Stanford eCorner

Classic Example of a Future Accident

Elisabeth Paté-Cornell, *Stanford University*

January 27, 2010

Video URL: http://ecorner.stanford.edu/videos/2381/Classic-Example-of-a-Future-Accident

The classic example of an accident that hasn't happened yet: the heating tiles of the space shuttle. The first 33 flights consisted of errors in maintenance. Dr. Elisabeth Paté-Cornell describes how she discovered that technicians were mixing water with the glue, so the heating would adhere faster to the surface; though, by diluting the contacting bond, it put the heating tiles more at risk during the space shuttle's reentry into Earth. Her team created a map of the space shuttle and the most crucial heating tiles. In the end, she made recommendations based upon the data and research.

Transcript

So let's start with the tiles of the space shuttle and this is a classic case of an accident that has not happened yet and so you have to think about it systematically. So we were looking at the first 33 flights. There have not been any accident but there were errors in maintenance. And we knew that for a fact. In fact, I spent half - I remember spending a week at Kennedy Space Center with the technicians under the Orbiters in my jeans and sneakers, somehow anonymously perhaps. But what I wanted to figure out were the kinds of errors they were making when they were under time pressure. And I found out and I'm gong to show you how. So we were calculating the contribution of tiles to failure risk. We're trying to look at which ones were really the most risk-critical. And we were looking at the effects of management on the risk.

This is what the tiles look like. Each of them was about 8 inches. And the interesting thing is that they are glued on the lattice of filament. So each of them has to be glued in the cavity. And in order to gain some time, some of the technicians I found out, one technician at least, that this glue would cure faster if you add water to it. And what they were doing, in fact, was to spit in it. And so the glue was curing faster, alright. He was gaining time but of course that was a dangerous thing to do. So how did we think about it? Well, we look first at what happens, what's the accident mechanism? We have an initial loss of a bunch of them for two reasons: debris damage or debris hits, or deboning because there is weak bone. Then at re-entry, there is a cavity.

Now, the flow of gases heats up that cavity, you can then lose additional tiles. You expose the aluminum of the Orbiter, you can have then hot gases inside, the sub-system malfunctions, and you lose the whole mission. So the way we looked at this was by decomposing the system into these different parts, getting all the data that we could. Some of them was statistics, for example, we could get he measurements of temperature on the shuttle skin. Some others, we needed to go to expert opinions. That's what I put in there. So what did we find? We find that in fact, the tiles were not as bad as the astronauts feared, and we showed them a map on which we have identified the most risk-critical tiles so that if you had a bit more time to test something before launch, you could start there. We made all kinds of recommendations for improvement. Some of them were listened to, some of them were not. And unfortunately, the payload where the Columbia accident where again, one of the pieces of debris from the external tank hit the Orbiter and caused the failure.

This is the thing of beauty that I presented to Kennedy Space Center and what I had put in darker tones were the most risk-critical zones. And we had computed the risks in each of the different zones. It's not symmetric because there are fuel lines running on the external tanks that weakens the attachment of the insulation. But these was used. It was put as a huge map on the floor and what they did was to test first and to show me they had done it, the places that were put in dark.