Problems with the shuttle cause concern for US space science programmes

David Dickson reports from Washington

TECHNICAL problems and the related cost over-runs of the National Aeronautics and Space Administration's space shuttle programme are raising serious concerns about the possible impact on planned space science missions. So far, no major changes in these missions have been necessary. But with performance margins being squeezed increasingly tightly, contingency plans are already being drawn up for two planetary missions that depend on space shuttle launches—one to send a pair of space vehicles to Jupiter, and the other to send two vehicles to the Sun—in case any further difficulties arise.

Equally important in the medium term is the effect the current shuttle problems could have on new space science programmes. At present Congress seems prepared to accept that the military need for the shuttle is sufficient to justify paying the increased costs recently announced by NASA; but whether it is also prepared to support new science programmes remains uncertain.

Senator Adlai Stevenson Jr., chairman of the Senate subcommittee on science and space, warned at a hearing of the subcommittee last week that the shuttle problems could require an extra \$500 million a year from the US taxpayer to maintain a civil space programme. "And that may prove to be too high a price to pay," he said.

The most direct manifestation of the shuttle's problems have been the delays caused by problems in engine testing and, more recently, in fixing the heat-protective tiles to the outer skin of the orbiter. NASA officials now admit that the shuttle is unlikely to be airborne before next spring, perhaps even as late as the summer: and Dr Robert Frosch, NASA administrator, told the Senate subcommittee that total cost overruns for the design, development, test and evaluation part of the programme were now expected to be about 15%—or roughly \$1 billion in current dollar values—compared to a 7% estimate last year.

The engine problems, however, have also had effects on the programme. For example the reduced performance estimates for early shuttle launches have led to erosion of engineering and weight margins in space science payload design. One programme to have been affected by this is Project Galileo, a twin probe and orbiter due to be launched from the shuttle in 1982, the former to provide the first direct samplings of the planet's atmosphere,

the latter to transmit data from an elliptical orbit through all regions around the planet, including at least 11 near encounters with its surface.

The complexities of the manoeuvring required of the two vehicles on reaching the planet have resulted in a slightly heavier design than first anticipated. Initial fears that this might require discarding some of the scientific experiments have now been circumvented; but the extra weight together with the reduced performance expected of the early space shuttle flights, have required significant design changes in the so-called Interim Upper Stage (IUS) which will launch the Galileo vehicles from the shuttle.

At present, assuming that the IUS development goes as planned, performance margins appear to be acceptable. "We seem to have got the weight problem under control, and the project itself looks in pretty good shape at the moment," project scientist Dr Torrence V. Johnson of the Jet Propulsion Laboratory in California said last week.

Any further problems, however, either in the IUS development or in the shuttle test schedule would be a serious matter. At present Galileo, which will be among the first operational shuttle launches, is planned for early 1982, to reach Jupiter in the middle of 1985. On this schedule the spacecraft would fly close to Mars,

using that planet's gravitational pull to help it on its way.

A major delay in the shuttle programme, however, pushing the Galileo launch into 1983, would mean that the gravitational pull of Mars could not be used. Extra fuel would then be required to get the spacecraft to Jupiter, and some of the scientific projects would be dropped to compensate for the extra weight.

Various contingency plans are already being studied by NASA. One possibility might be to split the mission into two halves, sending the orbiter and the probe separately, perhaps a year apart; but this would involve considerable extra cost, and a major redesign.

Another project similarly affected by weight considerations is the international solar polar mission (ISPM). This is a joint project between NASA and the European Space Agency, due for launch at the beginning of 1983, which will involve sending two spacecraft simultaneously past Jupiter and into opposing orbits over the poles of the sun. Some of the potential weight problems for this mission have been compensated for by changing the trajectory of the launch from the shuttle. But the margins are now very tight (technically the ISPM is now 70 pounds—or 5% overweight, compared to 146 pounds for Galileo); and any problems with the IUS could have severe consequences.

As a contingency plan, NASA has

Space shuttle: setbacks are keeping other projects firmly on the ground

suggested that the two vehicles might be launched separately, possibly up to a year apart. But ESA scientists are not very happy with this suggestion, pointing out that a simultaneous launch is one of the attractions of the mission.

Weight problems are also causing concern to planners for the first Spacelab flight. This is still scheduled to take place in August 1981, a date that ESA officials are confident can be met even with considerable slippage in the shuttle test programme.

However as things stand at present, the shuttle may not be ready to provide enough thrust by this stage to launch the full Spacelab payload. The current shortage is about 1,300 pounds out of a total weight of about 65,000 pounds; and it could mean that some of the experiments already lined up for the first Spacelab flight may have to be dropped. (One encouraging piece of news to ESA officials is that the US Air Force appears to be planning to use Spacelab for some of its own manned space-flight missions.)

