CHAPTER IV

OPTIONS

In the aftermath of the Challenger accident, policymakers focused on whether Challenger should be replaced. Indeed, this question is still unresolved. But the evolution of the national debate about space transportation policy has created a new context in which to consider this issue: whether to develop a private-sector industry to serve the commercial launch market and reserve the shuttle for government use.

The Administration has proposed replacement of the Challenger, but would restrict its use to government purposes. While the shuttle will provide service for those commercial payloads only it can carry--the European Space Agency Spacelab, for example--the U.S. presence in the commercial satellite market is to be maintained by private firms providing expendable launch vehicle (ELV) services. This ELV commercialization option could help the United States maintain its 50 percent share of the commercial market through the early 1990s.

Large Department of Defense (DoD) ELV procurements, limited foreign competition, and a backlog of commercial payloads all point towards this result. Beyond the early 1990s, however, the backlog of commercial satellites will be reduced, and new foreign capacity will enter the market. The result could be a loss of U.S. competitiveness. This possibility encourages the consideration of alternative institutional arrangements to ELV commercialization, specifically, a return to the preshuttle system of NASA as a provider of ELV launch services or the creation of a mixed public/private enterprise, a U.S. Space Transportation Company.

THE REPLACEMENT ORBITER DECISION

The case for buying a fourth orbiter is strongest when considered in the context of the space station program as currently planned and weakest when presented as a cost-effective launch vehicle to deploy satellites during the 1990s. Constructing the space station would require 19 shuttle flights spread over two years, roughly equal to the capacity of a three-orbiter fleet. As a bulk carrier, however, the shuttle has lost much of its attrac-

tiveness compared with expendable launch vehicles as the shuttle system has consistently fallen short of its projected flight rate, has been more costly to operate than estimated, and may, in the future, be restricted to lower payload weights.

Cost Comparison

The annual average new demand requiring U.S. launch capacity over the next 15 years probably will range from 10.5 to 16.5 equivalent shuttle flights rather than the almost 30 flights projected before the Challenger accident. With capacity estimated to be 21 to 24 equivalent shuttle flights annually by 1989, new annual demand and the backlog of cargos created by the grounding of the shuttle could be served more economically by increased production at operating ELV facilities rather than by the large investment entailed in procurement of a replacement orbiter.

The preaccident cost advantage of additional orbiter capacity relative to increased ELV production has been negated by increases in the marginal cost of providing an additional shuttle flight, lower annual flight rates which restrict the system's capacity, and diminished orbiter carrying capacity. In Chapter III, it was shown that shuttle marginal costs were likely to increase from about $48 million to a range of $65 million to $80 million and that a new orbiter could only contribute three or four flights a year rather than the six flights implied by the preaccident goal of 24 flights per year. It is most likely that changes resulting from the Rogers Commission report will add weight to the shuttle's configuration and restrict the thrust provided by the main engines, lowering the payload weight an individual orbiter can carry.

The CBO has compared the net present value of the stream of costs that would be generated from 1987 through 2000 by a notional fourth orbiter and comparable ELV carrying capacity, as shown in Table 11. The essential cost advantage of either system depends on the number of equivalent flights launched each year. If for the reason of inadequate demand, rather than flight rate restrictions, the orbiter flies less than four times a year, its comparative cost position is eroded. If a new orbiter was flown four times each year and the marginal cost of a shuttle flight was $65 million, then the real discounted cost of building and operating the additional orbiter at full capacity is estimated to be $5.0 billion from 1987 through 2000.[1] Expend-

1. Discounting is a way to convert a future expenditure or stream of expenditures (in this case those over the 1987-2000 period) to their value today (present value), reflecting the notion that a dollar held in the future is worth less than a dollar held today. The discount rate used in this paper is 2 percent.

able launch vehicles, each of which is capable of carrying only 40 percent of a shuttle flight and is launched at a cost of $60 million, can provide comparable capacity at a cost of $4.3 billion over the same period. If the replacement orbiter could add only three flights a year or was flown only three times a year because of insufficient demand, the cost advantage would shift to ELVs by $200 million. The Chapter III comparison of capacity and demand suggest underutilization is likely. The most dramatic illustration of the ELV cost advantage relative to an underused shuttle is the $1.3 billion difference between a new orbiter used only once a year at a cost of $2.7 billion and a comparable ELV capacity priced at $1.4 billion. Increasing the real discount rate to 4 percent would favor the ELV option; conversely, lowering the discount rate to zero would favor the orbiter option.

