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Soviet Reusable Space Systems Program: Implications for Space Operations in the 1990s

An Intelligence Assessment

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Soviet Reusable Space Systems Program: Implications for Space Operations in the 1990s

An Intelligence Assessment

This paper was prepared b .Office of
Soviet Analysis, and
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Soviet Reusable Space Systems Program: Implications for Space Operations in the 1990s

Key Judgments

Information available as of 1 July 1988 was used in this report.

The Soviets are developing at least one, and possibly two, reusable space systems. The space shuttle, crucial to future manned space station operations, is in the final phases of ground support and atmospheric testing. The initial launch of an unmanned shuttle is expected later this year. The Soviets also have examined the feasibility of a spaceplane similar to the US Dyna-Soar, but its current status is not clear. Although the shuttle and spaceplane may be parts of the same general program, an examination of their respective capabilities indicates that they are designed to perform different but complementary missions

We judge the primary mission of the Soviet shuttle will be to provide logistic support to future manned space stations. This appears to be the only mission that would justify the resource commitment required for its development. The configuration of the shuttle—an orbiter and separate launch vehicle—is well suited to a "space truck" to supplement or replace current Soyuz TM and Progress spacecraft, particularly in the return of materials or even specialized research modules. Other missions are likely to include retrieval and repair of malfunctioning spacecraft and the subtle deployment of high-value military satellites

The Soviet shuttle orbiter, like its US counterpart, could be used as a reusable launch vehicle to deploy satellites, but its design suggests this probably will not be one of its major missions. The extensive assortment of Soviet expendable launch vehicles provides a more cost-effective means to launch spacecraft the Soviet shuttle is not intended to replace expendable launch vehicles within at least the next decade

The Soviets have examined a number of possible missions and configurations for a spaceplane and have conducted a series of orbital and suborbital tests of a subscale vehicle that is seemingly related to development of a spaceplane. The characteristics of the subscale vehicle suggest that a spaceplane would be better suited than the shuttle to perform most potential military missions. A spaceplane's maneuvering capabilities, both in space and in the atmosphere, appear optimized for reconnaissance and space combat roles—satellite inspection, antisatellite operations, and space station defense

The shuttle orbiter and spaceplane probably would be developed by the same design bureaus and production facilities, and we judge that resource constraints probably played a major role in the decision not to complete these two expensive programs simultaneously. Because the Soviets have a more urgent requirement for a shuttle, they may have elected to slow down the spaceplane's development. The requirement for timely reconnaissance now can be largely fulfilled by a number of unmanned satellites. The other prospective missions of a spaceplane will become increasingly important, however, if the United States proceeds with the deployment of a space-based strategic defense system. Soviet efforts to curtail US antisatellite programs also probably influenced decisions on full-scale development testing of the spaceplane. Specifically, its appearance would have undermined Soviet negotiating positions that sought to restrict "close approach" to satellites

Following two or three successful launches, in all likelihood, the shuttle will be operational. Progress on the spaceplane is less clear. Early research work and data gathered from flights of the subscale vehicle should reduce the leadtime required to develop an operational spaceplane if the decision has been made to proceed. Completion of the shuttle program also may provide additional skilled manpower for the project. Should the Soviets remain committed to the development of a spaceplane, the combination of high development cost and current antisatellite concerns, including their self-imposed moratorium, may keep this program at its current low level at least into the early 1990

Contents

Scope Note

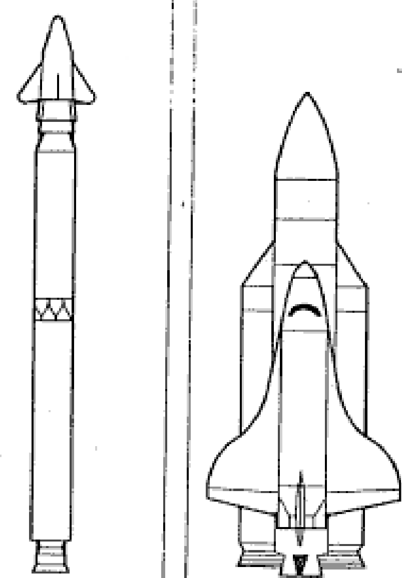
The addition of reusable spacecraft to the current fleet of Soviet space systems will provide Moscow with new space capabilities with potentially important economic, political, and military benefits. This paper compares potential applications [redacted] with the assessed technical characteristics and capabilities to explain the possible Soviet requirements that generated the observed research efforts

Figure 1
Soviet Reusable Space Systems and Their Launch Vehicles

Drawings to scale

The spaceplane, as postulated, on the SL-16

The orbiter with the SL-X-17



	The spaceplane, as postulated, on the SL-16	The orbiter with the SL-X-17
Launch weight (kg)	340,000	2,210,000
Weight in 185-kilometer orbit (kg)	14,000	100,000
Useful payload in orbit (kg)	1,000	30,000

Soviet Reusable Space Systems Program: Implications for Space Operations in the 1990s

Although the Soviets greeted the initial tests of the US Space Transportation System (STS) with derision and labeled it an expensive waste that they would not repeat, they also expressed concern over its ability to support military missions and sought to negotiate limits on its activities. This approach suggested that, despite their critical pronouncements, they were well aware of the potential benefits of such systems. Moreover, [redacted] during this same period the Soviets were developing their own reusable space systems. This effort is embodied in a major program to develop at least one, and possibly two, reusable systems: a space shuttle with the same general capabilities as the US STS and, possibly, a spaceplane with many of the characteristics of the US Dyna-Soar designs of the early 1960s (see figure 1).