The space shuttle problems are already affecting other areas of NASA's activity. Scientists involved in the Voyager mission, for example, feel that if it had not been for these problems, they might have had access to some extra money this summer for additional experiments.

The greatest uncertainty at present, however, is over what the political effects of the shuttle's problems will be on support for future projects. NASA, with the support of both the Office of Science and Technology Policy and the Office of Management and Budget, is adamant that none of the existing programmes should be cut to provide the additional funds needed by the shuttle.

Dr Frosch told the Senate subcommittee that cancelling the Galileo project—at one time discussed as a distinct possibility—would only save \$83 million in 1980, considerably less than the extra money needed by the shuttle; nor would much be gained by taking money from the space telescope. "We do not consider either of these reasonable ways of getting extra funds," he said.

But the concern is that Congress, having provided NASA with the extra shuttle costs largely on the grounds that the success of the programme is required for US Defense plans—in particular for launching surveillance satellites, will be reluctant to complement this with support for new space science missions.

The situation is already bleak following the decision of the Carter administration not to request any new starts for the fiscal year 1980 partly to ensure adequate support for space

shuttle. (Among projects which NASA had submitted to OMB were plans for a shuttle-launched gamma-ray observatory, an orbiting imaging radar to Venus, and a mission to the comets Halley and Enke.)

"The real question is going to be what the 1981 budget contains. A second year with no new starts could really put the science programmes in jeopardy; if the nation wants a vigorous space science programme, then you have to start something new," Professor A. Cameron of Harvard College Observatory, chairman of the National Academy of Science's space science board, said last week.

Of course, if there are no new starts in the 1981 budget request the fault will not lie entirely with space shuttle; equally important may well turn out to be President Carter's desire to greet an election year with an attempt at a balanced budget.

But the additional funding which NASA is currently seeking from Congress for 1980 (\$225 million above its original request), has not improved the situation. "We are still hopeful that our project will be funded, but we are not as optimistic as we were a month ago," says one of the scientists involved with the gamma-ray telescope, currently top of the NASA's space astronomy and astrophysics board's priority list for future projects.

The dangers in the current situation have not been lost to Senator Stevenson who, with fellow committee member and ex-astronaut Harrison (Jack) Schmitt, has been urging a more aggressive space programme on the administration for some time.

"The problem with the shuttle programme now seems to have been a serious underfunding in the early stages, something of which up to six weeks ago the Congress had been unaware. And now it has all come home to roost with a 15% cost over-run," Mr Stevenson said at the subcommittee hearing last week.

"The biggest cost may effectively be the end of the civilian space programme, since the real risk is that the price of the shuttle's difficulties will be taken out of the civilian side of our space efforts. And with the country in its present mood, this could well happen."

Not all observers are quite so pessimistic. But the problems raised for future space science funding are already being taken seriously, not only by NASA but also by both OSTP and OMB. And they will provide an unwelcome house-warming present to greet NASA's new associate administrator for space science, Dr Thomas Mutch, when he takes up his appointment next month. □

California plans to build world's largest telescope

THE University of California is in the midst of preparing preliminary designs for a 10-metre diameter optical telescope that planners hope will be operating in the mid-1980s. Two designs are being considered, each a radical departure from conventional optical telescopes, which would be prohibitively expensive to scale up to this size.

The proposed telescope would be by far the largest in the world, with a mirror twice the diameter of the Hale telescope on Mount Palomar. (Nominally the largest telescope in the world is now the 6m at Zelenchukskaya Astrophysical Observatory in the Soviet Union, but western astronomers generally comment that it has not yet been proved reliable.)

Jerry Nelson, of Lawrence Berkeley Laboratory and chairman of the technical design committee for the proposed telescope told a meeting of Californian science writers last month that it would be designed to produce images smaller than 0.5 arc seconds and that, for good infrared observations, it would have to be built at a site with low atmospheric moisture.

Historically, the costs of optical telescopes with thick, monolithic glass mirrors have risen roughly as the cube of the diameter. This means that a conventionally designed 10-metre instrument would cost around \$200 million—a figure Nelson says is "out of the question". On the other hand, the design committee has already rejected such alternatives as the use of independently focused multiple mirrors, like the recently opened telescope at Mount Hopkins (*Nature*, 3 May, page 9). Such multiple mirror devices may provide an economical alternative for studying point sources, but the new University of California telescope must have angular field wide enough to encompass an extended image like a galaxy with associated star clusters.

Nelson's design committee has thus narrowed the acceptable options down to two: a single mirror much thinner than those used previously, or a segmented mirror with focusing characteristics approximating those of the monolithic design. In either case the anticipated principal focal length would be between 15 and 20 metres, which would facilitate a relatively small containment structure. Traditionally half the expense of building a new observatory has gone into the telescope and half into the surrounding structure, so every effort is being taken to minimise the overall size.