, rather than draw off money from other essential uses, it will increase the total resources available for all uses."

The case for the space program is being broadcast by the administration well in advance of the appearance of any effective opposition, but the administration is stimulated to this effort by a number of portents. Prominent among these is the fact that the public has demonstrated that it it quite fickle toward space achievements. The initial Vanguard launchings drew massive television and press coverage, but today, a spaceload without a man has to be of a fairly spectacular order to command broad public attention. NASA officials were not altogether surprised, but then neither were they at all pleased, to note that the television audience for the second orbital shot fell off considerably from the first. Even at Cape Canaveral, the parade for the second orbiting astronaut drew a relatively placid audience. NASA officials now wonder at what point in the manned flight sequence the TV crews will fail to show up.

They also realize that success, in which luck is an indeterminate ingredient, has deceived the public into an unrealistic conception of the perils of manned space flight. The public has reacted joyously to NASA's short but unbroken string of successful flights, but what would have been the reaction if the flights had ended with death before several score million TV viewers? NASA officials and the astronauts have been publicly stressing that sooner or later space is going to claim lives. What they fear is that public opinion will then sour on manned space flight, rejecting it as a dangerous stunt.

Another source of concern is that while Congress votes for space expenditures without asking any serious questions, members of the House and Senate space committees are increasingly asked by their colleagues for assurance that the money requests are receiving careful committee scrutiny. In an effort to assuage this concern, and also to put pressure on NASA to start thinking about watching its money—a practice with which NASA has had virtually no experience—the House Science and Astronautics Committee will hold hearings next week on economy in space operations. Pressure for such hearings came from a number of House conservatives who are becoming alarmed over the National Aeronautics and Space Administration's plans to ask for $5 billion next year, and possibly double that amount within 3 or 4 years.

NASA's Broad Role

Some of their alarm comes from the broad view that NASA takes of its mandate to engage in whatever activities may be necessary to carry out its space mission. The desire to make this country first in space was the primary motivation for the accelerated program introduced by Kennedy, but NASA has now come to mean many things besides space use and exploration. For example, the legislation that established NASA says nothing about education. However NASA, to help meet its manpower needs, is preparing a large-scale move into graduate education. The agency recently announced plans for a pilot program involving a total of 100 predoctoral fellowships for ten universities, and it is now holding preliminary discussions with some 50 to 60 other universities that have shown an interest in obtaining NASA support. NASA officials say they have made no decision on the ultimate extent of their graduate support; mention has been made, however, of turning out 1000 Ph.D.'s annually, which would be a remarkable total, since the yearly national output now is around 10,000.

Despite their concern about the uncertainties of public support and the grumblings of fiscal conservatives in Congress, NASA officials stress that they are not helpless if the difficulties now on the horizon should become politically significant. They realize that the day may come when they will lose their carte blanche with Congress, but they have numerous weapons for assuring that financial support will remain high, and that the space program can

avoid the financial reverses that the atomic power program, for example, has experienced. One of the principal strengths of space is that no vested interest is against it. Labor and industry are for it, since it means contracts and jobs; the farm interests are at worst indifferent to it, and educational interests are growing increasingly aware of its potential as a source of money. NASA officials readily concede that they have not been aloof from political realities in selecting sites for installations and in assigning contracts. Political considerations, they say, come last, but they are not absent. The $90 million manned spacecraft center under construction near Houston sits next to the congressional district of Albert Thomas, who is chairman of the appropriations subcommittee that passes on NASA funds. The majority of NASA installations are in the south, where they are doing an invaluable job of upgrading the technological skills of long-neglected regions; they are also helping win the favor of a large bloc of congressmen who might tend to support a call for economy.—D. S. GREENBERG

Civil Defense: Administration Says Poll Shows Heavy Public Support

In one of its few pronouncements on civil defense in recent months, the Administration has released a public opinion poll which shows overwhelming support for the proposed community fallout shelter program.

