



SPACE SHUTTLE: ICON OF SPACE EXPLORATION

A brief history about a unique program that enabled many advances in science and technology

Space has always captivated man's imagination since the dawn of time and will continue to do so in the future as we unravel its secrets. The missions the Space Shuttle has made possible have greatly increased our understanding of that dark and cold place surrounding us. Now that the orbiter's final flights are planned, a look is taken back at its few, but eventful, decades of history.

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A VISION OF A FUTURE

A reusable re-entry vehicle was already on the minds of visionaries and researchers alike when studies on the feasibility of such a vehicle were started in the 1960's by both NASA and the United States Airforce. In 1972 this resulted in NASA drawing up a contract with Rockwell Space to design, build and test two working prototypes. The following two years, two other companies received contracts to design and build the external tank and the solid rocket boosters. In 1976 the first orbiter, the Enterprise, rolled out of the Rockwell factories and was subsequently taken to Edwards Air force base for extensive flight testing. The second prototype remained at Rockwell to undergo months of structural testing; this prototype would eventually be refurbished and operated as the Challenger.

SYSTEM TESTING

Unique and innovative testing took place to validate the Shuttle's flight capabilities, initially most of the tests took place with the prototype mounted on top of a

modified 747 designated the Shuttle Carrier Aircraft, SCA, (see figure 1). These tests first assessed the structural loads and handling characteristics of the pair of aircraft in all phases of flight, and helped prepare for transport operations and for when the Shuttle was to be released into free subsonic flight testing. The subsonic gliding approach on return from space was simulated several times to assess the Shuttles handling characteristics and automated landing systems (with 1970's technology) when flying on its own.

Following flight testing, the Shuttle was ferried to NASA's Marshall Space Centre where it was attached to the external fuel tank and subjected to extensive vertical ground vibration testing. On completing these tests the Shuttle was yet again put on the SCA and taken to the Kennedy Space Centre, where it served as a testbed to check that it would fit on all support vehicles and structures it would interact with. After refurbishment at Rockwell the Enterprise was used as a crew practice 'tool' at Vandenberg Airforce base.

The Enterprise was designed for testing and not for operational use and as such when testing on it finished in 1985, it was donated to the Smithsonian institute in Washington D.C, Virginia.

FIRST SPACE FLIGHTS

On April 12th 1981, exactly twenty years since the first manned space mission, the first reusable spacecraft flight took place. Columbia took-off with a crew of two from the Kennedy Space Centre on a mission that would last two days and six hours. Although not flawless the first flight was largely successful and with a few modifications to the Shuttle structure and operational procedures, it would continue and fly the following four missions.

The refurbished Challenger launched a few months later as the research and development flights of the Columbia came to an end. Both craft started their intended services by delivering satellites into space on a regular basis. Two additional newly built Shuttles followed a few years later as the number of missions per year



Figure 1. The Shuttle Carrier Aircraft with its payload in flight. The Shuttle has had aerodynamic fairings placed at the back to reduce drag.



Figure 2. Atlantis lands at the Kennedy Space Centre, Florida after its standard engines off (gliding) approach.

steadily increased.

All of the five orbiters; Columbia, Challenger, Discovery, Atlantis and Endeavour were named after famous exploration sailing ships. Each spacecraft was designed and built by the Rockwell company in California, Endeavour became the youngest and final orbiter when it was delivered in 1991.

EARLY SHUTTLE OPERATIONS

During the mid-eighties the Shuttles added satellite retrieval operations and EVA (extra-vehicular activity) to their services on top of satellite launches and missions to the Spacelab project. However disaster struck during the twenty-fifth mission on January 28th 1986 when the Challenger was destroyed one minute after launch. The cause was determined to be the failure of an O-ring which subsequently caused the complete structural failure of the launch system during a chain reaction. As a result all the Shuttles were grounded for over two years, NASA used this time to accelerate its upgrade program and fix the problems that cause the accident. Missions resumed in 1988 with the Discovery's seventh lifetime flight.

EVER EVOLVING PROJECT

The Shuttles have changed little externally since they first flew, one of the more marked differences being the decision to no longer paint the external fuel tank white (figure 3) since the third mission. This modification gave the launch system its distinctive orange colour and saved over 200kg of weight. Many other changes have been made, however, to internal or less visible systems. Examples are modifications to the wing structure, landing gear and main engines as a result of data gathered from operational use. The Challenger accident caused a redesign of the Solid Rocket Motors themselves and how they are attached to the external fuel tank. More recently the Shuttles have been upgraded with modern computer technologies and a new glass cockpit.

CONTEMPORARY MISSIONS

Modern day use of the Shuttle essentially came down to missions destined for various space stations such as Spacelab, Mir and more recently the International Space Station (ISS). Shuttle launches with satellite payload have become rare as cheaper (commercial) options have entered the market. There were, however, sporadic missions to retrieve or service important satellites such as the Hubble telescope. Interestingly the Shuttle has flown special missions for the US department of defence to fly highly classified cargo into space.

In the past decade Shuttle missions have been devoted almost exclusively to the construction of ISS. The Shuttle brought important parts such as the European Columbus laboratory module and the US Harmony module to the space station in addition to large structural components. It has also been the main means of crew rotation to and from the ISS.

In 2005 the second Shuttle accident, the loss of Columbia, cast doubt over the entire project. The accident was caused by the failure of the thermal protection system during re-entry as a result of damage during launch. The accident marked the beginning of the end of the program as within a year President Bush announced in his Vision for Space Exploration that, though the Shuttle program would fulfil its obligation to the international community by completing the construction of the ISS, it would retire in 2010.

A NEW HORIZON

As of October 2010 the Shuttle program had executed 132 missions, of which over 30 had been devoted to the construction of the ISS. The Shuttle has only ever used its emergency landing site in White Sands, New Mexico, once and that was for testing purposes, in all other instances the Shuttle has glided from re-entry to either Edwards Airforce Base or the Kennedy Space Centre (see figure 2).

NASA has planned 135 missions, with the final three missions each being the last flight of one of the three remaining orbiters. Atlantis is set to make the concluding launch of the current space program on June 28th 2011 which will either deliver cargo to the ISS or, if necessary, function as a rescue mission for the Endeavour.

The Space Shuttle program has been at the pinnacle of engineering since the early seventies and has captivated the minds of many generations. It has served a valuable role in man's exploration of space and has turned into a real icon of space travel. Its final flights will mark the end of major government run launch system, however a new horizon is appearing with Nasa's new mandate to assist the development of commercial space travel. Companies like Lockheed Martin, Boeing and Northrop Grumman are already working on designs of a commercial replacement for the Space Shuttle, those final flights may thus simply herald a new era of space exploration.



Figure 3. The first ever space Shuttle launch, Columbia. First of the two missions which use a white external tank.

References

NASA: <http://www.nasa.gov>

NASA History: <http://history.nasa.gov>

NASA Imagery: <http://grin.hq.nasa.gov>