Early Soviet Interest in Reusable Systems

The Soviets started examining reusable space system concepts shortly after the beginning of the "space age." In 1962 Artem Mikoyan, one of the two chief designers of the MIG-series aircraft, publicly proclaimed the need for a *kosmolet* (spaceplane) to provide the Soviet Air Forces with an operational capability in space. This view was expanded in subsequent articles. One author, for example, stated that such a system could be used to conduct bombing, reconnaissance, and antisatellite operations from space. He went on to write that to accomplish such missions, the vehicle would need to be able to perform large orbital inclination changes.

[redacted] although initial government reaction to the Mikoyan proposal was less than enthusiastic, studies on the feasibility of a reusable space system were conducted at the Moscow Aviation Institute during the mid-to-late 1960s. The idea for this system, called a *raketoplan* by the Soviets, apparently had been taken specifically from the US Dyna-Soar program.[1] [redacted] by 1969 the program to develop a military orbital aircraft had progressed "beyond the study phase" to the early research stage.

During the early 1970s, the Soviets apparently began investigating the feasibility of a larger reusable space vehicle along the lines of the US Space Transportation System. Their interest in a shuttle probably evolved from a decision to emphasize manned space stations in low-Earth orbit with the eventual goal of establishing a permanent space-based complex. (See appendix A for additional details.) Initially, the Soviets were able to compensate for the lack of a heavy booster by using existing boosters to launch modules that were assembled in space to construct space stations. Long-term goals for a permanently manned space complex, however, required the development of two additional elements—a heavy-lift booster to launch the larger segments that would be required for a space base and a means to return large volumes of materia

Two scientific industrial associations (NPOs) were created in the early or middle 1970s to manage the development of the new support vehicles required for future manned space stations. NPO Energiya was established to consolidate resources for developing a heavy-lift launch vehicle, which the Intelligence Community has designated the SL-X-17. NPO Energiya incorporated, for the first time, the services of two major booster design bureaus. The Utkin bureau designed the strap-on boosters, while the Glushko bureau developed the large central propulsion module and probably was responsible for the integration of the complete launch vehicle. NPO Molniya, with resources from the Mikoyan and Bereznyak aircraft

[1] The Dyna-Soar system was to have consisted of two major components: an expendable launcher based on the Titan ICBM and a reusable orbiter, the X-2

One Program or Two?

[redacted] the small aerodynamic vehicle or subscale spaceplane, which has been highly publicized in the Western press, is only a test vehicle used to gather aerodynamic, aerothermal, and materials data for the larger shuttle orbiter. [redacted] The timing of the space flights, for example, is consistent with [redacted] on the development of protective materials for the shuttle orbiter [redacted] Furthermore, the smaller vehicle may have been used for tests of aerothermal materials because a preferred subscale orbiter and its more complex computer and attitude control systems could not be developed in time [redacted] The Soviet shuttle is supported by several dedicated support facilities that were built years before the expected first shuttle launch

Several factors, however, suggest that the smaller vehicle is part of an independent spaceplane development effort even though it may have been used to conduct basic research in areas that would be applicable to both a shuttle and a spaceplane. First, the shape of the subscale vehicle [redacted] resembles early US lifting bodies more closely than it does the shuttle orbiter. With its unique shape, the subscale spaceplane would not be optimized for testing the shuttle orbiter design even though it could have been used to test materials. Second, assessments by NASA engineers indicate that a significant effort would be required to design a vehicle with the aerodynamic stability characteristics demonstrated by the subscale test vehicle. Such an elaborate design is not required for a test vehicle to collect data for limited aspects of orbiter performance. Third, tests are continuing even though the Soviet shuttle orbiter configuration has been finalized and several orbiters have been produced. Moreover, both orbital and suborbital flights probably would not be required if the subscale vehicle were designed only to test shuttle materials. Suborbital flights would provide similar data on reentry and atmospheric flight and are much less complicated logisticall

There are at least two possible explanations for the contradiction between [redacted] and analysis indicating there are two separate programs: the spaceplane program has been curtailed, or did not know of its existence. The Soviets, for example, refused to acknowledge the existence of their shuttle program, despite considerable evidence that there was one, until early 1987 just prior to the launch of the Energiya booster. If the spaceplane is a classified military project, many [redacted] would be unaware of its true mission. It would not be unusual for [redacted] to be unaware of all details associated with a military spaceplane program given the compartmentalization of Soviet programs in general.

design bureaus, was created to design and develop the reusable spacecraft. During the mid-1970s, the Mikoyan and Bereznyak design bureaus were developing both a small and a large reusable vehicle at a plant in the Tushino area of Moscow— that the small vehicle probably was a lifting-body vehicle much like earlier US lifting-body research vehicles, while the large vehicle was a shuttle orbiter similar to the US STS orbiter.

Soviet Missions for Reusable Space Systems

Soviet military and scientific writings, public and private statements by various Soviet officials, and analysis of the vehicles' technical characteristics identify four potential missions for reusable space systems:

- Support to manned space stations.
- Launch vehicles for satellites.
- Retrieval and repair of disabled satellites.
- Military operations, including intelligence collection and space warfare.

An examination of the respective capabilities of the spaceplane and shuttle indicates that the two systems are likely to perform complementary missions.