Noncost Elements

The cost comparison of the shuttle and ELVs as carriers of deployable satellites obviously fails to credit the shuttle for its unique capabilities as an on-

TABLE 11. THE DISCOUNTED COST OF SHUTTLE CAPACITY COMPARED WITH EQUIVALENT ELV PRODUCTION AT DIFFERENT ANNUAL FLIGHT RATES, 1987-2000
(In billions of 1986 dollars)

Annual Number of Equivalent Shuttle Flights	ELV	Shuttle
1	1.4	2.7
2	2.7	3.2
3	3.5	3.7
4	4.3	5.0

SOURCE: Congressional Budget Office.

NOTES: The estimates include: $2.2 billion cost for a replacement orbiter with funding authorized from 1987 through 1992; a marginal operating cost of $65 million per shuttle flight; a $60 million launched cost for a .4 equivalent shuttle flight ELV at the three and four equivalent shuttle flight operating rate; a $65 million launched cost for the same ELV at the two equivalent shuttle flights annual level; and $70 million launched cost for the same ELV at the one shuttle flight operating rate.

See footnote 1 in this chapter for a definition of discounting.

orbit laboratory or "factory" and as a platform for satellite servicing and in-space construction activities. On the other hand, a fourth orbiter is not necessary to reap most of the benefits from these activities in that three orbiters remain intact and will fly again beginning in 1988. 2/ In their favor, ELVs provide a degree of scheduling and inventory flexibility not present in the shuttle system and do not involve as direct a risk of human life.

The case for procuring an additional orbiter is more strongly made in considering the requirements of the space station program as planned by NASA. Under the assumptions used in this analysis, the two years of station construction would require almost the full capacity of a three-orbiter shuttle system for that period. Because some of the shuttle system will have to be used for other activities, the specifics of the current space station plan are unlikely to be accomplished without a fourth orbiter. Once the station is in operation, it would continue to provide a rationale for an additional orbiter, although the justification would be less powerful. The NASA has indicated that it is considering the use of ELVs to provide the station with logistical support. By the late 1990s, the European Space Agency (ESA) plans to develop its own manned vehicle, the Hermes, which could also provide logistical support to the station.

The case for a fourth orbiter is reenforced by the long-term outlook for the development of a new manned space vehicle. The shuttle system is likely to be the sole U.S. manned access to space for the next 20 years. While the fleet will be improved periodically, the basic vehicles will stay in service. The means to produce orbiters is limited to the next several years, since it is very unlikely that production lines will be reopened once they have been completely shut down. Given the unclear demand picture in the late 1990s and thereafter, additional orbiter capacity is arguably a reasonable insurance policy against an unforeseen increase in the demand for unique shuttle services or the loss of another orbiter.

On the other hand, the national space agenda continues to grow in scope and cost. With current budget constraints, the choice of a fourth orbiter implies forgoing or delaying other transportation options. The budget now contains funding for two major new programs for space transporta-

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2. The announced intentions of the European space consortium, Japan, and the Soviet Union to fly shuttle-like craft reflect the claimed benefits of shuttle capabilities. Foreign perception of these benefits, however, does not add any particular force to the case for four orbiters as opposed to three.

tion: the orbital maneuvering vehicle (a spacecraft carried into orbit by the shuttle and designed to move across low earth orbits or to park in orbit with the space station) and the transatmospheric vehicle (a fully reusable space plane). Among other candidates for future space vehicles, the most likely is a vehicle that can lift heavy cargoes to meet future SDI requirements.

FINANCING A FOURTH ORBITER

Several plans have been suggested to procure a new orbiter. The Administration has proposed that a replacement orbiter be built over five years (for delivery in 1991) and funded over six, primarily by reprogramming NASA's projected preaccident budget. If the Congress decides to procure a new orbiter, it could modify the Administration's plan in two ways: the timing of the spending and the source of the funding--whether from new funds and/or those already projected for other programs. The Senate has included full budget authority for a replacement orbiter in the 1987 Defense Appropriations bill, but has withheld obligation of these funds until August 1987. Because this bill must remain within 1987 budget targets, the replacement orbiter would have to be funded with reprogrammed rather than new defense funds. The bill requires that construction be completed by 1991, but does not specify a schedule for obligational spendout.

