

What did the space shuttle cost?

The space shuttle program cost \$116.1 billion. That paid for five orbiters, four test flights and 131 orbital missions flown between 1981 and 2011.

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What the officials promised to do was dramatically reduce the cost of moving people and machinery to space, to make space flight so easy and inexpensive that no one with the means to support extraterrestrial travel would be able to resist the temptation to do it.

Members of the 1970 President's Science Advisory Committee, writing during the course of debate over the Nixon space doctrine and its consequences, suggested that the future of human space flight would likely be determined by developments in this realm. At the time, no one knew whether humans would prove more effective than robots for exploring space. If the cost of transporting humans and the machinery needed to keep them alive remained high, the future for human flight looked dim. If the cost fell that would open incredible opportunities. Stanley Kubrick and Arthur C. Clarke visually represented the latter outcome in their classic 1968 film *2001: A Space Odyssey*. A winged space shuttle docks with a large rotating space station, a government official is transported to an existing lunar base, and astronauts depart on a human mission to the outer planets to look for evidence of intelligent extraterrestrial life.

At the time, a Saturn IB rocket could deliver a payload with a mass of 37,000 pounds (16,600 kilograms) to low-Earth orbit at a cost of roughly \$55 million. Engineers at NASA's Marshall Space Flight Center developed the Saturn IB to flight test equipment for use in Project Apollo. The much larger Saturn V could place 285,000 pounds (129,000 kilograms) in LEO for an estimated cost of \$185 million for the rocket and \$40 million more for flight operations. Thus the cost per pound to low-Earth orbit around 1970 ranged from \$650 to \$1,500 per pound.

NASA officials agreed to cut that amount "by a factor of ten," or more accurately, they agreed to try. Estimates of the total program cost varied from \$12.2 to \$14.6 billion. Those sums included the cost of spacecraft design, fabrication of five spaceships, flight testing, and operational expenses covering up to 580 flights over a twelve year period. The two figures were stated in 1970 and 1971 dollars, respectively. When translated into real year appropriations, the lesser number produces a sum equal to \$29 billion....Such an objective effectively achieved would have provided a technology irresistible to governments and firms in the space flight business.

In what has become an oft-repeated story, the effort failed. Initially, the program held to its cost goals. NASA met its cost goals for the first phase of the program (design, development, initial testing, and the production of the first two orbiters.) It actually spent \$10 billion, a cost overrun of just 15 percent. It also met its shuttle operations cost goals for flights through 1990. It actually spent \$15 billion, 37 percent *under* the original projection.

Although the agency met its cost goals for operations, it could not achieve its desired flight rate. The plan called for at least twenty-four flights per year to achieve profitability; the goal was twice that number. The agency averaged six. This eliminated the prospects for marginal cost advantages arising from the opportunity to fly many times per year. When NASA officials tried to increase the flight rate, the *Challenger* exploded.

To achieve the desired flight rate, NASA officials planned to produce five orbiters. After production of the first two, the agency planned to refurbish *Columbia* and *Challenger* and produce three more. This phase of the program was estimated to cost \$2.9 billion (1971 dollars). To meet these cost goals, NASA and its contractors needed to produce each new orbiter for about \$625 million. The actual cost grew to \$1 billion and beyond. Moreover, NASA kept incurring production costs. The original plan called for the agency to stop spending money on shuttle production after completion of the fifth orbiter and concentrate on operations. In fact, the agency continued to spend funds on shuttle production and upgrades through the year 2000, a total of \$24.8 billion.

Under the original plan, NASA planned to replace the space shuttle with a more advanced vehicle in 1990. By 1990, with no replacement in sight, NASA continued to fly what had already proved itself to be a costly and inferior system for another twenty-plus-years. The cost per flight closed on \$800 million as the challenges of flying what astronaut Michael Collins characterized as a “tender technology” became apparent. A private firm would have gone out of business; Congress continued to appropriate funds. In all, NASA spent slightly more than \$81 billion on shuttle flight operations, far more than anticipated for the number of flights achieved.

In public discourse, the cost of the space shuttle program is often exaggerated. The program’s Wikipedia page contains an estimate of \$1.5 billion per flight. The actual numbers are severe enough. In real year dollars, the shuttle program consumed slightly more than \$116 billion....Had anyone known in 1972 that the shuttle program would impose a burden on the U.S. space program roughly twice that of Project Apollo, the shuttle in its produced configuration would have never been approved.

Summary of NASA Space Shuttle Expenditures (billions of dollars)	
Design, development, testing, and two orbiters	10.2
Shuttle Operations	81.1
Through 1990	15.1
1991-2011	66.1
Shuttle production and upgrades	24.8
Total cost of space shuttle program	116.1
Source: NASA budget documents. Figures are in real-year dollars, not adjusted for inflation.	