Shuttle Missions

Space Station Support. Soviet officials have stated that support to the manned space program will be one of the primary missions for their shuttle orbiter. Analysis of these statements and current Soviet space station operations indicates that the shuttle is likely to be used for:

- Soft-landing recovery of large payloads, including sensitive test equipment, materials, and possibly the entire modules from Mir and future space-based stations.
- Crew ferry and resupply missions currently carried out with the Soyuz TM and Progress space vehicles.
- Orbital construction of large space structures.

In an interview with TASS, for example, Guriy Marchuk, president of the USSR Academy of Sciences, stated that the Soviets regard "manned orbital complexes as the main direction" in space exploration and that the development of new large orbital stations is under way. He noted that the reusable transportation system was intended to work with these future manned complexes. A 1986 publication, *Kosmonavtika SSSR*, depicted a shuttle-type spacecraft in the vicinity of a large multiport space station (see figure 2).

As an interim step on the way to such a space base, the Soviets in 1986 launched a new station called Mir that has multiple docking ports and is the first permanently manned space station.[3] The Mir station reportedly will serve as the core vehicle for a series of modules for missions such as astrophysics, remote sensing, biological research, and materials processing. The processing of materials in space is often discussed in open Soviet literature, and a number of Soviet statements have stressed the importance of manned orbiting laboratories and the economic benefits from "factories" in space (see inset). Some of the materials produced in these complexes, such as crystals, precision ball bearings, and exotic metals, also have significant military applications that would be important to the Soviets. To accomplish this goal, Marchuk stated that the Soviets would require a cost-effective cargo vehicle to ferry heavy materials to and from the station as well as to "make the cosmonauts' homecoming from space more comfortable."

In November 1987, Oleg Gazenko, director of the Institute of Biomedical Problems in Moscow, elaborated on the shuttle's function. He claimed that the real limitation on the use of Mir and, in the future, the biological/medical laboratory module is the Soviets' ability to return materials to Earth, but that once the space shuttle is operational these limitations will no longer exist. The orbiter can return approximately 15,000 kilograms of cargo. In contrast, the Soyuz TM spacecraft now used with Mir is capable of returning only about 250 to 500 kilograms of material, an amount sufficient to support the basic research

Figure 2. Space station support as depicted in Kosmonavtika SSSR

Marchuk's Statement on Space Production

Guriy Marchuk's interview with TASS following the first SL-X-17 launch included these statements on the industrial potential of space complexes:

The new tasks of industrialization in near-Earth space make significantly greater demands on space transportation systems as it has become essential to increase freight flows to space, cut net transportation costs, further increase the margin of safety, be able to bring heavy payloads back to Earth, and make cosmonauts' homecoming from space more comfortable. . . .

The use of the multipurpose Energiya booster rocket will enable us to broaden substantially work for the peaceful exploration of outer space, including the putting of heavy communications satellites into geostationary orbit, the launching of automatic interplanetary stations into deep space and toward the Sun, the assembly of versatile orbital complexes consisting of large modules and structural elements, and the placement of experimental solar power plants in orbit with a wide area of solar-cell batteries for use in space production. So, a prospect opens up for the industrialization of the near-Earth space. However, we do not intend to give up reliable booster rockets that have acquitted themselves well and that we shall continue to use in the future as well for the transportation of cargoes into outer space. . . .

An optimum combination of booster rockets of various classes, spaceships, interorbital tugs, and other space technology will make it possible to create a high-performance Earth-space-Earth transportation line, which is an objective necessity for the further development of cosmonautics.

currently being conducted but probably inadequate for most manufacturing applications. Moreover, the capsule has little additional volume available for consistent return of materials. Current experiments aboard Mir may mark the beginning of the transition from basic research on materials processing to actual production. Cosmonauts already aboard the station would be available to perform the periodic servicing required, and the shuttle can safely return a reasonable volume of delicate materials or even complete modules for refurbishment, if necessary

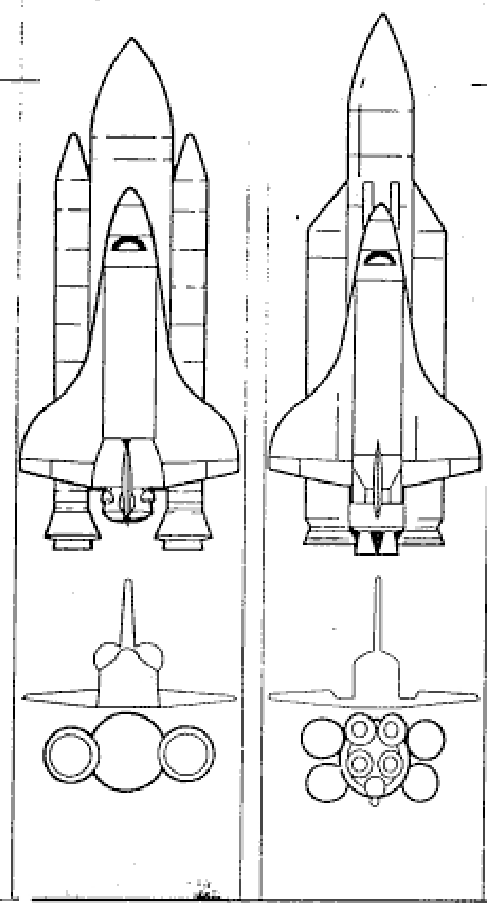
The ability to return hardware and data from covert military experiments performed aboard the space stations, without possibility of intercept, also probably is attractive to Soviet military researchers. Such research performed aboard future stations is likely to involve larger and more complex equipment, including actual components or subsystems that would be more easily concealed within the orbiter's cargo ba

The shuttle orbiter also can provide efficient crew rotation and cargo transportation to the large space stations apparently envisioned by the Soviets. The Soyuz TM ferry vehicle, which can carry only three cosmonauts, is adequate for the small crew changes required by current operations, but a more efficient vehicle will be required to support the 10- to 20-man space stations that are often mentioned by the Soviets.

