Salyut—Skylab's silent sister

The Soviet Union nearly got back into the manned space business last month with the launch of its Salyut 2 orbiting space station. Unfortunately, it failed to function properly — leaving three frustrated cosmonauts on the ground

Grigori Tokaty
is professor of aeronautics at City University, London, and formerly the Soviet Union's chief rocket scientist before emigrating to Britain in 1948

If all had gone as planned, three Soviet cosmonauts would have been working in their orbiting space station, Salyut, ready to greet the three US astronauts who are expected to inhabit Skylab when it is launched next week. The two space stations would have been respectively manned on and off throughout the year, and it is quite possible that joint ad hoc experiments may have emerged during the period.

Launched on 3 April, Salyut 2 first had trouble achieving its parking orbit. The orbit parameters were subsequently adjusted, on 4 and 8 April, by ingenious remote manoeuvre commands transmitted from Soviet mission control. Later, unfortunately, the orbital station suffered further systems failures, leaving the three Soviet cosmonauts waiting on the ground at Baikonur cosmodrome instead of being rocketed up to join their Salyut.

No doubt, Soviet space officials would have liked to have re-opened their manned space programme before the American Skylab project got underway. They are known, however, to be treading particularly carefully, following the tragedy three years ago that killed Air Force Lt-Col Georgi Dobrovolsky, Victor Patsayev and Vladislav Volkov during their return to Earth after a successful stay aboard the first Salyut space station.

Salyut 1, launched on 19 April, 1970, was a long-duration orbital station that was built and fitted out on the ground and then lofted unmanned into orbit. On 6 June of the same year, another carrier rocket put the Soyuz II spacecraft and its three crew members into the same orbit. After docking, the crew moved into the orbital station, activated its systems, and started their 23-day stay in the huge Salyut-Soyuz complex weighing 25 tons (Salyut alone weighed 18·9 tons), with a length of 21·4 metres, and containing 100 cubic metres of internal free space. A micro-world on its own, Salyut 1 was also the world's first orbiting garden. Patsayev's experiments endorsed the theory that among the most probable components of space ecological systems will be green vitamin cultures —onion, lettuce, cabbage, garden radish, spinach and dill—and that short-stalk wheats, potatoes, carrots, beans and soya beans look like being suitable for interplanetary manned flights. Unicellular algae, too, appeared to have a promising future in space.

Unfortunately, the unique experiments ended in the tragedy mentioned. On 29 July, 1970, the crew returned to their Soyuz 11 spacecraft, "undocked" from the Salyut without a hitch, and commenced their return to Earth. At first, all systems functioned faultlessly. But almost immediately after the spacecraft left its orbit for descent, a rapid drop in pressure occurred inside the cabin which led to the sudden death of the three cosmonauts. The programme was suspended for investigation and subsequent engineering redevelopment, and was not resumed until Salyut 2 was launched last month.

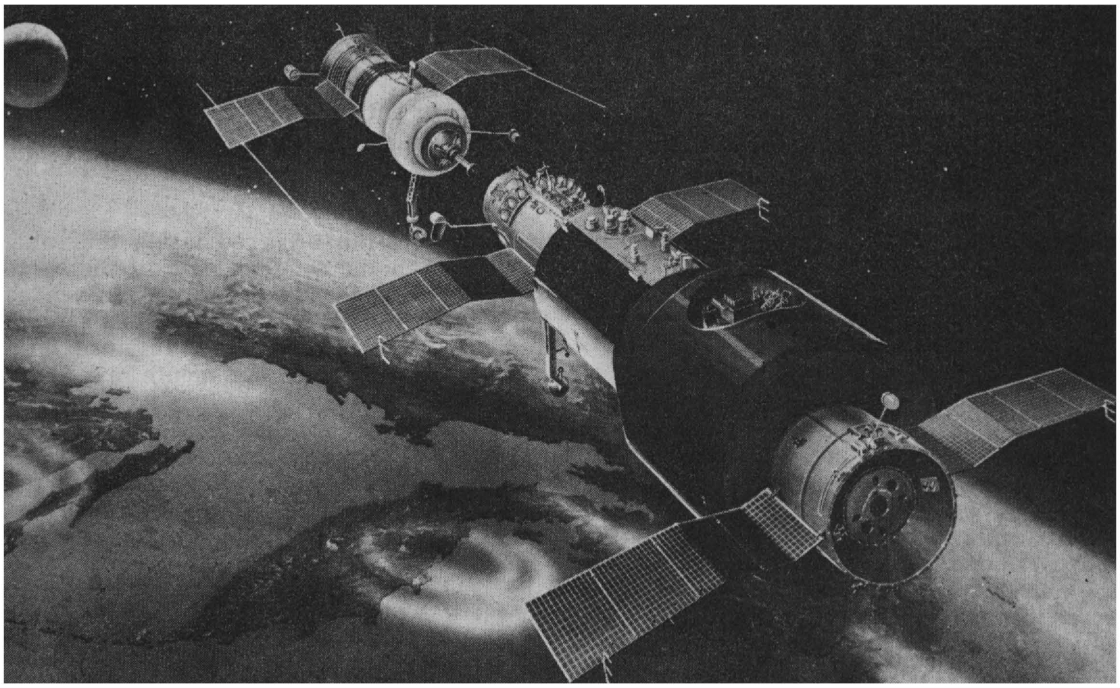
Skylab's early origins

It is often assumed that, throughout the 1960s, the United States worked solely on the Apollo programme. In fact, however, work on unmanned space probes and satellites was going on continuously and an active study of the orbital station had already commenced by the mid-1960s. By 1968, the Skylab concept had evolved in its final basic design configuration.

