

SPACE SHUTTLE VALUE OPEN TO INTERPRETATION

For more than 20 years, policymakers and analysts have been asking what appears to be a simple question: How much does the space shuttle program cost?

The answer is not simple. As a January, 1993, General Accounting Office (GAO) report noted, shuttle costs depend upon factors included in the tabulation and the purposes of the cost data.

With President Clinton's recent decision to support a Freedom-derived space station program—and its uncertain future in Congress—it is prudent to ensure the shuttle's cost benefit analysis is well understood so that the space program has the greatest chance to move forward with or without a space station program.

Shuttle costs are tabulated from NASA's annual budget request to Congress. Over the program's existence, they have been identified in various NASA budget categories including development, operations, civil service salaries and facilities construction.

The costs as tabulated by NASA are probably conservative by not more than 10%. For example, Defense Dept. money spent on the shuttle during the 1980s and the costs of developing the Advanced Solid Rocket Motor are not included in NASA's cost analysis.

THOSE COSTS HAVE BEEN inflated to 1992 dollars using the Gross National Product price deflators found in the 1993 Economic Report of the President. Expressing costs in constant dollars allows for meaningful tabulation of expenses incurred over an extended period when the effects of inflation are significant. Because the 1971 dollar value was worth more than it is today, GNP price deflators help to correct for the difference.

Shuttle costs can be viewed from three perspectives: the taxpayer, who is concerned with aggregate costs; the space policymaker, who wants information that can facilitate decisions within the space policy arena, and the national policymaker, who is concerned with the space shuttle in relationship to all other national priorities.

From the taxpayer's point of view, the central questions are: How much has the shuttle program cost since its inception? How much will it cost from beginning to projected end? What is the average cost per flight based on these totals?

In Fiscal 1992, the shuttle cost \$79.2

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billion dollars in constant 1992 dollars. Without adjusting for inflation, the program cost \$57 billion. For the sake of comparison, total cost estimates of the Apollo program ranged from about \$25 billion in uninflated dollars to more than \$95 billion in inflated dollars. Using constant dollar figures, the shuttle program's total cost will eclipse that of Apollo by 1996. Using current dollars, the shuttle program has cost more than 2.25 times the Apollo program.

In Fiscal 1993, the shuttle program is projected to cost about \$4.5 billion. Based on 1992 dollars, if the program's annual expenses average this amount for the remainder of its operations or through 2005, its total cost will reach \$137.7 billion and if the program ends in 2010, \$160.2 billion.

If the program had ended at the completion of the Fiscal 1992 budget year, then the average cost per flight (using inflated dollars) would have been \$1.6 billion (\$79.8 billion spread over 50 flights).

If the program averages eight flights per year for the remainder of operations or through 2005, then the average cost per flight, using the above cost assumptions, will be about \$900 million (\$137.7 billion for 154 flights), and about \$825 million if program termination occurs in 2010 (\$160.2 billion spread over 194 flights). If a lower rate of just four flights per year is assumed, then the average cost per flight will be \$1.35 billion in 2005 and \$1.2 billion in 2010.

It is important to note that these average costs are not the most relevant figures upon which to base policy decisions

about the future of the program because they include development costs. A more reliable measure is the average operational cost per flight. Aggregate cost data can provide the taxpayer with a sense of shuttle program costs that can be used in comparison with past and proposed space (and non-space) programs.

From the policymaker's perspective, aggregate expenses can help to provide an overall sense of the program's costs and how taxpayers (and voters) react to them. For the purposes of making an informed decision about the program's future and whether it is worth pursuing, a finer cost assessment is necessary. Thus, a distinction is required between development versus operational costs.

ONE WAY TO DRAW this distinction is to classify costs incurred before the first operational flight as development, and those following, as operational. The first operational flight was the fifth shuttle launch and the first of Fiscal 1983. Thus, development costs were \$32.4 billion in constant 1992 dollars (\$17 billion in uninflated dollars), which were incurred from 1971-82. Operational costs have been \$46.8 billion in 1992 dollars (\$34.5 billion in current dollars) for the period 1983 to 1992, or an average of \$4.7 billion annually.