Before the Administration announced its plan, NASA had proposed a crash effort to procure and produce a new orbiter for delivery as early as 1990, with the Administration's six-year funding schedule compressed into four years. Other proposals would finance a new orbiter with private capital and then lease it back to the government. While such programs would be consistent with a number of production schedules, they essentially are stretch-out schemes that, like the Administration's proposal, would allow the cost of the new capacity to be spread over more rather than fewer budget years. The lease-back scheme would add an additional set of costs stemming from the higher, competitive rate of return required by private investors.

If a replacement orbiter is built, it would probably be cost-effective to do so as quickly as possible. For example, under the assumptions developed in this analysis, the annual additional operating cost of an orbiter providing three flights a year is $195 million, while a comparable ELV capacity could cost from $450 million to $515 million. An additional cost of a stretched-out construction period is the increase in the unit cost of the orbiter attrib-

utable to additional years of exposure to inflation and to less than optimal scheduling. The NASA estimated these additional costs at about $200 million before the Administration announced its plan for a new orbiter funded over six years.

In March 1986, CBO prepared a preliminary analysis of the budgetary effects of the Challenger accident.[3] Using NASA data and estimates, the report concluded that replacing the capacity lost in the Challenger accident would require new budget authority or cuts in other NASA activities, since savings from not operating the shuttle system would be consumed by the cost of improving the existing system and new requirements to maintain research and development activities. Although specific cost and saving estimates have changed since that report, it remains clear that a new orbiter will require either new NASA budget authority or deferral of planned activities. To date, only the space station has been explictly identified as an activity that will **not** be cut. Until such time as explicit cuts are identified, the effects of funding a new orbiter out of the preaccident NASA budget cannot be determined.

INSTITUTIONAL OPTIONS

As multiple uncertainties surround the shuttle system's immediate future--how many orbiters, what carrying capacity, what flight rate--a consensus has emerged that the United States should provide ELV services to the commercial market. The Administration has proposed an ELV commercialization option, and moved to implement that option by phasing the shuttle system out of the commercial market. In considering how to achieve space policy goals, the Congress could choose to encourage ELV commercialization or either of two alternatives--providing ELV services through NASA or creating a mixed enterprise to provide space transportation. Each of these three options is described in the following sections.

Commercialization of Launch Services

This option emphasizes incentives to draw U.S. ELV producers into active participation in the commercial launch market. The NASA would be re-

3. Congressional Budget Office, Staff Working Paper, *Budget Effects of the Challenger Accident* (March 1986).

moved from the commercial market as a primary carrier, either directly by executive order or less directly by raising shuttle prices to very high levels. Under this option, the shuttle system could be used only by those commercial payloads that could only be carried by the shuttle.[4] The NASA would continue to provide shuttle services for its own needs and for DoD. The DoD would also procure and operate the Titan and the medium launch vehicle (MLV) for national security missions. As in the public launch service option, NASA could procure launch vehicles through DoD to meet its own needs. Both DoD and NASA could also procure ELV services from private providers, if the need arose. In fact, a bill introduced before the Subcommittee on Space of the House Committee on Science and Technology, the Assured Access to Space Act (H.R. 5469), calls for NASA to procure ELVs to meet government demand and to provide additional incentives to commercialization.

Current producers of ELVs and new entrants to the market would be encouraged to compete directly with foreign launch providers, such as Arianespace. A primary incentive would be the removal of the federal government from the commercial market. A second incentive would be federal procurement of ELVs, such as the Titan, MLV, and Delta. A complementary third step to encourage the commercial U.S. ELVs industry would be to slip launch dates for noncritical government payloads in order to provide space for commercial loads with critical time frames.

The federal role in space transportation would change dramatically under this option. In the immediate future, federal procurement of ELVs would improve the competitiveness of U.S. producers in the commercial market by lowering the unit costs of ELVs through larger production runs. Thereafter, the federal government would assume the roles of a facilities operator for launch sites, a regulator of the launch service industry, a purchaser of services, and a guarantor of fair trade practices in the international arena.