On board Skylab there are 390 cubic metres of interior space—nearly four times more than in Salyut 1. It weighs more than 80 tons and has excellent facilities for work, rest, sleeping, cooking, eating, and personal hygiene. It will fly in a 95 minute, nearly circular orbit about 386 km above the Earth and inclined 50° to the equator. Skylab will therefore pass over any given point within the latitudes 50°N and 50°S every five days, its flight path thus covering about 75 per cent of the Earth's surface.

The so-called Apollo Telescope Mount, and the four solar battery "wings", is attached outside the Mutliple Docking Adapter, and carries a sophisticated solar observatory of eight telescopes covering wavelengths from visible through near and far ultraviolet to X-ray. An array of solar cells generates about a half of the electrical power required by the station. In addition to gathering information on the Earth's resources and environmental problems, biomedical experiments and solar studies, Skylab will carry out a programme of experiments in industrial processes in zero gravity (casting perfect balls, growing pure crystal structures, and developing high strength materials). It will also provide data on cosmic radiations, stellar astronomy, micrometeoroid quantities and composition, interaction between Sun-ejected particles and the Earth's magnetic field and atmosphere, and will lay a groundwork for more permanent orbiting stations of the future.

Both the Soviets and the Americans are, of course, working also on still larger orbital stations, launched in parts and assembled in space. Some of these projects are already quite advanced, and almost all designs are for stations that rotate in order to maintain a certain centrifugal force to act as artificial gravity. The parts of a very large orbital station must be capable of being launched separately; be convenient for towing to the assembly point; and be simple enough to be joined together in zero gravity



Soyuz 11 spacecraft docked successfully with the Soviet Union's first space station, Salyut 1 (right in picture), in June 1970. The three cosmonauts transferred to the 18·9 ton orbiting laboratory and worked in it for two months. But after a highly successful mission in orbit, the three cosmonauts tragically perished during re-entry

conditions. One of the configurations meeting these and other requirements is a huge hollow ring capable of accommodating 60 to 120 men and women in comfortable rooms with all domestic facilities.

Obviously, the construction of such an orbiting station demands a vast amount of technological experience—which is why the respective countries are taking Salyut and Skylab so seriously. It is clear, for instance, that towing parts to an orbital assembly point, docking the parts together in space and activating all the systems into a normal working mode will require not only supremely perfect remote control technology, but also a wide range of extra-vehicular activities by cosmonauts/astronauts—activities far more difficult and risky than any "space walk" performed so far.

Rescue in space

To everyone's regret, the list of space victims is already too long: three Americans burnt to death in a launch pad fire (Apollo 7) and four Soviet cosmonauts killed while landing (Soyuz 1 and Soyuz 11). This cannot be allowed to continue. What would we do if, say, something went wrong inside a manned orbital station, or if two of the crew were taken ill, or if the re-entry retro-rockets failed to fire? Absolute reliability is a practical impossibility; consequently, one of the most acute problems of manned space exploration is space rescue—the one problem which did not receive adequate attention throughout the 1960s.

From the beginning of the 1970s, however, the situation changed dramatically. We now have direct Soviet/American space cooperation, one aspect of which is geared to this particular problem. The basic idea is to modify the Soyuz and Apollo spacecraft so they can dock with each other in orbit. This work has now reached an advanced stage: the first experimental rendezvous and docking is planned to take place in 1975, when an American Apollo crew member will enter the Soviet Soyuz, and vice versa.

Should, in future, a manned Soyuz or Apollo be in need of help, another Soyuz or Apollo could thus be launched to dock with it and rescue the crew—this applies equally to the orbital stations served by these spacecraft. Rescue operations will, of course, be much easier once America's Space Shuttle is in operation. The Shuttle's orbiter section has a special hatch which will enable it to dock with orbiting spacecraft or space station. Normally the hatch will be used for replacing crews and delivering food, water and exploration equipment.

The Shuttle will carry into orbit virtually all of America's civilian and military payloads —manned and unmanned satellites of all kinds—instead of launching them by costly rockets. It will provide an opportunity to check out existing satellites, calibrate their instruments and control systems in orbit, or even to retrieve and return them to Earth for repair (out of the 131 satellite failures so far, 78 have been related to launch problems; the remaining 53 inoperable or erratic satellites could have been returned to Earth for repair if the Shuttle had been available).

The Soviet Union has now assigned high priority to its Earth-Orbit-Earth vehicle (303-Project), a multipurpose aero-spacecraft capable of transporting payloads and teams of cosmonauts to and from orbital stations, performing rescue operations if needed, carrying satellites into orbit, and exploring the possibilities and limitations of hypersonic aerospace transport. The success of the American Shuttle and Soviet 303-Project will change the mode of space exploration dramatically. For the first time in the history of civilisation, men and women living in long-duration orbital stations will be able to do, in conditions of zero gravity, what they have learnt over the millenia to do under the heavy pull of gravity. And the consequences for life on Earth will be profound.