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Space Shuttle

After Neil Armstrong's small step onto the moon and one giant leap for mankind, NASA turns its attention to the next generation of space flight, the space shuttle. The legacy of the space shuttle remains one of not only scientific and technological expansion but also mistakes and tragedies. The reasons for the space shuttle conception, the time and money spent on the program, the people involved, and the history it leaves behind is clouded by the question if the entire experiment was worth the trouble.

The introduction of the space shuttle program resulted from the people's wild imagination, NASA's desire for a new space vehicle using new technology, and the government's pressure for less expensive space travel. Before man even transcended to the moon, the Collier's articles, an eight-part series, implanted the idea of space travels in “shuttle rockets”, moon landing, and various flight to other planets. These articles, inspired and corrected by Von Braun, immerse the general public and NASA into the idea of manned winged-shuttles through space. The idea became so ingrained that when the need for a new way to travel through space was considered, the space shuttles were at the forefront minds of NASA (Heppenheimer 6).

With the growing cost of space rocket launches, their inability to be reusable and the end of unlimited funds from the government as the Nixon administration took over the White House, the pressure for less expensive vehicle changed the course of NASA's design for its next spacecraft. The mounting cost of sending humans into space was evident, the Saturn I-B amounted up to $45 million, Saturn V was $185 million, human participation as astronauts cost $60 million each, and these amount does not even take into consideration the cost of the Apollo spacecraft and the operations of the mission (Heppenheimer 73). NASA began to offset this large cost by starting from scratch, designing a reusable spacecraft that will become according to President Nixon “the workhorse of our whole space effort.” Although some believe a new design to reduce the expense for space mission might actually increase the cost (Thompson 1). Whatever the cost NASA's final decision to start the Space Transport System, using the shuttles as their main vehicles, began a thirty year experiment.

When NASA finally had the go-ahead to construct the space shuttles, companies competed for the lucrative contract to design and build parts for the NASA space shuttles. NASA intended to use the Michoud Assembly Facility, many times manufacturing military vehicles before becoming inactive again, to build the external tanks. NASA had previously use the facility for the Apollo program to construct rocket stages. Before the external tanks could be built, NASA must first contract a company to design and build the best optimize tank. NASA issued a Request for Proposal to several competing companies: McDonnell Douglas, Martin Marietta, Boeing, and Chrysler. Out of the four issued RFP, Martin Marietta Company won the contract (Heppenheimer 67).

> Technically, Martin Marietta was just slightly better than the next company, McDonnell Douglas, but their costs both for [design, development, test, and engineering] and for production work was considerably lower. Although we recognized that the Martin Marietta Company was partially “buying in” with their lowest costs, we nevertheless strongly felt that in the end in the Martin Marietta cost would, indeed, be lower than those of any of the other contenders. McDonnell Douglas had a different kind of buy-in, in that they shaved the weights below a reasonable value. Boeing's major weakness was their selection of General Dynamics as a partner in area where they really did not need this company. This presented an awkward marriage and probably would have caused

> major problems during the years. Chrysler was weak all around. In the selecting the Martin Company we felt that they will undoubtedly do the best cost management job in that they have clearly proposed doing this "the new way" (design to cost). The others, in effect, were proposing to do business as usual (Heppenheimer 69).

The solid rocket boosters needed less design time since much of the core concept already existed in the standard practice. The boosters came from United Technology Center and assembled at Solid Motor Assembly Building. The contract to optimize the two solid rocket boosters went to Thiokol, not for its best overall design and cost savings, but for the better management in carrying out the order than competing company. Consequently, the belief in Thiokol's design and an old network of friends between Thiokol and NASA caused the loss of the shuttle *Challenger* (Heppenheimer 73).

The research and development of the orbiter require longer time periods to complete than the other two key shuttle components. After many companies attempted different designs of reusable crafts like winged astroplane, astrorockets, and many other designs ahead of its time, NASA rejected them all and finally decided to contract Lockheed and National Aeronautics Association to design the "Reusable Ten Ton Orbital Carrier Vehicle" (Heppenheimer 80). The research concluded that future orbital vehicle would have fix wings and launch vertically. This design would save costs from increasing and allow most of the component to be reuse. Years of turmoil in the United States, from escalating deficit in the U.S. Government to the Vietnam War to riots across the country, impeded on NASA's plan for a shuttle, but slowly as time blew by the orbiter took shape. The orbiter's basic design came mainly from the idea of reusability, and cost limits from the Office of Management and Budget (Heppenheimer 286) .

