

NASA's Space Shuttle

'Re-usability' is the catchword

Having generated plenty of controversy, the Shuttle is now being proven. **Colin Norman** reports

IF you have a piece of hardware weighing up to 65,000 pounds that you would like to put into Earth orbit after 1980, the National Aeronautics and Space Administration (NASA) would be only too pleased to rent you the Space Shuttle for \$20 million. Or if your requirements are more modest—a 200-pound experimental package which doesn't need special handling, for example—NASA would be glad to take it aloft for as little as \$3,000. Although some advance notice and a small deposit would be required, it shouldn't be too difficult to make a booking because there is likely to be considerable spare room in the Shuttle when it eventually flies.

With three years to go before the Shuttle is scheduled to begin full service, NASA is starting to drum up business. A list of fees to be charged to such users as the Department of Defense, foreign governments, commercial operations, and individual researchers has recently been drawn up, and NASA officials have developed an ambitious flight plan calling for as many as 60 shuttle launches a year in the late 1980s.

The flight plan indicates that NASA has not changed its basic thinking on the Shuttle since it won approval for the programme after a bitter fight in the early 1970s. NASA officials are still confident, in short, that the Shuttle will revolutionise space activities by sharply reducing the cost of launching payloads and providing routine access to space. If the flight plan is remotely accurate, in fact, it would represent a staggering increase in the space programme, resulting in more activity than during the height of the Apollo era. Many of those who fought the Shuttle programme in its early stages, including some prominent space scientists, remain sceptical of NASA's projections, however.

The design of the Shuttle was determined in 1972, following an intense struggle between NASA and the Office of Management and Budget. NASA had originally wanted to build a fully re-usable system, consisting of an orbiter and a booster rocket, both of which would be piloted back to Earth and re-used, but in the end it had to settle for an economy model which will be only partially re-usable. It will consist of an Orbiter mounted atop an external fuel tank and strapped to two booster rockets. Soon after launch, the

boosters will separate and be parachuted into the ocean for recovery, refurbishing and re-use. The external fuel tank will be discarded in the upper atmosphere where it will burn up, and the Orbiter, after completing its mission, will re-enter the atmosphere and glide to a landing like an aircraft.

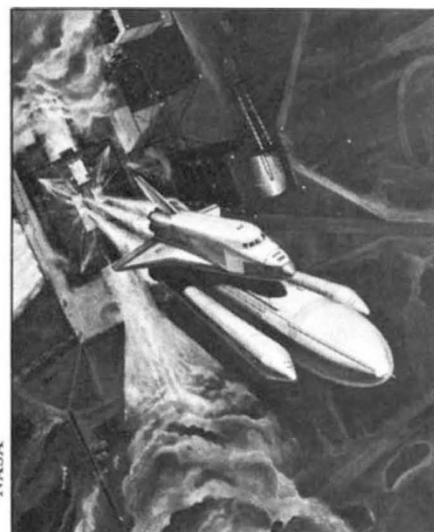
Launches and landings will take place at two locations, Cape Canaveral in Florida and Vandenberg air force base in California. When launched due east from Canaveral, the Shuttle will be capable of delivering 65,000 pounds into a 185 km orbit, or 25,000 pounds into a 500 km orbit at 55 degrees. Missions requiring polar orbits will be launched from Vandenberg because such launches from Canaveral would involve flying over heavily populated areas soon after launch. The Shuttle can deliver 32,000 pounds into a 185 km polar orbit.

The Shuttle itself is capable of reaching only low Earth orbits, and thus an extra piece of gadgetry is needed to hoist communications satellites into higher orbits and to fire planetary spacecraft out of the Earth's gravitational field. Again, NASA was originally planning to develop a re-usable rocket, called a 'Space Tug', for those tasks, but it has had to settle for a cheaper, disposable system, at least for the time being. It consists of a solid-fuelled rocket, called the Interim Upper Stage (IUS), which will be launched from a Shuttle in orbit; the IUS is being developed by the Air Force. Though NASA officials claim that they still hope to build the Space Tug someday, there is some doubt about whether that day will ever come.

Costs go up

When the Office of Management and Budget finally approved NASA's plan in 1972, the estimated cost of developing the Shuttle was about \$5,200 million. The latest projections put the total research and development costs at about \$6,800 million, of which about \$4,500 million will have been spent by the end of this year. Virtually all the increase is accounted for by inflation. In addition, NASA reckons that it will cost about \$2,500 million to produce five orbiters and associated boosters and fuel tanks, bringing the total research, development and production costs to some \$9,300 million.

So far, development of the Shuttle is proceeding on schedule and no major



Shuttle: take-off to recovery

snags have been encountered, which is an impressive record for such a mammoth undertaking. The first Orbiter was unveiled last September and, thanks to a massive mail campaign from *Star Trek* fans, it was named the Enterprise. It is now being flight tested in the atmosphere, riding piggyback on a Boeing 747, and in July or August it will be cast loose at 22,000 feet to glide on its own to a landing at Canaveral. The first orbital test flight is scheduled for March 1979, and if all goes according to plan, it will be ready for full operation in the spring of 1980. Development of the IUS is also proceeding apace, and it is also supposed to be ready by 1980.

After the Office of Management and Budget gave its approval to the Shuttle in 1972, the real battle began. NASA's cost estimates and projected savings for the system were subjected to severe criticism by a group of Senators led by Walter Mondale, now Vice President, who took their cues from a number of prominent space scientists and systems analysts. They included Thomas Gold, Professor of Astrophysics at Cornell, James van Allen, Professor of Physics at the University of Iowa, George Rathjens, Professor of Political Science at MIT, and Brian O'Leary, a former astronaut.

