Beginning summary with sources—blending complete (MLA style)

Note: I have placed the inserted quotations in red text to make them easy to locate.

Repairing the Hubble Telescope

Several years ago, the Hubble Space Telescope was launched from a space shuttle flight. Astronomers had hoped that with the telescope orbiting high above earth's cloudy atmosphere, several questions about the birth and fate of the universe could be answered. Unfortunately, after the telescope was in orbit, technicians discovered that the telescope lens had a flaw that made the pictures it sent to earth too fuzzy and imperfect to lead to new discoveries. As one expert said, "It was a view akin to a dusty contact lens or trying to see a sharp image through dirty water" (*Why Couldn't*). Needless to say, this was a major disappointment to those hoping to peer deeper into space. Because of this unforeseen defect, a new lens would have to be fitted onto the telescope if it were to perform as it was designed to.

For several months after the defect was discovered, scientists and technicians considered three different ways to fix the problem. One was to build and launch a new telescope. However, this would cost millions of dollars and delay receiving any deep space information for several years (Jacobs and Moore 68). Another idea was to build a super computer that could clear up the pictures the current Hubble sent to earth. However, even a super computer would have to "guess" several parts of an enhanced picture. As Carl Landis, a local astronomer, said,

> Even the most sophisticated super computer wouldn't have the power and speed necessary to clear up the image. Plus, the computer program would have to make several guesses concerning the image it was trying to process. We would be spending millions on an image we couldn't really trust or make accurate measurements from. It would be like guessing what was out there.

The final option was to build and install a corrective "contact lens" for the Hubble, much as doctors and technicians make for humans with vision problems. This solution would require tolerances never before achieved in a lens. Added to this was the necessity to install the corrective lens in space. Trying to anticipate as many problems as possible before the construction of the lens was a daunting task. As one mission planner said, "Planning the mission was probably more difficult than deciding which 'cure' to use. In fact, many of us doubted we could complete the planning successfully" (Davis and Hill 123).

Once scientists decided to build and install a corrective lens, the construction began in June of 1992. The lens was designed to bring into focus the flawed part of the original telescope lens, thus giving the Hubble the equivalent of 20/20 vision. As said earlier, to achieve this, tolerances had to be nearly perfect for the corrective lens to work. "If the lens measurements were off more than the width of a human hair, the Hubble's vision would probably be made worse" (*Why Couldn't*). Fortunately,

technology was up to the task, and the corrective lens fell well within required tolerances.

Once the corrective lens was formed, astronauts on a space shuttle mission would attempt to install it and make fine adjustments. This was a repair job without rival in terms of complexity. One researcher said that "to complete the mission would require orchestration of countless tasks without error" ("The Hubble Finally Works" 69). The risk was great, but so was the payoff: the original Hubble Space Telescope would be saved along with millions of dollars and several years of work.

In December 1993, astronauts aboard the space shuttle successfully installed the corrective lens. Since no space robot could have done the intricate work the astronauts were required to do, their success became one more reason why human repair and shuttle teams continue to be part of our space program. According to one report, "No more was there any doubt that humans should be involved in space. Even though the risk to life remains, humans cannot be replaced by machines when an intricate, changing situation occurs" (*The Edison Page*).

After a few stressful weeks of "tuning," scientists and technicians reported that the Hubble's vision was perfect. The corrective lens installed by the astronauts exceeded all expectations in repairing the flaw. Because of the success of the repair effort, questions such as "do black holes exist" and "how did the universe begin" would receive fresh, never-before-seen information. In addition to discovering new clues about the universe's origin, astronomers were also thrilled at the prospect of unlocking even more wonders (Baker 365). In many ways, it seems fortunate that the

Hubble needed repair. Its story is a one of human error being corrected by human ingenuity to give all humans greater vision.

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