13 engineering truths proved by NASA's Curiosity Rover

Suzanne Deffree - May 07, 2015

Luke Dubord, technical group supervisor, avionics subsystem engineering group, NASA, laid some truth on the opening keynote audience at this week's Embedded Systems Conference in Boston.

Dubord is a member of the team that safely landed NASA's Curiosity rover on the fourth planet from the sun, early on August 6, 2012, eastern time. Since then, it has been communicating with NASA's Mars Science Lab, passing valuable data and photos back to Earth.

In discussing the NASA Curiosity Rover's design, launch, successful landing, and continuing mission on Mars, Dubord touched on topics that, whether engineers want to accept or not, are real of all engineering, from simple consumer devices to complex spacecraft.

1. 'Fake it 'til you make it' doesn't apply to engineering.

"There are many things we can fake here on Earth. Gravity is one of the things we can't fake." – Dubord

In discussing the challenges of planning for Curiosity's successes, gravity was a key issue. Gravity on Mars is only a third of the gravity of Earth, and not something easily coordinated for.

Unlike other professions where you might be able to fudge a bit here and there to reach a goal, facts are facts and numbers are numbers in engineering.

2. Timing can be everything.

"We had to work with astrology—not astronomy, astrology. When was it all aligned and favorable to launch our spacecraft?" – Dubord, laughing a bit

NASA had a two week window, open only every two years, that offered favorable conditions for Curiosity's launch, travel, and landing. Kind of puts that tight deadline your manager set in perspective, eh?

3. Communication is key.

"Mars is really far away." – Dubord

Indeed, our neighboring planet is approximately 248,000,000 km at landing. Light at 2.99x108 m/s takes 14 minutes to travel that far. That delay means that if there was a problem on the rover, Earth wouldn't hear of it until 14 minutes after Curiosity registered it.

4. Safety first.

"During surface operations, the rover must react to unexpected results itself."– Dubord

With such a 14 minute delay, rovers need to be able to take care of themselves and priority was given to Curiosity's safety in landing. Its autonomous systems become vital to success. Entry to landing, itself, took 7 minutes and was over before NASA received the signal from Curiosity.

5. The best laid plans can still fail.

"As engineers, we think we know what the system can handle, but there are things we can't design around." – Dubord

If Mars' thin atmosphere, tricky gravity, low air pressure, and intense cold weren't enough to challenge design, an uneven landscape with a rocky terrain, wind, and other variables made Curiosity's landing even more difficult, impossible in some ways, to plan for.

6. You are going to fail sometimes.

"Only 50% of Mars landers have landed successfully." – Dubord

Sure, we know Spirit and Opportunity – still going strong beyond expected lifetimes – but what of the other many rovers that didn't touch down as their engineers had hoped? There have been

other well-designed rovers, but 1 out of 2 hasn't landed successfully for various reasons. Sometimes even the best designs fail.

7. And sometimes there are no second chances.

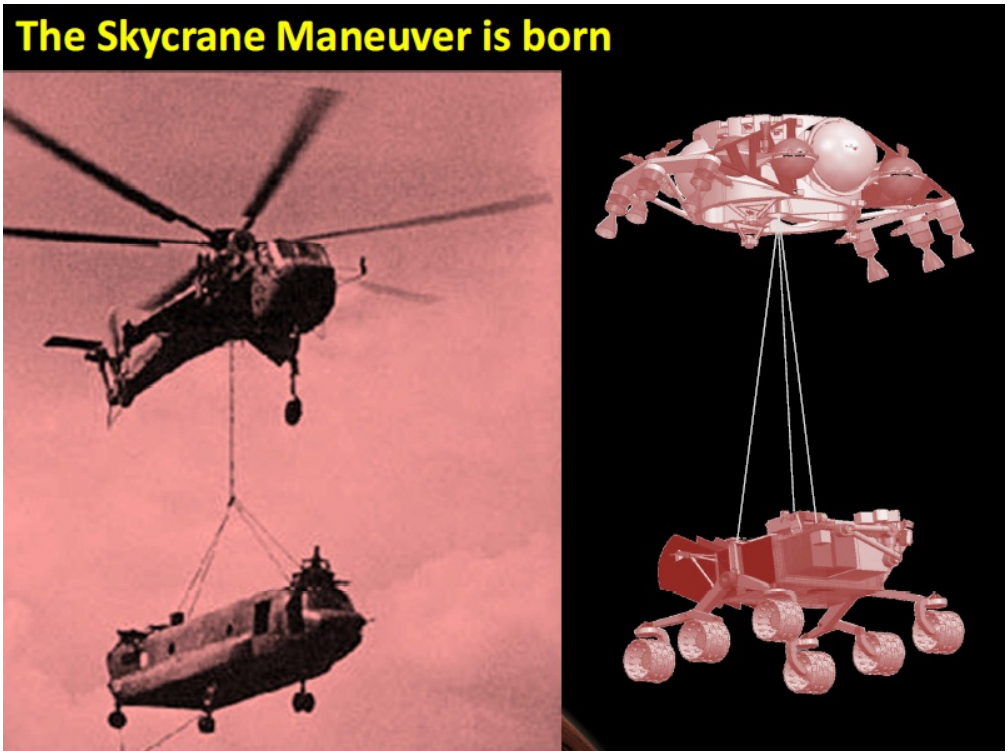
"Software can be updated but hardware is fixed." – Dubord

While Curiosity was on its way to Mars, NASA noticed a software bug, which lead them to find other bugs. They could correct these issues with Curiosity on its way, but the hardware was done and out of their hands the second Curiosity left Earth.