In this option, the shuttle system would continue to be operated by NASA for the immediate future. The precedent established for commercialization, however, could eventually lead to the transfer of the existing fleet to commercial operators or to the financing of additional shuttle capacity by the private market.

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4. There are gradations of shuttle and ELV dual compatibility. In the longer term, only payloads requiring a roundtrip and/or human support are not dual compatible. In the immediate future, however, a small group of deployable satellites has been designed to fly the shuttle only and would require modification to be flown by an ELV.

The Public Sector as Launch Provider

This option represents a return to the system of the past. The NASA would provide launch services for all civilian users, both public and private, by using the shuttle and procuring expendable launch vehicles--perhaps the Delta-class rocket, for example. The NASA and DoD would divide space transportation capacity to avoid redundant operating and procurement systems. The NASA would provide launch services for its own and other civilian agency requirements and sell services to the commercial market. The DoD would provide services for its national defense needs by procuring and operating the Titan and medium launch vehicles. If, in servicing its own needs and those of other civil users, NASA required a Titan or MLV, it would be procured through the Air Force. Conversely, DoD needs for the shuttle or smaller expendable vehicles would be met by NASA.

Under this option, the cost of space transportation would be carried in the federal budget, with fees from the commercial community counted as offsetting receipts and intragovernmental financial transfers made to cover the cost of service provided by one part of the federal government to another. The NASA would provide ELV services to the private sector. The NASA's use of ELVs would not preclude the shuttle from flying commercial payloads in the future, but it would remove this immediate pressure on the shuttle's capacity. Launch prices to the private sector could be established at the level of the marginal cost of ELV services as this cost measure would lead users to value space transportation services at the cost of replacing them, the correct economic standard for pricing such services. 5/

This option would require an examination of the Commercial Space Launch Act (Public Law 98-575). The private sector would continue to be involved in space transportation by selling rockets and launch services to NASA and DoD, but incentives to sell private launch services outside the NASA framework would essentially disappear.

A National Space Transportation Company

A third option would create a mixed public/private U.S. space transportation company similar to the European consortium, Arianespace. A proposal of this type could be structured in a number of different ways, but it would require a continued federal role in the near term, and the application of

5. See Congressional Budget Office, *Pricing Options for the Space Shuttle* (March 1985).

private management and market discipline to increase the operating efficiency of U.S. launch services. This goal would be sought in a mixed ownership structure with NASA as the government representative, aerospace contractors as a second party, and the public, through a stock offering, as a third party. The company would assume control of the shuttle fleet and procure ELVs to provide launch services to DoD, NASA and other federal agencies, and the commercial market. Establishing such an entity would involve the transfer of federal assets and personnel to the company, thus entailing major legislative changes.

The physical process of providing launch services would remain much as it is under current policy. Existing contractors would manufacture hardware and provide services. Contractor and NASA personnel would conduct launch operations at existing facilities, but under a new management organization. The role of NASA would be dramatically changed as it would no longer provide launch services even for its own payloads. While the DoD could maintain a separate ELV capacity, this option would work best if all U.S. government launch services were procured from the company which, in turn, would obtain hardware and other services from the aerospace members of its ownership.

These procurements and use of the orbiter fleet would be undertaken to provide the most cost-effective mix of services to meet federal requirements and market demand. The shuttle would continue to carry commercial payloads when it was cost-effective to do so. Production of ELVs would be consolidated into a single production system, and eventually a single, more competitive ELV should emerge. Advocates argue that only by lowering cost in this way can the objective of the U.S. competitiveness be achieved. In this arrangement, as in the others, the cost of space transportation would largely be borne by the federal government, but as the purchaser of launch services rather than through hardware procurement.

INSTITUTIONAL OPTIONS COMPARED AND EVALUATED

The first goal of any institutional mechanism that seeks to serve the U.S. and international commercial launch market is to provide adequate launch capacity. Each of the options considered above can accomplish this objective by the late 1980s. The options show various strengths and weaknesses when measured against certain other criteria, as follows:

- The international competitiveness and economic efficiency of the U.S. industry;

- o The cost-effective use of the federal space transportation investment;
- o The impact on the NASA and its budget; and
- o The legislative and administrative ease of the alternative arrangements.