Using only the costs incurred during the operational stage, the average cost per flight through 1992 was about \$1 billion, representing an average of 4.6 flights annually.

If the program continues to average the same number of flights, policymakers' best estimate of future costs per flight—based on program experience—is \$1 billion. Estimators suggesting a higher (or lower) flight rate or lower (or higher) cost per flight should be prepared to justify their claims.

This calculation of average cost per flight differs from NASA's tabulation of \$414 million in two important respects:

- NASA calculations are based on projected flight rates and costs. So if the shuttle fails to meet planned flight rates, as it has often done, actual costs will be higher. Launch schedule data is the best guide to future cost benefit analysis.

- NASA uses data only from the current fiscal year. Historical data yields more reliable estimates. Thus, while actual shuttle costs may approximate NASA's estimates, experience suggests more con-



servative estimates are warranted.

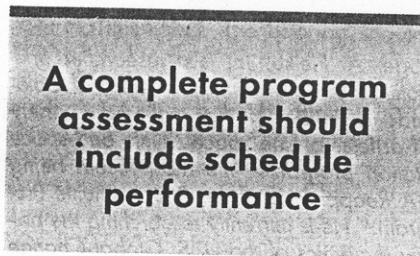
From the perspective of policymakers concerned with daily space policy decisions, there are other ways that shuttle costs may be calculated. These include marginal costs, fixed costs and the costs of attrition.

Marginal costs are those associated with adding or deleting an additional flight to the schedule. The GAO reports that the marginal cost of deleting a shuttle flight in Fiscal 1993 would be about \$44 million. This means that NASA would save \$44 million if one shuttle flight were cancelled.

If the shuttle flight rate is already at its maximum, then it makes little sense to talk of adding flights. Thus, consideration of marginal costs is most relevant to making decisions about reducing the flight rate.

The low marginal cost implies that the program's fixed costs are high. In other words, the program would be expensive even if there were no launches. In Fiscal 1987, when no launches were made, the program cost about \$4 billion (in 1992 dollars). In Fiscal 1988, when there was one launch, the cost totaled \$3.8 billion (in 1992 dollars). This implies that any alterations to the flight rate would be unlikely to result in cost savings of more than about 10%.

Another measure important to space policymakers is attrition. The Challenger was the only orbiter lost in the program's first 50 flights. Its replacement cost about \$2.5 billion (in 1992 dollars). Assuming that reliability is 1 in 50, then one measure of the cost of at-



trition is \$50 million per flight. A \$50-million surcharge over 50 flights would raise enough to purchase a replacement orbiter. But no orbiters are scheduled to be built, and the loss of another orbiter would introduce radical changes in policy. So attrition costs may be more relevant to future programs.

How much will the shuttle cost for the remainder of the program? The answer, based on past shuttle program experience, is about \$4.5 billion a year (in 1992 dollars), with the average flight costing about \$1 billion. And these

costs are unlikely to be reduced significantly.

There are several other points to bear in mind when discussing shuttle costs:

- An emphasis on reducing costs per flight can create incentives to increase the flight rate. An increased flight rate provides more flights over which to spread the program's high fixed costs, reducing the average cost per flight.

Pressure to increase flight rates could possibly lead to lower reliabilities. However, because annual costs are relatively independent of the flight rate, policymakers may wish to use annual costs to assess the program and then determine the proper flight rate on other factors.

- A complete program assessment should include schedule performance, which includes the ability to launch and relaunch on schedule, and operational capability.

With solid grounding in the areas of cost, schedule and operational capability, policymakers can make informed decisions on the future of the space shuttle program. Setting the data record straight is the first step towards clarifying what our space policy interests should be and elevating the debate to broader issues that go beyond dollars-and-cents alone.