who was asked by President Carter to look into shuttle overruns and delays. "I would worry more about it than I did for Apollo Eight due to narrower safety margins (e.g. fallout from reduced hardware qualifications and unmanned flight testing)," Anders wrote. "I believe that this narrower-than-Apollo-margins situation should be brought to the attention of the President for his review of any national and international political/policy implications."

Under the influence of success-oriented management, NASA officials perhaps began to confuse prediction with reality. NASA suffered from a "technological hubris," says a Senate aide. Managers became overconfident that technological breakthroughs would materialize to save the situation. NASA officials outside the shuttle program were caught unprepared. "There was no appreciation at the center directors' meetings that the problems would be anything this bad," says Bruce Murray of JPL. John Casani, director of the Galileo project to orbit and probe Jupiter, notes that the availability of the shuttle was taken for granted during all mission planning. "We were originally scheduled to be taken up on the 26th launch, and then schedule slippages moved us up to the seventh," he says. "We sure thought we had enough padding." Now, delays and problems with the shuttle's weight-lifting capability have forced the agency to defer the launch until 1984, when the Jupiter orbiter and an atmospheric probe have to be launched separately, costing millions of dollars more. The solar polar orbiters, designed to peer at heretofore unexamined parts of the sun, are in similar straits, facing additional expense and a 13-month delay.

As problems of this variety loomed on the horizon, NASA decided in 1978 to ask for more money. By this time, enough had been spent on the program to minimize the chance of its being canceled. The Senate subcommittee on science, technology, and space then asked the National Academy of Engineering to look into the shuttle's engine problems. The academy found that because the Columbia's engines had been installed before the development work was complete the engines that NASA intended to certify as fit for flight—in a separate testing program—were "significantly different" from the engines that NASA would actually be flying. Alarmed, the academy committee asked for, and got changes: the testing program was revised. In return, NASA got the academy to drop a statement in its report that there would be at least a 1-year delay past the mid-1979 launch date, a statement that would have brought about more political troubles. "The folks at NASA nearly fainted," says a congressional aide. The academy reported nonetheless that NASA's optimism about the launch date was not likely to be realized in practice.

At the urging of Defense Secretary Harold Brown, who was concerned about the shuttle's availability for conducting intelligence missions, President Jimmy Carter eventually got into the act. In October 1978, Carter had stood on the shuttle landing field and said he sincerely hoped the first flight would be before his next birthday, 1 October 1979. "I have every assurance from those involved that there will be no slippage in the present schedule as it now stands" (Applause). When his birthday—but no launch—was fast approaching, Carter asked NASA administrator Robert Frosch and several consultants for a special report on the shuttle and its problems, which the White House is presently mulling over. The consultants were generally critical of NASA's management approach, and one wrote, "Care should be taken to insure [sic] that excessive optimism is weeded out and that adequate contingency reserves—[in] cost and schedule—are now provided." In other words, the success-oriented approach should be scrapped immediately. "If NASA has a credibility problem," the consultant went on, "I believe it is more due to a tendency to overly accommodate to budget pressure for the sake of preserving a national commitment [to the shuttle] rather than to a lack of candor."

NASA officials respond to such criticism by embracing the accusation that the agency fudged in 1971 about how much the shuttle would cost. Their original proposals called for an even more complicated shuttle, with an expected cost of $8 billion. The Nixon White House slashed the request and the program down to a cost of $5.15 billion, entailing fewer technological challenges. Rather than admit this was an illusory estimate, NASA assented. Officials now say there was no other way that the shuttle would have got through a skeptical Congress and a barrage of criticism that it was not cost-effective.

Some of the critics' original accusations appear to be justified. Although costs are still hard to predict, it is not clear that the shuttle will be cheaper than conventional rockets. The European Space Agency is billing its proposed customers less to use its rocket Ariane than

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Ex-President Disputes Election

Audiences at scientific conferences in pre-Watergate days would sometimes be electrified to hear a voice declaring, "I am President Nixon. . . ." Heads would turn, and then the other shoe dropped: ". . . of the American Chemical Society." Alan C. Nixon is now an ex-president, in retirement in California, and trying to get back into the political limelight.

He has recently brought suit against the American Chemical Society, claiming the October 1978 election for the ACS director from Region VI was unfairly conducted, and that in a fair election he would have been successful.

During his presidency in 1973, Nixon posed an interesting challenge to the traditional character of the ACS as a learned society. A write-in candidate, he tried to make the ACS more interested in professional issues such as conditions of employment.

In the disputed election to the ACS's board of directors, Nixon lost to another candidate by a vote of 1913 to 1916. He claims that about 3000 members in the region received no ballots or got them too late because they were sent by third-class mail.

The ACS is contending the suit. At its meeting in April in Honolulu, the Council Policy Committee voted by 12 to nil, with one abstention, that the election should not be rerun.

CO_2 in Climate: Gloomsday Predictions Have No Fault

A group of experts has told the President's science adviser that they can find no flaw in a central argument of several recent climatic studies, that an increase in the CO_2 content of the atmosphere will lead to a global warming and significant climatic changes.

The group, convened by the National Academy of Sciences, says that the basic model relating CO_2 to global warming is correct, so far as they can see. "We have tried but have been unable to find any overlooked or underestimated physical effects that

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could reduce the currently estimated global warmings due to a doubling of atmospheric CO_2 to negligible proportions or reverse them altogether," says the group.

