REPAIRING THE HUBBLE

Cause Map

1 Problem

What	Problem(s)	Hubble telescope out of focus, flaw in mirror
When	Date	April 25, 1990 - Hubble launched
		June 21, 1990 - Announced flaw in mirror
	Differences	System not independently tested prior to launch
Where	Physical Location	Low Earth Orbit
	Component	Main Imaging System
	Task Being Performed	Initial on-orbit testing

Impact to the Goals

Safety	None	
Mission	Potential loss of mission objectives (images)	$ 2,000,000,000 (Potential)
Materials & Labor	Flaw on mirror	
Compliance	Mirror built incorrectly	
	This incident	$ 2,000,000,000
Frequency	First time this issue seen	

Don't focus on "the problem"; find the best solution

The images provided by the Hubble telescope have been a stunning achievement for the scientific community. However, the Hubble project was not without its share of problems. The development of the telescope took over a decade and billions of dollars . . and it was almost lost due to a tiny flaw in the main mirror.

"In an optical system this is like missing by a thousand miles."
- Charles Pellerin, NASA director of Astrophysics, referring to the 1.3mm misalignment of the Hubble mirror

Cause Mapping is a Root Cause Analysis method that captures basic cause-and-effect relationships supported with evidence.

CAUSE MAPPING

Problem Solving • Incident Investigation • Root Cause Analysis

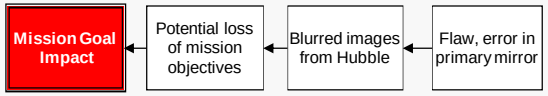
Step 1 **Problem** — What's the Problem?

Step 2 **Analysis** — Why did it happen?

Step 3 **Solutions** — What will be done?

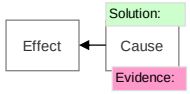
2 Analysis

Basic Level Cause Map - Start with simple Why questions.

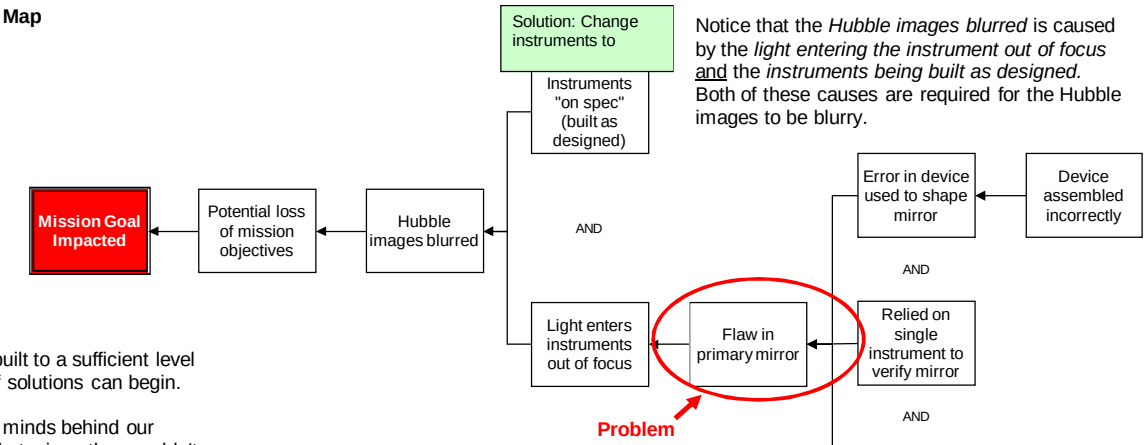


Basic Cause-and-Effect

Using the simplified Cause Map on the left, many would identify the flaw on the main mirror as the root cause, with the only possible solution to fix the main mirror. Unfortunately at this point the main mirror was already in orbit and this solution was discarded as impossible. Luckily a deeper look into the issue saved the telescope, the images, and the billions spent on its development, manufacture and delivery.



More Detailed Cause Map



Notice that the *Hubble images blurred* is caused by the *light entering the instrument out of focus* and the *instruments being built as designed.* Both of these causes are required for the Hubble images to be blurry.

Many organizations narrowly focus on what they call "the problem." The Cause Mapping method identifies the causes of why the overall goals were not met. Too much emphasis on "the problem", as the single cause, can miss other, more effective solutions.

3 Solutions

Once the Cause Map is built to a sufficient level of detail, brainstorming of solutions can begin.

This is where the brilliant minds behind our space program realized that, since they couldn't change the mirror, they could make adjustments to correctly read the "off spec" images being produced by the flawed mirror.

For a free copy of our Root Cause Analysis Template in Microsoft Excel, used to create this page, visit our web site.

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