will be launched later this year, to be followed by a Mariner Jupiter-Saturn mission in 1977. The Viking orbiter/lander mission to Mars is set for 1975–76. Other activities will include the launching of the Orbiting Solar Observatory in 1974, of two German-American solar probes in 1974 and 1976, and of a number of technological "applications" satellites (for earth resources reconnaissance, weather studies, and the like) between now and the end of 1977. With the foregoing manned and unmanned space activities, together with a modest program in aeronautics, NASA would have about 25,000 civil service employees throughout the 1970's and support about 100,000 contractor personnel (the latter figure going somewhat higher at the peak of work on the space shuttle).

A clear indication that NASA's major programs were safe (certainly for the moment) came several weeks ago when the agency, faced with White House demands to do its part toward holding total federal spending for fiscal 1973 to a $250-billion ceiling, escaped with a cut of only $179 million. To make the cut, development of the shuttle was ordered slowed by somewhat less than a year off of its original schedule and the launch dates for two of the technological applications satellites was ordered delayed. In addition, there were decisions to suspend the High Energy Astronomy Observatory project (pending redesign of HEAO in a cheaper configuration), to phase out the communications satellites project (letting industry take over), and to terminate long-term projects for development of nuclear propulsion and large-scale nuclear power sources.

Should there ever come a decision to kill or indefinitely postpone the space shuttle, the agency's status may slip to that of an inconspicuous scientific and technological agency quietly doing interesting but not very exciting things. The shuttle is in fact critical to NASA's future, as that future is now envisioned. During this decade as much as a third of the agency's civil service personnel and up to one half or more of its contractor personnel will at times be working on this project. And, for the long term, once the shuttle becomes operational—at a total cost of at least $6.5 billion—an ambitious program of flights will have to be carried out to justify having built it. In terms of cost-effectiveness, the shuttle does not start breaking even unless at least 30 heavy scientific, military, or other payloads are launched annually over a 12-year period.

NASA officials probably are not going to be able to rest easy about the shuttle until a few billion dollars have been spent on it. Not more than about $775 million will have been spent by the close of fiscal 1974—little enough that the Administration might be tempted to cancel the project should severe budgetary difficulties again arise.

Yet NASA officials seem confident that the shuttle will be built, and there perhaps is little reason to believe otherwise. President Nixon has supported the project—although his new budget message contained no mention of the space program whatever—and, in Congress, it has survived handily all past attempts to kill it. The fact that the project helps sustain an aerospace industry that has suffered grievously from layoffs is a point lost on no one. And, then too, NASA has going for it the fact that, both in Apollo and in the unmanned programs, it has generally met its goals and stayed within its budget.—L.J.C.

Supersonic Technology

Ever since that day two years ago when the White House lost, by a close vote in the Senate, the battle to keep the supersonic transport alive, there has been speculation that President Nixon would ultimately seek to revive the project. The evidence now is that the President does indeed look to a possible revival of the SST, but not until later in the 1970's. The new NASA budget contains $28 million—more than twice as much as last year's budget—for research and development on supersonic technology. The work will focus on problems of noise, pollution, and efficiency of configuration.—L.J.C.

RESEARCH NEWS

Cholera: New Aids in Treatment and Prevention

The current epidemic of cholera, which began a decade ago in Indonesia and is still rampant on the Indian subcontinent and in Africa, has stimulated research on the biochemical and immunological, as well as the clinical, aspects of the disease. It is now known that the profuse diarrhea of cholera is caused by a toxin made by *Vibrio cholerae*, the bacterium that causes cholera. In the intestine this toxin stimulates the enzyme adenylate cyclase, which in turn causes production of an excessive amount of cyclic adenosine 3′,5′-monophosphate (cyclic AMP). Then, by a mechanism still not understood, the cyclic AMP induces the hypersecretion of water and salt characteristic of the disease.

Effective therapy for cholera now consists of replacement of the water and salt lost through diarrhea; when initiated early enough, this therapy can save almost all victims. Although cholera is best prevented by modern sanitation and clean water supplies, improved vaccines may be a more readily attainable means of reducing the incidence of cholera in underdeveloped areas of the world. Preliminary evidence suggests that an inactivated form of the toxin (toxoid) may be superior to the vaccine made of killed *V. cholerae* that has long been in use.

The diarrhea caused by cholera results in the loss of large amounts of body fluids and electrolytes (sodium, potassium, chloride, and bicarbonate ions). Although these losses have been attributed to the effects of cholera toxin, the precise site of action of the toxin was identified only recently. For example, Michael Field, working first at Johns Hopkins University and later at the Beth Israel Hospital in Boston, discovered that cholera toxin increased the amount of chloride ion secreted by the intestine and decreased the net ab-