If and when there is a doubling of the atmospheric CO_2, there will be a global warming of probably 3°C, give or take 1.5°C, the new report estimates. The CO_2 concentration has risen from about 314 parts per million (volume) in 1958 to about 334 ppm in 1979. The time to the doubling of the present level will occur by about 2030 if use of fossil fuel continues to grow at 4 percent per year as it did until a few years ago. But the time for doubling will be delayed by up to 20 years if the fossil-fuel growth rate is only 2 percent, and until the 22nd century if use remains at today's level.

The Academy group puts new emphasis on a mechanism that may act as a giant flywheel in the system, delaying warning signals until matters are past remedy. This is the ability of the deeper ocean waters to absorb heat from the surface layers through pumping action in the large subtropical gyres. If the deep ocean is indeed acting as a heat reservoir, it could delay the attainment of ultimate global thermal equilibrium by a few decades. Once its heat capacity had been absorbed, however, nothing could be done to prevent the climatic consequences that would ensue.

"Of course, we can never be sure," the report says, "that some badly estimated or totally overlooked effect may not vitiate our conclusions. We can only say that we have not been able to find such effects. *If* the CO_2 concentration of the atmosphere is indeed doubled and remains so long enough for the atmosphere and the intermediate layers of the ocean to attain approximate thermal equilibrium, our best estimate is that changes in global average temperature of the order of 3°C will occur and that these will be accompanied by significant changes in regional climatic patterns."

The review was requested in May 1979 by science adviser Frank Press, who noted that the several recent studies of the CO_2 problem rested on a common body of scientific knowledge and asked the Academy to test its underpinning. The group, chaired by Jule G. Charney of MIT, included a predominance of experts who had not been involved in the previous studies. It was a different Academy group that reported recently on the issue of whether a massive synfuels program would lead to a significant increase in CO_2 (*Science*, 31 August 1979). A study by Gordon MacDonald of the Mitre Corporation had suggested that large synfuels programs by the United States and USSR could lead to a doubling of CO_2 by the year 2010; the Academy review, performed for Senator Abraham Ribicoff, concluded that this would not be the case.

The atmophere has taken another bad beating from a new Academy report on the ozone problem. A study released on 8 November concludes that the ozone in the stratosphere is being depleted at twice the rate estimated in a 1976 survey. Continued worldwide use of fluorocarbons will produce a 16.5 percent reduction of the ozone layer, half of which will occur in the next 30 years. The earlier report estimated the eventual ozone reduction at 7.5 percent. Better data and improved computer models are the reason for the change of prediction.

Too Much Light May Be Shed on Body Public

A new craze has sprung up in the American heartland around Little Rock and Memphis and is about to sweep the outlying provinces of the nation. It is the tanning booth, an artifice that accomplishes with ultraviolet light a skin color that could otherwise be procured only by an expensive winter holiday.

Patrons pay for a graded course of exposures to ultraviolet light. Since most of the franchises have trained operators, the tanning booths may be less hazardous than lamps used at home. But the potential for accidents is severe. The intensity of radiation in some of the booths is five times that of the noonday sun. Operators claim, doubtless with justice, that a few minutes in a booth is equivalent to a few hours of sunbathing.

The Food and Drug Administration started receiving reports of accidents in May this year, generally of fairly serious burns. Lesser accidents are probably underreported because of the embarrassment factor. The agency's immediate concern is to prevent equipment-caused injury such as failure of timing devices when the radiation-bather has fallen asleep. This month it issued safety standards for sunlamps requiring them as from next May to be furnished with protective goggles, timers, and warnings.

A longer term hazard is the known role of ultraviolet radiation in inducing both skin cancer and premature aging of the skin. "It is hard to impress people with the long term effects when they are more concerned about looking beautiful the next day," notes an FDA official.

In most of the tanning booths patrons strip completely to get a whole body tan. Light is shone from all directions to bathe parts of the body that usually never catch the noonday sun, such as the armpits, the underneath of the arms and breasts, and the groin. Burns on these delicate zones may become a national distraction unless the tannees take care.

The FDA is also concerned about the possible role of photosensitizing chemicals in causing unexpected burns in tanning booths. Carrot juice, celery juice, and lime (but not lemon) juice contain an agent that makes the skin more sensitive to light. So do the chemicals in certain cosmetics, aftershave lotions, and medicines.

The tanning booth industry started in Europe, launched by advertisements appealing to the tan-associated image of health and leisure. The booths are particularly popular in the north of Germany where, during the long winter months, a touch of even ersatz sun is a welcome break. The craze is spreading rapidly in the United States with a dozen manufacturers already in the field and hundreds or possibly thousands of booths now built.

Having issued safety standards for sunlamps, the FDA is preparing additional instructions for the operators of tanning booths. In 2-months' time it plans, after consultation with the American Academy of Dermatologists, to prepare health warnings for the customers of tanning booths.

Sunlamp-related injuries amounted to 7,700 cases last year, a sharp decrease from the 12,000 people injured in 1975. The reduction in the accident rate may be a result of the manufacturers' adopting safety features in anticipation of the standards promulgated by the FDA this month.

Nicholas Wade