The main overall design may be inspired from the Collier's series, but the components and make up of the shuttle come from the restriction and limitation of budget issues. The final design, comprising of mainly one large orange external tank (ET), two solid rocket boosters (SRBs), and the orbiter, which the general population mistakenly call the shuttle, is currently the United States main transportation into space (Lee 153). Starting with the largest component of the space shuttle, the external tank, measuring forty-eight meters long and 8.4 meters in diameters, the ET actually consist of two tanks, one containing 541,428 liters of liquid oxygen and the second holding 1,449,905 liters of liquid hydrogen (Heppenheimer 67). If the main fuel was contain in the orbiter itself to achieve escape velocity, then the weight of the fuel would make such action impractical. Instead the orange external tank is jettison after the fuel is expended from its two compartments. Originally coated with white paint to complement the rest of the shuttle, the ET is now brownish-orange to cut weight from the extra paint. The brownish-orange color comes from the layer of polyisocyanurate, which prevents ice from forming on the ET, keeping the boil-rate off (Lee 157).

The two white solid rocket boosters (SRBs) provide the main initial boost to augment the acceleration to escape into orbit. Measuring at 45.5 meters in height, each rocket ejects 11,790,000 Newtons of thrust when launched (Heppenheimer 74). The SRBs actually has enough force to launch itself and the orbiter, but does not contain enough fuel to send the orbiter into orbit. This is why the ET is needed. Because of budgetary reasons, the original idea of using liquid rocket fuels became replace with the modern idea of using solid fuel to cut cost. The main reason NASA had prefer liquids over solid because once ignited solid fuel will not stop until the entire fuel has been expended. The solid fuel is a mixture of atomized aluminum powder fuel, ammonium perchlorate oxidizer, polybutadiene acrylic acid acrylonitrile and epoxy with small amounts of iron to regulate the burning rate of the fuel. Since solid fuel manufacture requires complex fabrication, the solid fuel comes in four segments for each SRB (Lee 157-8).

Finally, the shuttle orbiter, “the world's first reusable spacecraft”, resembles a Boeing 747 with three boosters, called the Space Shuttle Main Engine (SSME), on the end and carries the astronauts to their destination and back. The rocket engines burn a mixture of liquid hydrogen fuel and liquid oxygen oxidizer. Currently design to accommodate six to seven passengers in the crew cabin, the orbiter's can also carry large payloads in its bay, measuring 18.3 meters long, 5.2 meters wide and 4 meters deep. The bay doors protect the valuable satellite or equipment use for scientific experiments inside the compartment (Lee 154). An winged orbiter cost around two billion dollars to construct. Presently, six orbiters have been constructed, five have actually been launched into space, and two have been destroyed. The first shuttle ever built, the Enterprise, was never flown into space. Originally plan to be christen the Constitution, NASA renamed it Enterprise after a massive petition from Star Trek fans to name the first shuttle orbiter after the TV shows spacecraft, but to the disappointment of the fans NASA never plan to launch the craft into orbit. The other five operational orbiters are Columbia, Challenger, Discovery, Atlantis, and the Endeavour (Lee 152).

NASA officially launch the Space Transportation System with the *Columbia* on April 12, 1981 and have to continue to launch shuttles into space for more than twenty-five years since then. Launching a rocket is difficult enough, therefore launching a space shuttle with men and women aboard from Earth and return safely is extremely complex. The entire process to launch the shuttles takes teams of scientists in organization to accomplish such a task. The manufacture construct and send the ET to the launch pad at the Kennedy Space Center. The SRBs are reuse from previous mission, but they must be dissemble before travel and resemble at the Space Center. Finally the orbiter must be carried flown from its hold site on top of a large Boeing 747 and inspected for damage between missions (Lee 160-2). NASA place the entire space shuttle onto the mobile launch vehicle, transporting it towards the the launch pad at 1 mile per hour. All this must be completed before the countdown begins.

