The people from NASA were skeptical. Should they entrust one of the most crucial aspects of the new shuttle program to a relatively untested engineering team from Canada? Their decision, in 1975, to do just that has meant that Canadians are responsible for one of the most significant advances in space engineering—the Canadarm.

Actually called the Shuttle Remote Manipulator System, one of the Canadarm's most impressive engineering achievements is its ability to capture a free-flying payload in a zero gravity environment. The slightest contact with an object in space, regardless of size, will send it spinning away. Astronauts had to be able to control a 50-foot arm over a wide range of commands and for a wide range of payload sizes. Operating the Canadarm may mean moving it very accurately and slowly over a distance of millimetres or it may mean moving it precisely over several metres at a very high speed. During more than 50 missions and after 7,000 orbits around the earth, the Canadarm has never malfunctioned. Indeed, it is used to help solve other problems on the shuttle, everything from knocking ice off the fuselage of the Orbiter to fixing the Hubble Space Telescope. And of course, it is instrumental in assembling the new international space station. The Canadarm is truly one of the greatest Canadian engineering achievements.

Every part of Canadarm had to be thought through from scratch. NASA's design requirements were severe - stiffness, weight, heat tolerance, toughness, and the like. Often, new techniques had to be devised to produce parts meeting all these demands. Much of Canadarm's initial $100 M cost went for testing.

The next time you reach for a cup of coffee, notice how your hand wobbles slightly from your predetermined path, even after repeated practice. Such wobbling is not acceptable in the Shuttle's arm. But how can a single astronaut, acting through two hand controllers like those which guide Columbia from her forward control station, possibly keep track of three huge arm segments moving six ways at once? Again the answer came from the way Canadarm mimics our own bodies. When we reach for that cup of coffee, we do not consciously command our wrist to rotate, our elbow to pitch down, our shoulder to yaw left. Our eyes set a goal, and our brain achieves that goal without troubling our active mind. Similarly, the operator of the arm uses hand controllers in the crew compartment to command Canadarm's end effector to move in a desired direction. Shipboard computers then determine what each part of the complex system should do to fulfill that demand in the safest, most effective way.

The first space arm was officially signed over to NASA in February 1981, at the Spar plant in Toronto where it had been built. Trucked gingerly to Kennedy Space Center by the same driver who had taken the King Tutankhamon exhibit across North America the previous year, Canadarm was integrated into Columbia in June 1981. At that time, NASA officials praised Canadarm as an exemplary subsystem: dependable, simple to install, and virtually trouble-free.

The tasks of the officially-designated Shuttle Remote Manipulator System are many and varied: over the years, the Canadarm has deployed satellites into their proper orbit and retrieved malfunctioning ones for repair. Beginning with Mission STS-88 in December 1998, the arm has been used in 11 Space Station Assembly missions to date, both to install new elements on the station and to support space walks by space construction workers. It has performed the expected, such as successfully loosening a jammed solar array panel or using its elbow and wrist joint cameras as flying « eye-in-the-sky » for visual inspection of the orbiter

and payload . It has also performed unusual tasks, such as knocking ice off the shuttle's waste water dumping vents. The arm has been used for public relations activities, as its two cameras, or IMAX cameras attached to its lower boom brought the experience of space to the general public.

Perhaps its most notable mission to date occurred in December 1993, with the dramatic first servicing mission of the Hubble Space Telescope (HST). Astronauts used the Canadarm as a mobile work platform to stand on during the five space walks, a record-breaking number at that time, required to repair the $1.5 billion astronomy satellite on orbit. The Canadarm played a critical role in retrieving the telescope, placing it in the shuttle Endeavour's cargo bay for repairs, and releasing it in space afterwards.

Nobody could have anticipated the visibility and pride which the Canadarm would generate for Canadian space technology. Every time the arm is observed through the aft window of the shuttle's crew cabin, the first thing that is seen is the Canada logo with the red maple leaf flag proudly displayed on the upper boom of the Canadarm. This is a statement about Canada's reputation as the first nation to have successfully built a robotic arm that was designed to work in the harsh environment of space and that kept true to its promises. The Canadarm is our nation's most recognized science achievement. It is the icon of Canadian scientific know-how.

Flight History

Five Canadarms have been built and delivered to NASA on the following dates: April 1981, January 1983, December 1983, March 1985, and August 1993. Four arms are currently in service - one arm destroyed in Challenger accident 1986.

Canadarm Article Questions:

1. What does skeptical mean?

2. Why was NASA skeptical with the Canadian engineering team?

3. What is the other name for the Canadarm?

4. What is a payload?

5. Describe some of the many tasks that the Canadarm has performed.

6. What were the requirements for the robot arm set by NASA?

7. How much did the part originally cost?

8. How do astronauts control the arm?

9. Where and when was the first Canadarm built?

10. How is the Canadarm related to IMAX theatres?

11. What is the Hubble?

12. Why is the Canadarm considered a “Great Canadian Achievement”?

13. How many arms have been built for NASA? Are they all still active?