In addition to crew ferry and resupply missions, the shuttle will probably have a role in the construction of the future space base mentioned by Marchuk or any similar large structures consisting of numerous modules. The modules themselves would most likely be launched by expendable boosters such as the SL-13 and the SL-X-17, but the large solar panels, girders, and other structural components necessary to transform the modules into an operational complex could be carried in the orbiter's cargo bay. The shuttle cosmonauts would also be available to aid in the assembl;

Figure 3
A Comparison of the US and Soviet Space Shuttle Systems

Drawings to scale



Space Launch Vehicle. The Soviet shuttle orbiter, like its US counterpart, could be used as a reusable satellite launch vehicle, but this probably is not one of its primary missions. The extensive assortment of Soviet expendable launch vehicles can provide more cost-effective launch services than the shuttle. The Soviets recently improved their ability to use expendable launchers [redacted] Together these measures more than double the potential production and launch-rate capability for the Proton system

The Soviet shuttle's configuration suggests that it was not designed primarily as a launch vehicle.[4] Unlike its US counterpart, the Soviet shuttle consists of two major subsystems—the orbiter and the SL-X-17 booster (see figure 3). By locating the main rocket engines on the core rather than the orbiter, the Soviets have designed a heavy-lift booster that can be used without the orbiter to orbit payloads weighing up to 120,000 kg. The addition of the orbiter dramatically reduces this payload capacity—probably to about one-fourth that of the SL-X-17 alone—and increases the total launch cost as well. The diversity of operational orbits employed by the Soviets may also require additional kick stages, tugs, or propulsion modules, increasing mission complexity. Figure 4 presents the estimated cost per kilogram of putting a payload in orbit using the SL-X-17, with and without the orbiter. It indicates that expendable launch vehicles, including the SL-16, provide a more cost-effective means to launch Soviet spacecraft

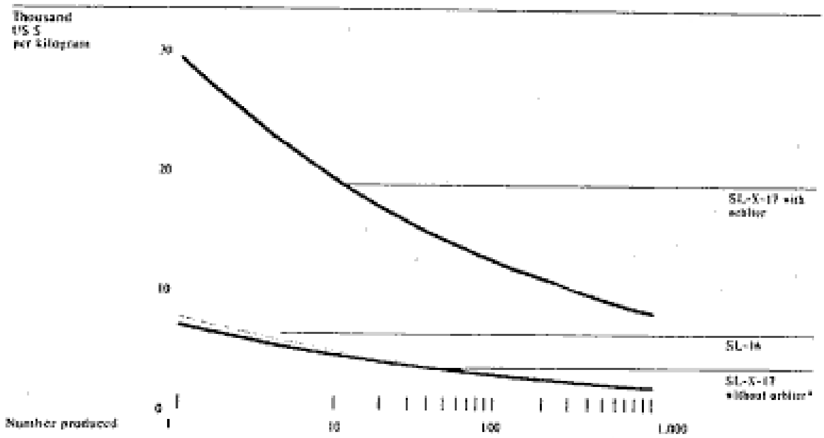
[redacted]

The Soviets may look to their shuttle, however, as a part of their attempt to break into the Western commercial space launch market. They are currently seeking entry into the market with a fleet of seven expendable launch vehicles and appear to be optimistic about their chances for acquiring some Western clients. Moscow, however, probably would be stymied in any effort to market the shuttle as a launch vehicle in the near term. Many payloads that were originally configured for launch by the US STS have already been modified for launch aboard expendable vehicles [redacted] Prospects for winning clients in the 1990s are equally tenuous. Demand for new launches will probably taper off, with customers facing an oversupply of satellite capacity in orbit. According to forecasts by aerospace industry experts, Moscow is unlikely to see a resurgence in business for launch vehicles until at least the end of the centur

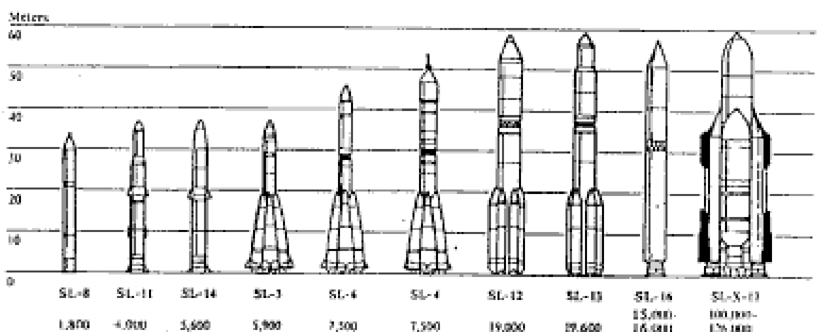
Satellite Retrieval and Repair. Use of the orbiter for retrieval and in-orbit repair of malfunctioning satellites could reduce the cost of Soviet space operations, but only if combined with other orbiter missions. Soviet satellites historically have had relatively short operational lifetimes, often because of premature failure of electronic components. The ability to replace major components aboard the orbiter or at a manned space base, without having to return the satellite to earth, could reduce the annual launch-rate requirement—currently 90 to 110 satellites per year—and provide considerable savings in the associated launch costs. Further savings could be realized from the corresponding reduction in spacecraft manufacturing costs