All in all, NASA had 1 chance to get Curiosity to the surface of Mars without fail.
The best ideas are the crazy ones, more
8. Sometimes the best ideas are the crazy ones.

"Everyone we showed this to thought we were nuts." – Dubord

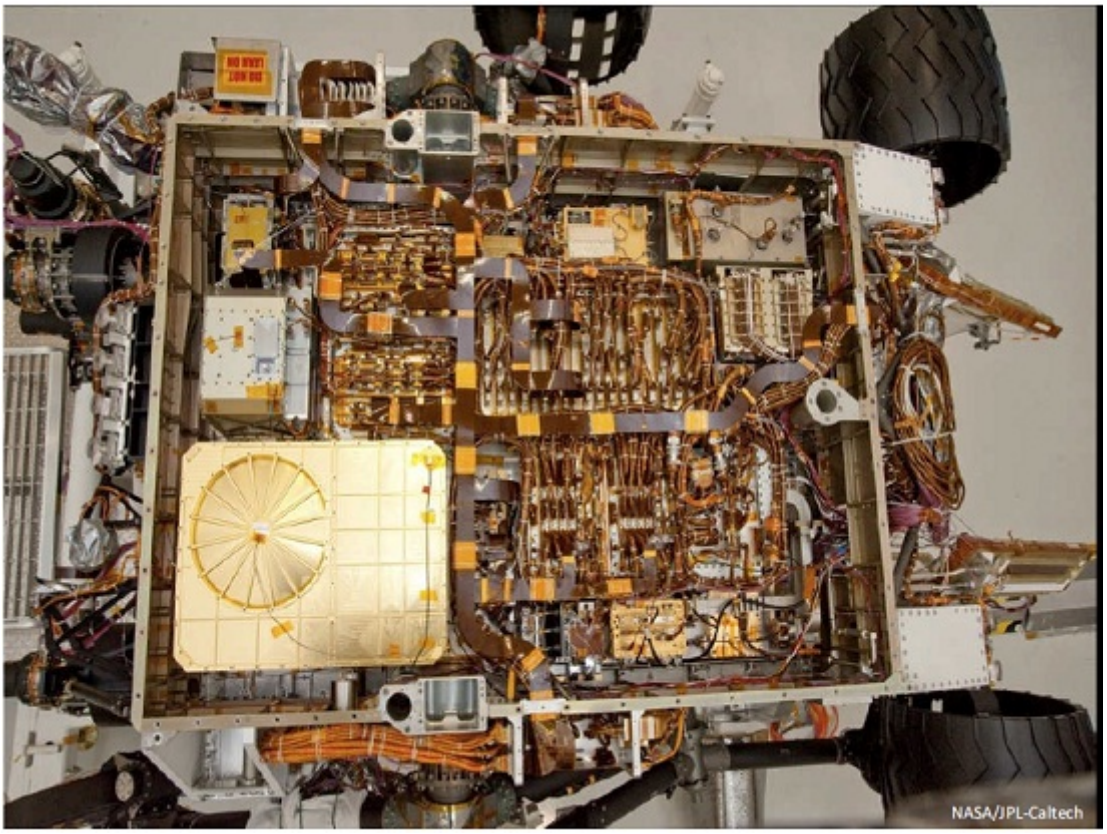
Once through the atmosphere, Curiosity was slowed by parachute and lowered through a sky crane maneuver (see photo), an unusual landing process based on a helicopter lowering another helicopter that caught some skepticism but ultimately worked.



9. Engineering can be messy.

"You can't even tell where the boxes and wiring end." – Dubord

This look inside the embedded guts of Curiosity prove that engineering is not always neat.



10. Good engineering is a thing of beauty.

"This is 1 of the most beautiful pictures of my life." – Dubord

Beyond messy, good engineering can be a thing of beauty. Dubord smiled ear to ear when showing the below photo, the first from Curiosity on Mars, to the ESC audience.

11. Trust your designs.

"Sand dunes scare us a lot." – Dubord

When Curiosity reached a steep sand dune, it halted and messaged back to NASA that its navigators were not steering it into a safe zone. No one wants a resource-intensive rover stuck in a sand trap on Mars. So NASA trusted its design's autonomous intelligence and steered in a new direction.

12. There's always another project ahead.

"2020 is a copy with new instruments and upgrades." – Dubord

Although Curiosity is cruising along, NASA and the world's other engineers haven't kicked back and relaxed.

Curiosity's goal is to look for habitable environments, while future rovers, including the ESO ExoMars Rover and 2020 Science Rover will seek signs of life and will do so with designs built off of previous rover and rover engineering experience.

13. There's no I in "team."

Dubord estimated that some 300 to 400 members of the NASA Jet Propulsion Laboratory made up the core team of people working to get Curiosity safely on its mission on Mars. The photo below includes their signatures.

Add to that support staff, vendors, and others and the engineer credits thousands of people for making Curiosity possible.

Also see:

Mission to Mars: NASA engineering and the Red Planet

Curiosity Rover lands on Mars, August 6, 2012

NASA: Revealing the unknown to benefit all humankind

NASA's Spirit rover lands on Mars, January 4, 2004

Happy Birthday Curiosity: One year on Mars

Slideshow: DESIGN West gets virtual Mars rover tour

Power innovations for the Mars exploration Rover mission