Competitiveness, Efficiency, and Subsidy

The end of the U.S. monopoly on space transportation in the noncommunist world has made international competitiveness (defined as a substantial share of the commercial launch market) an important space policy goal. The shuttle pricing debate of 1985 ended with the establishment of a commercial market price roughly equal to the long-run marginal cost of a shuttle flight. This price would have allowed NASA to win no less than 50 percent of the market, without damage to larger goals of U.S. economic policy, such as free trade and efficient resource allocation. Specifically, no explicit subsidies were to be tendered to the shuttle system and thus, the goals of competitiveness and efficiency could be pursued simultaneously.

Removing the shuttle from the commercial market in favor of U.S. ELV entrants, public or private, would change the prospect of meeting these goals simultaneously, regardless of the choice of institutional arrangement. By removing the shuttle system from the commercial market, the United States will forgo any cost advantage provided by the shuttle technology and its unique circumstance as a "declining cost" enterprise, while facing increased competition from foreign enterprises.[6/] Although the immediate backlog of commercial payloads could leave U.S. market share unaffected by the loss of this "least-cost" technology option, by the early 1990s excess launch supply is likely to exist. Under conditions of excess supply, realizing the goal of a substantial share of the world market might require subsidies, regardless of the institutional arrangement.

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6. The present value comparison of cost between an additional orbiter and federal ELV capacity granting no advantage to a replacement orbiter is consistent with the cost comparison between shuttle services offered to the commercial market and ELV services that grants the shuttle an advantage. In evaluating the stream of costs to the government of an orbiter, the full investment value of the replacement orbiter was included, whereas the cost calculation for the efficient commercial price level included only part of the orbiter investment and spread that cost over a longer life.

The ELV commercialization option could foster a competitive and economically efficient U.S. presence in the commercial market into the early 1990s. The backlog of demand would provide willing customers. Federal procurements would drive down the unit cost of ELVs. Arianespace would capture as much of the market as its capacity permits, but it would have every incentive to maximize revenues through increasing prices rather than increasing its share, given substantial excess demand.

But, beyond the early 1990s, market conditions are likely to change and the commercialization option might leave the United States in an uncompetitive position. The demand for launch services would revert to its lower level as the backlog is flown off. At the same time, new foreign capacity would enter the market, in some instances with the support of direct government operating subsidies. In this environment, the ELV commercialization option might require U.S. government actions beyond federal ELV procurement by the government to maintain the U.S. share.

Countervailing subsidies to lower the operating cost of U.S. private firms is one response. But such subsidies would be inconsistent with a commercialization option emphasizing the use of markets and the value of private enterprise. Moreover, since the level of subsidies would be tailored to individual firms under the commercialization option, they might be considered inequitable within the overall economic system. The commercialization option would be more consistent with eliminating subsidies through trade negotiations and international agreements, such as the General Agreement on Trade and Tariffs (GATT). It might be difficult to reach such agreements, however, or to enforce them once reached, jeopardizing the goal of maintaining the U.S. market share.

Development of newer, lower-cost U.S. ELV technology is another response to a more competitive environment in the launch market of the 1990s. But the commercialization option would be unlikely to induce private firms to invest the substantial sums of money necessary to develop new vehicles. While these firms would be quite willing to accept government funds to develop a rocket system uniquely designed for the commercial market, the advantage to the federal government would be lost relative to the other options in which public investment would directly benefit the public sector as well as private producers.

The commercialization option offers both advantages and disadvantages in the 1990s if the U.S. response to increased competition is to reintroduce the shuttle system into the commercial market. On the one hand, ELV commercialization would provide a precedent for commercialization of

the shuttle. On the other hand, the alternative of providing an integrated shuttle and ELV space transportation capacity under a unified management would be precluded.

The NASA option would produce results similar to those of the commercialization option in the immediate future. Eager customers would be as willing to buy NASA launch services as those of private firms over the next few years, and the level of foreign competition would not change, regardless of whether the public or private sector provided service. The cost of services provided by NASA would likely be higher than equivalent commercial services because government involvement would impose regulatory and administrative costs above those that would occur under a private enterprise.