The nub of the debate was this. NASA claimed that the Shuttle would more than pay for itself over its projected 12-year lifetime because it would be able to deliver payloads into orbit much cheaper than expendable rockets could. Critics of the system argued, however, that NASA was assuming an unrealistically high launch rate with the Shuttle, and that the cost comparisons didn't properly take into account the research and development costs of the system. Another objection was that the costs of developing and building the Shuttle would soak up so

much of NASA's budget that many space science and applications projects would get squeezed out. The debate raged for about a year, but died down when Congress finally sided with NASA and voted the money to begin developing the system.

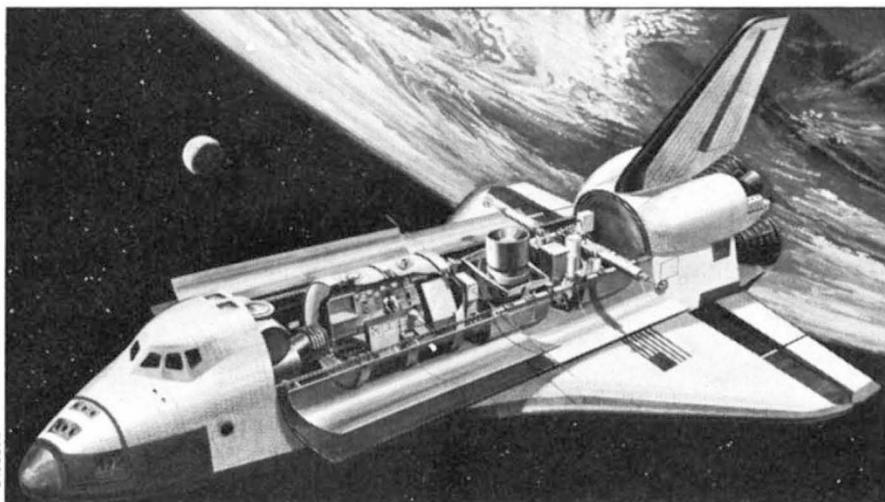
At least one of the critics' complaints has already proven correct. While NASA's budget has remained approximately constant in real terms since 1971, spending on the Shuttle has climbed from less than \$100 million to more than \$1,300 million a year. As a result, there have been very few new space science projects started: some have been scrapped (such as the grand tour of the outer planets), others (such as the High Energy Astronomy Observatory) have been pared, and still others (such as the Large Space Telescope) have been deferred. As O'Leary noted last week, "Our dire scenario has been played out".

Nevertheless, since the project got under way in earnest, NASA officials have been working out a flight plan for the Shuttle based on an assumption that NASA's budget will stay roughly constant in terms of purchasing power over the next 10-15 years, and they have come up with a flight plan very similar to the one which was used to justify the Shuttle in the first place. It should be noted that the plan doesn't represent firm commitments to develop or build a set number of satellites; it is simply a planning document.

NASA calculates that there will be about 560 separate Shuttle flights between 1980 and 1991, with an average of about 60 flights a year between 1985 and 1991. With the massive payload capability of the Shuttle, that represents a very large increase in space activities. According to the flight plan, the breakdown between users will be NASA, 267; other US government agencies, 28; US commercial operations, 60; foreign organisations, 65; Department of Defense, 109. When broken down by type of mission, the plan calls for 229 Spacelab flights, 35 launches of large structures, 168 launches involving upper stages, and 97 launches of free-flying satellites.

Defense's satellites

Aside from the very considerable size of the programme represented by the flight plan, the number of launches envisaged by the Department of Defense is interesting. Though the nature of the defence missions is classified, some two-thirds of them would require use of upper stages, indicating that they are communications satellites or other satellites in geosynchronous orbits. It has also been speculated that the Shuttle's ability to manoeuvre in space will give it the capability of studying, or even capturing, enemy



The Shuttle's Spacelab configuration



Shuttle takes a trip, March 1977

satellites in low orbits.

As for the fees to be charged to users, NASA has recently circulated for comments a proposal which would allow NASA to recoup the operating costs for the Shuttle. The fees would not, however, include payment for a share of the research, development and production costs. Briefly, NASA has proposed that a fee of \$20 million would be charged for chartering the entire Shuttle for a single launch. The Department of Defense and foreign governments which have contributed to the Shuttle development would get a discount, as would US commercial operations. Users who require only a part of the Shuttle capacity would pay on a pro-rated basis with the smallest experimental packages which require no manual attention getting in for only \$3,000 apiece.

NASA reckons that those fees represent about a 40% discount in launch costs when compared with the use of expandable rockets. Asked whether commercial organisations are showing any interest in booking space on the Shuttle, one NASA official said that he has noticed a recent awakening of interest on the part of payload manufacturers. "At one time they were between lukewarm and disinterested in

the Shuttle", he said, "but I have seen a definite reversal in attitude".

As for space scientists, the Shuttle seems to have generated some resentment because of the fact that its development squeezed out a number of scientific missions. Nevertheless, several former critics of the Shuttle contacted last week all agreed that, with nearly \$500 million already spent it would be folly to seek to cancel the programme at this stage. And the Space Science Board of the National Academy of Sciences said in a report published in 1974 that the Shuttle "can be an important asset to scientific research in and beyond the 1980s".

At least one former critic of the Shuttle has also recently been converted into a supporter. Brian O'Leary said last week that although he still believes that NASA's justification of the project is seriously flawed, the Shuttle "by good luck" would be a useful transport vehicle for the possible establishment of space manufacturing systems using lunar materials, to construct space habitats and solar power stations. O'Leary, who is now working with Dr Gerard O'Neill at Princeton exploring the concept of space habitats, said that he now supports the Shuttle for that reason. □