Comments in Soviet open literature on the USSR's planned capability to retrieve disabled satellites and return them either to near-Earth orbit or to Earth for repair imply that the Soviets are also developing an unmanned orbit-to-orbit transfer vehicle or space tug to work in concert with their space shuttle. A space tug, similar to the US Inertial Upper Stage, would be

Figure 4
Estimated Cost of Putting a Payload in Near-Earth Orbit With Selected Soviet Launch Vehicles



* Other Soviet SLV costs are slightly lower than those for the SL-X-17. Component recovery and reuse will reduce these costs by approximately 10 percent.



Maximum payload weight (kg) to 185-kilometer orbit

Shuttle orbiter

Advantages	*Disadvantages*
Large cargo area for resupply and return missions *Large crew compartment* *Soft-landing capability*	*Costly*
Highly suited	
Can launch satellites weighing up to 30,000 kg	*More expensive than conventional expendable launch vehicles* *Unnecessary launch risk to crew* *Requires "space tug" or other upper stage for some orbits*
Limited suitability	
Large cargo area to contain satellite *Some repair capability in cargo bay* *Support to extravehicular activity*	*Costly unless combined with other missions* *Mission duration limited by power supply*
Well suited	
Man-aided target discrimination *Large weapon-carrying capacity in cargo bay*	*Costly* *Limited orbital maneuverability*
Limited suitability	

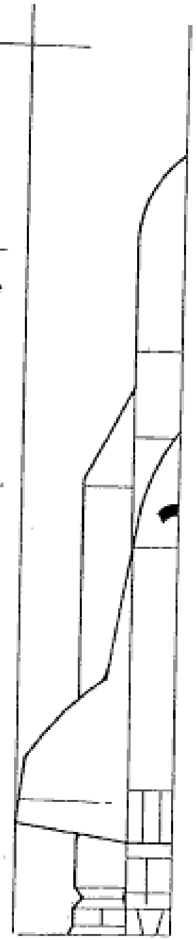
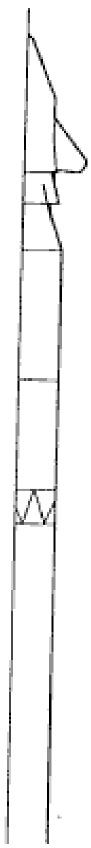


Figure 5
Suitability of Soviet Reusable Spacecraft for Various Missions



Spaceplane: *Disadvantages*	Spaceplane: *Advantages*	Mission	Shuttle orbite: *Advantages*
Limited to small crew *Small cargo area*	*Frequent flights possible* *Quick turnaround* *Less expensive than shuttle*	Space station support	*Large cargo are resupply and re missions* *Large crew com* *Soft-landing ca*
Suited for some aspects			
Too small		Space launch vehicle	*Can launch sat weighing up to*
Not suitable			
Limited cargo volume	*Maneuverability allows it to reach many orbits*	Satellite retrieval and repair	*Large cargo are contain satellite* *Some repair cap cargo bay* *Support to extra activity*
Limited suitability			
Cheaper alternatives for some reconnaissance roles *Short mission duration*	*Rapid launch* *Quick recovery* *Excellent capability to change orbital plane and altitude* *Man-aided target discrimination and kill assessment*	Intelligence collection, space warfare	*Man-aided targ discrimination* *Large weapon-c capacity to carr*
Highly suited			

Reverse Blank

required to place many shuttle-launched satellites into their operational orbits and to transfer malfunctioning satellites between high and low orbits for servicing. Several Soviet statements, however, have indicated that a space tug will be used to assemble large space stations, solar power stations, and other large structures in space, suggesting that several variants of an orbital transfer vehicle may be planned, possibly including versions that are launched by expendable launch vehicles rather than the shuttle orbiter.

Military Operations. The shuttle's lack of orbital maneuverability and the time required for prelaunch checkout limit its usefulness for most potential intelligence collection and combat missions. If the Soviets believe they can continue to portray their manned space program as nonmilitary and hope to use their shuttle for commercial launch services, the orbiter is more likely to be restricted initially to covert military research similar to that currently performed aboard Soviet manned space stations under the guise of "peaceful exploration of outer space." Unlike expendable launch vehicles, the shuttle also could be used to deploy certain military satellites in order to make initial detection and identification more difficult.

Spaceplane Missions

A vehicle of this size could carry a crew of up to four with a small amount of cargo.

The payload compartment on such a vehicle would be big enough to accommodate a small camera or some other sensor system.

We estimate that a full-scale spaceplane will have the ability to change the plane of its orbit by up to 15 degrees or change its orbital altitude by about 4,200 km using purely propulsive maneuvers.

Synergetic plane changes, which use the aerodynamic shape of the vehicle to increase its ability for changing the plane of its orbit, may also be possible with the spaceplane but appear to only marginally increase in-orbit performance. The spaceplane's aerodynamic configuration, while not required for space operations, dramatically improves its performance within the atmosphere. Maneuver capability in the atmosphere would be critical to a spaceplane's ability to return to selected military airfields. We estimate that, after reentering the atmosphere, the spaceplane could perform a crossrange maneuver of up to 2,400 km, providing many additional opportunities each day to return to a designated landing site.

