

FIXING THE HUBBLE SPACE TELESCOPE

Produced by the staff of the Charles Hayden Planetarium, Museum of Science, Boston

NARRATOR

This is the Hubble Space Telescope, one of the most famous spacecraft ever launched. For over twenty years, it has played an integral role in our search to understand more about the Universe.

However, when Hubble first launched in 1990 it quickly became apparent that the new telescope had a problem.

MIT professor and former astronaut Jeff Hoffman has personal experience with Hubble's flawed optics.

JEFF HOFFMAN

When you have a new telescope, just like when you pick up a pair of binoculars, the first thing you normally do is you run through the focus to find the sweet spot where the focus is best and this is what they started doing with Hubble.

The problem was that no matter how they moved it they weren't getting perfectly focused images. They moved through the best and then it would start to get worse but even the best images were still fuzzy.

NARRATOR

At two and a half meters, or nearly eight feet, in diameter, the primary mirror at the center of the telescope was designed to be one of our sharpest eyes on the cosmos.

But the mirror had a defect.

JEFF HOFFMAN

The mirror was slightly too flat, only by about 1/50th the diameter of a human hair, which is something that you could never pick up with your naked eye, but Hubble's optics are so precise that that tiny mistake led to the inability of the Hubble Telescope to focus images properly.

NARRATOR

The source of the problem occurred before the mirror was even made.

JEFF HOFFMAN

There's a special measuring tool which tells the technician who's in charge of forming the mirror when the mirror has gotten to the right shape, and this measuring instrument was installed incorrectly.

And so when it said that the mirror was the right shape, in fact the mirror was slightly too flat.

It was a disaster.

NARRATOR

If engineers couldn't come up with a way to deal with the mirror's flaw, Hubble would never achieve its mission.

JEFF HOFFMAN

The optical engineers came up with a brilliant solution.

If you could block the out-of-focus light and bounce it off a mirror onto another tiny mirror, only about the size of your thumbnail, and that second tiny mirror would be slightly curved to compensate for the lack of curvature in the primary mirror, and then bounce the light back into the detecting instruments, you could fix it.

NARRATOR

It was a clever fix that would allow Hubble to reach its potential. But first, astronauts would have to install it.

It was one of the most complex space missions ever attempted, made possible by the fact that Hubble had been specifically designed to be modified and upgraded over time.

In 1993 the space shuttle *Endeavour* rendezvoused with Hubble, and a team of astronauts, including Jeff Hoffman, mounted the corrective mirrors and a new primary camera inside.

JEFF HOFFMAN

The engineers figured out a way to encapsulate the optical corrections into large boxes that were the same shape as the optical instruments that Hubble was originally designed to have.

It was just a case of removing some of the old instruments and putting in the new instruments. I say it was just a case of doing that but actually that was a very, very critical job.

NARRATOR

A few weeks after *Endeavour* returned to Earth, astronomers and engineers held their breath as Hubble took its first pictures with the adjusted optics.

JEFF HOFFMAN

And I'll never forget getting the call New Year's Eve from a friend at the Hubble Telescope Science Institute to tell me that "Jeff, we've just gotten the first real images down from Hubble and the repair that you guys did worked and Hubble is fixed."

NARRATOR

The images were crystal clear. The skillfully engineered solution was a success.

Since then, Hubble has changed the way we look at the cosmos, offering us unparalleled pictures of the Universe.

(MUSIC INTERLUDE)

JEFF HOFFMAN

It was such a beautiful telescope and I felt really privileged, both as an astronomer and an astronaut, to have worked with that telescope for a whole week, and to actually put my own two hands on the Hubble Space Telescope in space. What a thrill!

NARRATOR

We still have much to learn about space, and Hubble continues to help us search for answers to our questions.

But even the telescope's initial failure has something important to teach us.

JEFF HOFFMAN

It's from failures that you really learn what your problems are and that's how you improve your equipment and your hardware.

So it's this fine balance, you have to have the right attitude towards failures.

The important thing though is if you do have a failure, you really need to be able to learn from it.

To have a failure that you don't learn anything from, that's tragic.