The countdown for liftoff begins at T- 12 hours, during this time teams of engineers begin preparing the shuttle for launch with “holds” for any unprepared difficulties. Nearing the 6 hours mark, then engineers begin filling the tanks with fuel and inspect the ET for ice formation and debris that could potential jeopardize the mission and astronauts. At T minus 3 hours, the astronauts wake up for a final physical exam and breakfast. After television reporter glamorize the twenty minute walk and drive to the shuttle, technicians strap and seal the astronauts in the cabin of the orbiter. In the final two hours engineers constantly monitor the weather to make sure favorable weather allows the launch to proceed. Before the T- 9 minutes, the director holds for ten minutes for a go/no-go procedure that will determine whether all systems are ready for launch and no malfunction exists. After the hold, T- 9 minutes continues to T- 0 as system simultaneous check and recheck for any errors, the “arms” detach from the shuttle, engines begin to warm up, and the countdown transfers into the internal orbiter computer. Before launch the shuttle becomes drenched in water spray to reduce the deafening noise coming from the engine which might damage the shuttle itself. At T- 0 there is no chance to stop the shuttle as the SRBs ignite their fuel and will not stop until the entire fuselage ejects. Upwards the space shuttle flies leaving behind twin pillars of smoke and steam (Lee 160).

After the first test launch of the Enterprise to the first shuttle launch into space by the Challenger to modern days, NASA carried out over a hundred space shuttle missions each for the purpose to expand the human race technologically and man's understanding of the universe. Sometimes, in the pursuit of knowledge devastation may occur as with the first tragic loss to NASA, the crew of Challenger. “One day one of these...[space shuttle] is going to blow up,” predicted Dick Scobee (Thompson 1). Unfortunately for Dick Scobee, commander of the Challenger and his crew, his prediction came true on January 28 at 11:39.

> One moment Challenger, the most technologically advanced machine every built, arched toward the heavens as flawlessly as the 24 shuttles that had gone before it. The next moment, it disintegrated in a powerful explosion, killing the crew of six astronauts and a guest passenger, high school teacher Christa McAuliffe. The craft flew for only 73 seconds. After 56 previous manned missions over the past 25 years, these were America's first deaths in flight, although others occurred on the ground (Thompson 1).

The Challenger also carried a school teacher, Christa McAuliffe, the first who would have been sent into space. Investigation into the matter reveal a design flaw in the joint seal of one of the SRBs. The government grounded NASA pending a full investigation and administrative changes until the problem was fixed. NASA ordered a replacement, the Endeavor, to continue the missions of the Challenger (“space shuttle” 1).

A second tragic incident occurred with the destruction of Columbia and its seven crew members aboard the space orbiter upon reentry. As it flew over North Texas the orbiter exploded, killing all seven astronauts, including first Israeli astronauts to go into space, Ilan Ramon. Again NASA grounded all present and future space mission pending an investigation into the matter. The investigation concluded that a piece of insulating foam broke off the external tank and damage the orbiters wing as the shuttle liftoff. Upon reentry the damaged and exposed wing failed under the heat of the atmosphere, destroying the spacecraft (“Space Shuttle” 1).

Although one may look upon these tragedies and frown upon the space shuttle program from which NASA created, but one must look at the big picture to understand the legacy the space shuttles have left behind. Originally destined to be the technical marvel of the decade, pushing the technological envelope of human kind, the space shuttles have also become a tool in pushing the boundaries of science. The experiments range from deploying space probes for astronomic inquiry in our solar system and beyond to researching new sources of power. Not only do the experiment pertain the space exploration but also biological life. More than a hundred shuttle missions dedicated to scientific experiments, be it towards the spacelab or other inquires (Launius 3).

With creation of the space shuttles, NASA and the United States of America solidified their standing as the world's most technologically creative nation. Many nations in the 1960's, 1970's and even now have the capabilities to construct and launch such a vehicle. The influences of the space shuttles stretches across so much land that it has become a symbol of the United States. Every achievement strengthens the symbol while each setback breaks down it. Nations around the world repeat again and again the crown achievement and the United States symbol of power lies with the creation of the space shuttle. “The Space Shuttle must be viewed as a triumph of engineering” (Launius 3).

From the time the space shuttles were first conceived as a future transportation vehicle to its actual construction, the space shuttle fuel the imagination of the people. The amount of time, money, and people spent on this project to expand the knowledge of all human kind. Even though tragedies have occur while using this technology, its continuing existences as the most technological machine to be ever built astounds the world. Its creation not only to prove whats out in the universe, but also to prove the technological sophistication and supremacy of the United States. As retirement nears the space shuttle's legacy will live on.

Work Citation

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