The poll was designed for the Office of Civil Defense by Michigan State University and was conducted by Elmo Roper Associates. The findings conflict sharply with virtually every poll that congressmen have conducted among their constituents. A review of a dozen of these congressional polls shows that regardless of their wording and the political complexion of the recipients, the results were overwhelmingly against the fallout shelter program.

The Office of Civil Defense poll found 77 percent in favor of the Administration's program, which would provide matching funds for the construction of shelters in public buildings. The issue is moot at this point, since congressional action on the community shelter program has been sidetracked and is likely to remain so for the remainder of the session.—D.S.G.

Announcements

The National Bureau of Standards, in cooperation with universities in the Washington, D. C., area, has instituted a **work-study program** which will allow graduate students to complete courses for advanced degrees in science while employed by the bureau and earning 70 percent of a junior scientist's salary. Beginning in September, students with a B.S. degree in physics, chemistry, mathematics, or mechanical or electrical engineering, may work in an NBS laboratory 3 days and attend classes on alternate days; summer employment will be on a full-time basis. It is expected that the course work can be completed in 4 years, after which participants may complete thesis research at the bureau or the university.

Suitable part-time course programs are available in physics, chemistry, and mechanical engineering at Catholic University, and in physics at the University of Maryland. Payment of tuition and fees will be the responsibility of the participants. (Ruth B. Armsby, Personnel Division, NBS, Washington 25)

A 3-man **self-propelled deep sea vehicle**, capable of operating at a depth of 12,000 feet, will be built by Westinghouse Electric Corporation as its own laboratory facility for marine studies. Designed by Jacques-Yves Cousteau, director of the Institut Océanographique at Monaco and developer of the Aqualung, the 7-ton spherical vessel, to be called *Deepstar*, is 6 feet in diameter and has remotely controlled mechanical arms. The craft, capable of traveling about 3½ miles per hour over a range of 20 nautical miles, will rise and descend almost vertically. Changes in attitude will be effected by pumping mercury from one tank to another. The maximum period of submergence will be 24 hours, the effective life of the propulsion batteries.

The outer spherical portion of *Deepstar* will be fabricated and tested in Europe; final assembly, scheduled for completion in late 1963, will take place in the United States.

The Birla Institute of Technology, Ranchi, India, plans to establish a **rocketry department** to undertake research in the science and technology of rockets. A small two-stage rocket is scheduled to be built and launched late this year.

Australia's Commonwealth Scientific and Industrial Research Organization has announced plans to construct a **radio heliograph** to take detailed radio pictures of the sun. The instrument, financed with the assistance of a $550,000 grant from the Ford Foundation, will consist of 100 saucer-shaped aerials, each measuring 42 feet in diameter, which will be arranged in a 2-mile-wide circle. Receivers and computers will combine the waves received by the dishes to give a motion picture of explosions and storms in the sun's atmosphere, and of accompanying radio flares that occur near sunspots.

Although the exact location of the instrument is yet to be decided, tentative plans call for construction at Parkes, N.S.W.

Grants, Fellowships, and Awards

Applications are being accepted for the 1963–64 Glorney-Raisbeck fellowship in the **medical sciences**, to be awarded for 1 year of research and study in any field of medicine or its allied sciences. The $6000 fellowship is renewable for 2 years on a yearly basis. Applicants must have the M.D. degree, and should have an institutional appointment in the United States; preference will be given physicians from the New York area. Deadline: *1 December*. (Aims C. McGuinness, New York Academy of Medicine, 2 E. St., New York 29)

The State University of New York is offering two-year fellowships for post-residency research training in **psychiatry**, leading to the Doctor of Medical Science degree, available to M.D.'s who have completed 3 years of resident psychiatric training. Fellowships will amount to $6000 for the first year and $7000 for the second, and may be supplemented by stipends for special research or teaching.

Candidates who have completed only 2 years of residency will take the final year of residency at Kings County (N.Y.) Hospital concurrently with this program, receiving the regular third-year residency stipend in addition to the fellowships. Deadline for the 1963–64 academic year: *1 February 1963*. (Office of Admissions, State University of New York, Downstate Medical Center, 450 Clarkson Avenue, Brooklyn 3, New York)