Military Operations. Unlike the shuttle, a spaceplane's maneuvering capability, both in space and within the atmosphere, could provide the Soviet Air Forces with a highly maneuverable, manned spacecraft to conduct military operations. The missions most often discussed for reusable spacecraft are direct combat support and space warfare. An article referred to a combined "reconnaissance-strike" mission in which a manned spacecraft would conduct both targeting and subsequent destruction of critical targets—an ideal mission for a winged spacecraft because it would take advantage of the vehicle's unique ability to maneuver within the atmosphere. A spaceplane launched from the ground or, possibly, from a space station, also could be used:

- As a rapid reaction reconnaissance vehicle to augment current reconnaissance systems and to overfly specific areas during crisis or conflict before a conventional satellite's orbit would pass over that target.

[redacted]

- To more accurately identify foreign space objects and to assess their threat to Soviet systems by maneuvering close to an unidentified spacecraft and scanning it with a variety of sensors.

- For antisatellite missions against selected US satellites. The spaceplane currently would have limited use in this role because of the small number of US satellites in the near-Earth orbits that can be reached by a spaceplane, but it could be a useful adjunct to other antisatellite (ASAT) systems, particularly against a maneuvering spacecraft.

- For space station defense

Space Station Support. A spaceplane also has some capability to support space station operations. Even though a full-scale spaceplane would have only 500 to 1,000 kilograms of return cargo capacity, it could be useful for rapid return of high-priority cargo. It also could provide the Soviets with a means to support crew transfers in emergency situations. A spaceplane, for example, can be launched within hours rather than the several days it takes to prepare and launch a Soyuz capsule and the weeks that would be required for the shuttle. Moreover, with its large crossrange maneuver capability, the spaceplane would have numerous opportunities to land at a preselected location after a reentry

Program Prospects

The Shuttle System

The Soviet shuttle development program appears to be paced by the evolving complexity of Soviet space operations rather than a deficiency in Soviet technology. Current space station operations can be adequately supported by the existing fleet of supply and ferry vehicles at least until the early 1990s. The materials-processing module most often mentioned by the Soviets as requiring the shuttle is not likely to be launched before 1989 and will not be in full operation immediately. Soviet launch needs also can be met with the USSR's fleet of expendable boosters

Over the past decade the Soviets have made steady progress with their shuttle program, [redacted] We estimate that the Soviets will have four operational orbiters by the early 1990s and possibly as many as six by the late 1990s

Recent press reporting, including statements by Soviet officials, indicates that preparations for the first launch of the Soviet shuttle are nearing completion and that the first launch may occur later this year. [redacted] suggests that the first launch attempt will be unmanned if the Soviets can resolve problems with the automatic tracking and landing system. Although the SL-X-17 performed successfully on its maiden flight in May 1987, the first few launches of any new booster involve considerable risk. An unmanned launch would avoid risking a crew that may

[redacted]

be unnecessary to these initial missions in any case. A successful unmanned test probably would lead to a manned test within one year.

[redacted]

The Spaceplane

Progress on the spaceplane does not appear to have been as steady, and we are uncertain about its status. Spaceplane research and development may have begun as early as 1976 [redacted] Testing moved into space in 1980 with a series of suborbital and orbital flights [redacted] involving the SL-8 booster and spacecraft [redacted] With this progression the Soviets should have been able to conduct full-scale space tests using either the SL-13 Proton booster or the SL-16 [redacted]

Soviet Proposals To Restrain Shuttle Activities

During the period 1978-84 the Soviet Union sought international legal restraints to limit US shuttle activities primarily because of its concern about the shuttle's military potential, including its ability to maneuver close to Soviet satellites and to serve as a weapons carrier or as a test platform:

- *At the 1978-79 US-Soviet ASAT talks, the Soviets insisted that a suspension of ASAT testing should apply to "any means" of damaging, destroying, or changing the trajectory of a space object.*
- *In 1979, in the UN Committee on the Peaceful Uses of Outer Space, the Soviets proposed developing rules for the first orbit of maneuvering spacecraft, when the system might pass through the airspace of another nation, and a ban on the use of a shuttle system to remove objects of another state from outer space without permission.*
- *In August 1981, following the maiden flight of the US shuttle, the Soviets proposed a multilateral treaty to ban the deployment of any weapons in outer space. It specifically called for a ban on the use of the shuttle for weapons deployment.*
- *In August 1983, following the US announcement in March of the Strategic Defense Initiative, the Soviets proposed a multilateral treaty to ban the use or threat of force to, in, and from space that would ban the testing or use of the shuttle for military, including ASAT, purposes.*
- *On 29 June 1984, a Soviet Government statement on the militarization of space proposed that manned systems of any kind be banned from introducing into space any kind of weapon—conventional, nuclear, laser, particle beam, or any other.*

By early 1985 the United States and the Soviet Union reached agreement to begin negotiations on nuclear and space issues, but when the talks opened in March the Soviet proposal did not contain provisions specifically aimed at the shuttle. The Soviets undoubtedly viewed the US SDI program as the more serious threat, and thus directed their arms control proposals at banning weapons in space, not at the method of deploymen