The NASA option might offer the advantage of long experience in the launch business and, consequently, greater reliability than potential private entrants. But this point should not be overemphasized since the contractors providing extensive support to NASA in its launch activities are the potential commercial ELV entrants and would provide service in one form or another under all the options. Moreover, much of the NASA in-house ELV experience was lost during the 1980s when NASA activities were focused on the shuttle.

A NASA public sector option might enjoy an advantage relative to the commercialization option in maintaining the U.S. market share as competitive conditions change. As NASA would control a mixed commercial fleet, the shuttle could be reintroduced into the commercial market more easily. The threat of easy shuttle reentry might discourage some foreign competitors from offering subsidies, or a least decrease their size. Public funding for new vehicle development could be appropriated in the traditional way through the NASA budget (although other concerns, such as the space station, might be more pressing). The NASA option would also provide a ready conduit to channel U.S. subsidies should they be deemed necessary to countervail support by foreign governments. The use of international trade negotiations to eliminate subsidies would probably be less effective under the NASA option for these very reasons.

The U.S. Space Transportation Company option offers no short-term advantages relative to the alternatives. It could be less efficient and more costly than either the ELV commercialization or NASA options over the next several years, because of the added expense of transferring assets and establishing a complicated new structure. Like the alternatives, however, the mixed enterprise would establish itself in the relatively easier market conditions of the late 1980s and early 1990s.

Into the 1990s, the mixed enterprise would share with the NASA option the advantages of direct government participation in responding to subsidized foreign competition, and would share with the commercialization option the subjection of its operating cost to the discipline of the market. The case for a mixed enterprise option could be made most strongly, however, for its potential to modernize the supply of U.S. space transportation by the early 1990s, and to allow high production volume to force down unit costs.

Advocates of a mixed enterprise have been explicit in including development and extensive federal use of a more cost-effective U.S. ELV as part of their proposals. Countering foreign competition is the objective. The relatively easy market of the next several years would provide a breathing space for a new enterprise, during which both public and private funds could be channelled into a new vehicle that would allow the United States to meet its market share goals in the 1990s, without providing operating subsidies. Such an effort could be undertaken under either of the other options. The motivation to do so is lacking, however, in the NASA option, as NASA is committed to the shuttle in the long run. The merits of public investment in new technology are less clear under a strict regime of ELV commercialization, because a single firm might benefit disproportionately.

Cost-Effective Use of Federal Transportation Capacity

The choice of an institutional option to provide a U.S. ELV capacity to the commercial market is related to the cost-effective use of federal space transportation capacity. If commercial payloads were not flown on shuttle flights dedicated to their use, but rather were placed on flights that would have been flown in any case, the cost of federal space transportation would decrease by opening the shuttle to commercial payloads. Even if the shuttle was temporarily removed from the commercial market, the benefits of such an integrated approach would more likely be realized in a framework in which the shuttle and civilian ELV capacity was controlled by a single organization as in either the **public sector or mixed enterprise options.**

If federal capacity exceeded launch demand and U.S. ELV producers required continuing federal procurements of vehicles to maintain cost competitiveness in the international market, the goals of gaining a share of the commercial market and effectively using the shuttle system might be in conflict. Extensive use of ELVs to meet federal needs could result in underutilization of the shuttle. Full use of the shuttle could result in insufficient federal ELV procurements to permit international competitiveness by the

private sector. The **public sector and mixed enterprise approaches** are more likely to reach both goals simultaneously than is the **commercialization option.** Regardless of the institutional arrangement, procurement of a replacement orbiter would increase the possibility of overinvestment by the federal government, while stronger demand for launch services would decrease this prospect.

The NASA Budget and NASA's Role

Under the preaccident institutional arrangement, NASA functioned as a provider and operator of infrastructure, in addition to its primary mission of research and development. This role has immediate consequences for the NASA budget over the next five years as well as more long-term implications for the space station program.

