

billion in nonrecurring costs. Based on a flight schedule for 13 years—1978 to 1990—and considering payload effects (the fact that with the shuttle satellites could be built cheaper and could be repaired for reuse) the study concluded that the shuttle would pay for itself or break even with a total of only 40 flights a year for both NASA and the Air Force. In 1970 NASA and the Air Force launched 36 payloads.

Mathematica considered many variations and produced 26 scenarios of plans for the space program. For their traffic model the analysts used 736 missions identified by DOD and NASA. The continued use of current expendable booster rockets or new expendable rockets instead of the reusable shuttle resulted in a modest investment, but the recurring cost of operation remained high. For example, with the shuttle, the initial cost would be \$12.8 billion and the cost per launch only \$4.6 million; with the expendable boosters, the initial cost would be only \$1.5 billion but the cost per launch would be \$13.1 million. Mathematica also concluded that use of the shuttle would save \$14 billion on the cost of satellites and other hardware put into orbit. (They would not have to be nearly so miniaturized and automated.)

All this may be confusing to the layman but it appears to be necessary to forecast approximately the effects of a new system. The shuttle is still in the study phase. So far \$94.5 million has been spent on shuttle studies. This year, however, the first moneys will be placed into hardware—\$58 million for initial development of the shuttle engines and \$42 million for the vehicles. Shuttle defenders point out that nothing NASA has spent so far commits the agency to immediate development of the two-stage vehicle. In fact, some NASA supporters are now favoring the phased approach, which has two noticeable advantages: it would eliminate the need for a peak \$6 billion or \$7 billion space budget and would allow engineers to use the orbiters to test the flight regime of the booster.

Included in the options of the phased approach are solid- or liquid-fuel expendable boosters. Although NASA is not too enthusiastic about it, Lockheed's stage-and-a-half shuttle is still in the running (only the orbiter with drop tanks). The stage and a half would probably cost as much to operate but would possibly save \$3 billion to \$5 billion in development cost.

This year's debate on the shuttle is only the beginning. But several things seem in the shuttle's favor. Space theorists had been advocating reusable systems since the late 1950's but the Apollo program allowed neither the time nor state-of-the-art development. The Air Force's need for an already

developed shuttle is also a vote-getter in Congress. For example, the Air Force has testified that 50 percent of its space requirements are to reach synchronous orbit. Here they could place not only monitoring devices and missile detectors but perhaps also devices such as lasers to destroy missiles. On the negative side, current antimilitary sentiment in the country does not bode well for NASA's developing a shuttle that would also be used by the military. NASA responds that the cheaper route is to build a shuttle everyone can use. □

SCIENTIFIC FREEDOM

Protecting the scientist



NBS

Astin: Head of AAAS committee.

Last year Sen. Edmund S. Muskie (D-Me.) called on the American Association for the Advancement of Science to make a judgment in an alleged case of denial of scientific freedom. Drs. John W. Gofman and Arthur R. Tamplin, outspoken critics of national radiation standards, had their staffs cut by the Atomic Energy Commission. This, they claimed was in retaliation for their criticism and therefore a denial of scientific freedom.

In answer to Muskie's request, the AAAS last December decided to set up a committee to study and report on specific instances of alleged abridgment of scientific freedom. This committee has now been formed, although not quite along the original lines. Dr. Athelstan Spilhaus, chairman of the AAAS board of directors, has announced a five-member, national policy-making committee "to develop policies for safeguarding independent scientific inquiry and to develop procedures to ensure responsible scientific conduct." The committee will not look at individual cases but will set up "guidelines and procedures that will enable the association to develop machinery for handling individual cases." □

Dr. Allen V. Astin, former director of the National Bureau of Standards, and now Home Secretary of the National Academy of Sciences, will be chairman. The other members, like Dr. Astin, have been involved in or concerned about issues of scientific freedom and public responsibility; Dr. Mary Catherine Bateson, associate professor of sociology and anthropology at Northeastern University in Boston; Walter J. Hickel, former Secretary of the Interior; Dr. John H. Knowles, director of Massachusetts General Hospital in Boston, and the Hon. Earl Warren, former Chief Justice of the United States.

Their specific charge is to study and report on the general conditions required for scientific freedom and responsibility, develop criteria and procedures for the impartial study of these problems, and to recommend mechanisms to enable the association to review specific instances in which scientific freedom is alleged to have been abridged or otherwise endangered or in which responsible scientific conduct is alleged to have been violated.

This will not be a completely novel role for the AAAS. William Bevin, AAAS executive officer, says the association has in the past even sent its lawyer to court (for moral support) with scientists involved in civil liberty cases. And whenever scientists asked for help they were given as much information and advice as was available. Now, says Bevin, the AAAS will have the official means, machinery, resources and policy guidelines to stand up for "civil liberties in the context of the scientific community." The only problem he foresees is funds. Once this machinery starts into motion Bevin expects to be deluged with requests from distressed scientists. And it will take quite a lot of money to implement whatever mechanisms the group comes up with.

As to what these mechanisms will be, no one is prepared to say. But Bevin promises that the committee will have complete freedom and will be more autonomous than any other AAAS committee. As a result he will not predict what it might come up with.

The same is true for the members themselves. Drs. Astin and Knowles both say that they have some ideas, but they will not discuss them until after the committee has had time to meet. Just when this first meeting will be is still a question, but the AAAS board of directors and the committee members are excited about the prospect and hope to get things going as soon as possible. Dr. Astin says that this will happen as soon as all of the members can get together at the same time. He hopes it will be in September or October. □