A number of factors may have reduced the spaceplane's priority, and the first full-scale prototype—assuming Moscow is still committed to the program—may not be launched until the early 1990s. Two of the primary missions that a spaceplane could perform—real-time reconnaissance of critical targets and post-strike reconnaissance—have now been at least partially fulfilled by the Soviet near-real-time imaging satellite. Moreover, we judge that resource constraints played a role in any recent Soviet decision not to complete the shuttle and spaceplane programs simultaneously. The shuttle and spaceplane probably would be developed by the same design bureau. The Soviets may have allocated available people initially to the shuttle in order to support near-term space station operations. Even if these trained personnel were available, however, in light of current economic difficulties the Soviets may have chosen to complete the two costly programs sequentially rather than simultaneousl

A Soviet decision to slow, or possibly even curtail, work on the spaceplane may also be related to Soviet efforts to delay US antisatellite programs and, more recently, the Strategic Defense Initiative (SDI). The negotiating record of the 1978-79 US-USSR ASAT talks and subsequent Soviet arms control proposals (see inset) indicate that Moscow is concerned about the potential of the US STS to interfere with or destroy Soviet satellites and to deploy space-based weapons. The Soviets have sought to negotiate limits on military-related orbiter activities to ensure protection from near-term US capabilities. Full-scale testing of a Soviet spaceplane would undermine these efforts as well as their campaign against SDI.

Implications

The Soviet space shuttle will provide new options for conducting space operations, but we judge that its key contribution will be to support the growing space station program and to showcase Soviet technological progress. Current Soviet efforts to attract Western customers to the USSR's commercial launch and space station programs also may be enhanced by the addition of the shuttle. In all likelihood, operational activities will begin after two or three successful test flights clarifying Soviet requirements for the shuttle.

Progress on the spaceplane is less clear. The early research and data acquired from tests of the subscale vehicle could reduce the leadtime required to develop an operational spaceplane once a decision is made to proceed. The impending completion of the shuttle development program also will free experienced design and production specialists to work on a spaceplane project or on other advanced aircraft at the Mikoyan Design Bureau. The spaceplane's high development costs, however, combined with current attempts to inhibit US ASAT and SDI efforts, including a self-imposed moratorium against ASAT testing, will probably keep this program at a low level at least into the early 1990s. Should the Soviets proceed with this program, however, its capabilities to operate in and from space would present a potential threat to future US space operations in near-Earth orbit.

Appendix A

Evolving Requirement for a Soviet Shuttle

The Soviet manned space effort began in the early 1960s, but much of the effort in the first decade was directed toward a manned lunar landing to compete with the US Apollo program. The manned lunar missions were canceled in the mid-1970s, following the unsuccessful attempt to develop a Saturn-V-class launch vehicle, the SL-X-15. This program failure set the Soviets back in many planned space ventures and undoubtedly was a major reason for the shift in emphasis to manned space stations in near-Earth orbit. The development of orbital stations has progressed through several evolutionary stages designed to reduce technological risk and to compensate for the lack of a heavy-lift launch vehicle (see figure 7).

First-generation Salyut stations had limited potential because the propellants and life-support systems were not renewable. All supplies were carried to the stations in the Soyuz crew ferry vehicle. Initially the program consisted of separate scientific and military research stations. Salyut 1 and Salyut 4 were used primarily for scientific research, although they also conducted some military-related experiments. These experiments were conducted while the cosmonauts were aboard the station. In comparison, the military stations—Salyuts 3 and 5—operated largely autonomously, with crews required only for periodic servicing.

The separate military and scientific space station programs were combined on the second-generation stations—Salyut 6 and Salyut 7—beginning in 1977. These stations also were equipped with an additional docking unit at the aft end, making it possible to automatically replenish expendable resources through the use of unmanned Progress resupply vehicles. In 1981 the Soviets assembled their first modular space station when Cosmos 1267, described by the Soviets as a new multipurpose space station module, was docked with Salyut 6. The multipurpose modules have been used as independent stations, as specialized research modules for both the second- and third-generation stations, and, in a modified form, as a space tug to maneuver another module.

Mir, the third-generation station launched in 1986, expanded the modular station concept with a new radial docking adapter that permits as many as seven spacecraft or modules to be docked simultaneously to the station. An astrophysics module, Kvant, was docked in 1987, and the Soviets have discussed several others, including a materials sciences module and a biological and medical laboratory. All Soviet space stations and modules to date have been launched by the Proton launch vehicle, and crews and materials have been returned in variants of the basic Soyuz ferry vehicle. Future fourth-generation stations probably will be launched by the new SL-X-17 launch vehicle and use the Soviet shuttle to supplement or replace existing crew ferry and resupply vehicles, particularly in the return of materials produced aboard the complex.

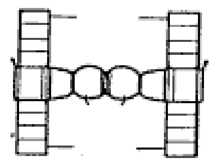
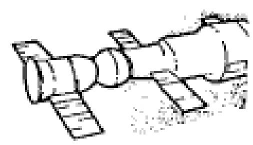
The Soviets have followed a similar evolutionary path in conducting space-based materials-processing experiments. In addition to the experiments conducted aboard manned space stations, the Soviets also have launched short-duration, unmanned materials-research satellites. These experiments were used to define the most promising technological processes that, according to Soviet open statements, will culminate in an orbital production facility. A dedicated Mir materials-processing module is scheduled for launch by the early 1990s and probably will begin the transition from basic research to pilot production.