The **commercialization and mixed enterprise options** would directly affect the NASA budget over the next five years by lowering the inflow of funds from the commercial market, estimated to total $1.04 billion for 1986 through 1990.[7] The move away from the shuttle-only system to a mixed fleet for all U.S. users would further intensify the budget issue by calling into question an additional $3.3 billion that is scheduled to be transferred from the DoD to NASA during the same period. Table 12 presents the annual estimates of these user fees from the commercial market and intragovernmental transfers from DoD.

The net of commercial revenues over the cost of services provided will not be as great as NASA projected in any case, since the marginal cost of shuttle services is expected to increase, as shown in Chapter III. Pursuit of the *commercialization option*, however, would create a need to reexamine the NASA budget plan and to increase expenditures or cut back activities.

More significant from a budgetary point of view is the potentially greater use of ELVs by DoD and related cutbacks in anticipated funding transfers to NASA. This prospect is aggravated to the extent that national policy implicitly requires public use of ELVs to permit private competitiveness on the international market. Because either of the options directly involving the public sector would secure easier integration of ELV and shuttle capacity, they would lessen these disadvantages. None of the options,

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7. Because the reimbursements discussed here are based on preaccident shuttle schedules, and shuttle flights are now being held in abeyance until 1988, NASA obviously will not receive all these funds until the shuttle resumes launches, regardless of the option considered.

however, would facilitate the accommodation of lower DoD reimbursements in the NASA budget.

Beyond budgetary questions, the institutional arrangement chosen to provide U.S. ELV services to the commercial market will affect NASA's role in the long run. Before the Challenger accident, NASA was to be the preeminent provider of space transportation to all U.S. users. But even granting technical feasibility, this position was sometimes viewed as incompatible with NASA's basic research and development mission. From this perspective, the *commercialization and mixed enterprise options* would be superior to NASA's continued participation in the market.

Those who support removing NASA from the space transportation business see NASA as burdened by operational responsibilities, including marketing, that it is ill-suited to carry out. These responsibilities, it is contended, have required a disproportionate share of the agency's time and budget and would continue to do so into the indefinite future as NASA takes on operating a space station and, perhaps, a lunar base. Spinning off space transportation, if only the civilian ELV operation, would allow NASA to concentrate on research-related tasks. The *mixed enterprise option* would move the

TABLE 12. ESTIMATED SHUTTLE REIMBURSEMENTS UNDER SHUTTLE-ONLY SYSTEM
(By fiscal year, in millions of dollars)

Revenue Source	1986	1987	1988	1989	1990
DoD	223	531	787	775	983
Foreign/ Commercial	97	173	252	348	169
Total	320	704	1,039	1,123	1,152

SOURCE: Congressional Budget Office, based on NASA budget for fiscal year 1987.

NOTE: These estimated reimbursements are based on shuttle flights scheduled before the Challenger accident. With the flights held in abeyance until 1988, NASA will not receive these revenues until the shuttle starts to fly again, regardless of the option considered.

shuttle system and ELVs outside NASA as currently structured and, at the same time, establish a model for space station operation after NASA has built the initial configuration. The *commercialization option* would be more incremental in that only ELVs would be commercialized; however, it would establish a path that the shuttle system could follow in the future.

Administrative and Legislative Ease

The **commercialization option** would have a clear and immediate advantage in meeting these criteria. The essential machinery to implement a commercialization policy already exists. The formal issues of use of government-developed technology and rental of government facilities are now being addressed by the Department of Transportation. The more substantive issues of removing NASA from the launch business and federal procurement of ELVs are also moving forward, although a clearer definition of how soon NASA will leave the launch business would help new U.S. private entrants in signing critical early launch agreements.

The machinery to **restore NASA's role** in providing ELVs to the launch market is also in place. Legal questions and the need for new legislation could well arise if NASA began to market ELV services, however. At a minimum, ELV commercialization would have to be dropped explicitly as a goal of national space policy if NASA were to stay in the commercial market.

The **mixed enterprise option** would present substantial legislative and administrative obstacles. The form of the enterprise would require precise and complex new legislation. Complications abound: how would national security requirements be integrated? Would special antitrust relief be necessary? What level and type of federal support should be provided? Should providers of U.S. communication satellites be included or not? On the other hand, moving towards such an enterprise now could diminish longer-term administrative problems, including that of the eventual ownership and operation of the shuttle system.