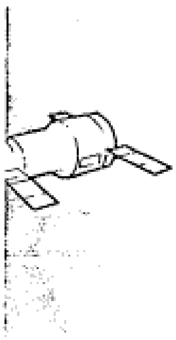
Early semiconductor production experiments conducted aboard space stations reportedly demonstrated that, while crewmen are necessary for servicing long-term production processes, they also can be a "contaminant" to that process. Space station vibration, resulting either from crew activities or from spacecraft maneuvers, can have an adverse effect on some experiments. Because of this, the Mir technology module may not be permanently attached to the station but rather a "free flyer" visited periodically by cosmonauts in order to maintain a steady flow of materials to and from the module.

The Soviet shuttle orbiter should provide a reliable means to return to Earth the volume of materials produced in these modules. It will be even more crucial if the Mir pilot production facility is further expanded on future fourth-generation stations. Although the orbiter appears to be capable of returning the entire module to Earth for refurbishment, it will be more cost effective to return materials in containers that have been specifically configured to fit the orbiter's cargo bay. The shuttle's ability to make a relatively soft landing also will reduce the amount of packing materials required and therefore can increase the actual volume of materials returned on each missior

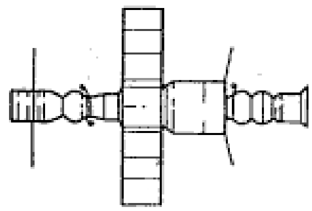
According to recent reporting in the Soviet press, a number of Soviet scientists and space officials have been openly critical of this effort, contending that materials research has progressed too slowly and has not yet provided sufficient return to the economy. Other scientists, such as Oleg Gazenko, head of the Institute of Biological Problems in Moscow, claim that too much attention is focused on the manufacture of semiconductor materials at the expense of biological and medical research. Much of this criticism, although apparently valid, probably results from impatience with the methodical Soviet approach and, perhaps, from a parochial view that ignores other research that also is being conducted aboard these stations. The dedicated Mir astrophysics, remote-sensing, biological research, and materials-processing modules will significantly expand the space available for experimentation and production. Thus, the programed expansion of Mir combined with the shuttle orbiter's ability to function as a space truck should alleviate much of the current criticism.

Figure 7
Evolution of Soviet Space Shuttle

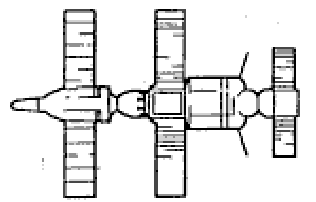
	1969	71
		
	Two Soyuz spacecraft docked	Soyuz/Salyut
Purpose	*Tested rendezvous and docking procedures* *Crew transfer by EVA only*	*First-generation space station; docking, end only; crew transfer through internal docking mechanism*
Related developments		
Materials processing		*Initial materials-processing experiments on Salyut-1*



77



82



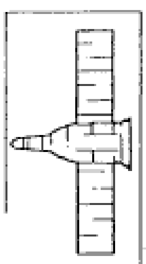
...ation; docking at forward ...hrough internal hatch in

Soyuz/Salyut 6/Progress

Second-generation space station with docking mechanism at both ends. Allowed automatic resupply of propellant and life-support systems, extended mission durations

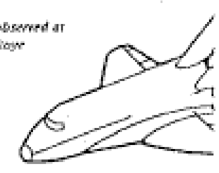
Cosmos 1267/Salyut/Soyuz

Modular second-generation space station created by longitudinal docking of "multipurpose space station" module at forward end of Salyut



1977
Cosmos 929/1267 type "multipurpose space station" (future space station module, adapted as propulsion module or tug)

1983
Shuttle observed at Ramenskoye



1976
Splav furnace on Salyut 5

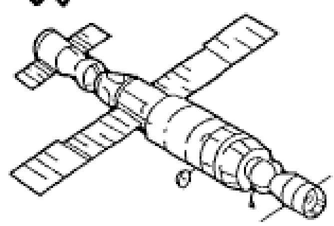
1977-82
Materials-processing furnaces, Splav and Kristall, on Salyut 6

1982-86
Korund and Kristall furnaces on Salyut 7

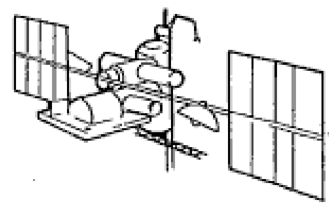
1985-86
Series of unmanned materials-processing satellites carry Splav and Zona furnaces

Reverse

86



90s



...ation created by
...ar space station"

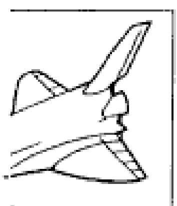
Soyuz/Mir/Kvant/Progress

Third-generation space station with multiple, radial docking ports on forward end will support a variety of docked and undocked modules equipped for astronomy, earth resources, materials-processing, and biological experiments

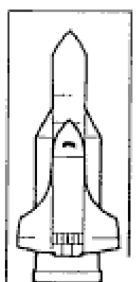
Mir II (conceptual)

Skylab-class space station core for enhanced modular space station

Shuttle probably required for support of "industrial" activity



1988
First launch of unmanned shuttle



1987-88
Improved Korund furnace installed on Mir

1989-90
Dedicated materials-processing module to Mir (minifactory)

Appendix B

Selected Facilities To Support Reusable Systems

Figure 8