**Mission of Opportunity**

**DLN:** That sounds like a really fantastic mission, but then again this isn't the end, so tell us about the NExT mission. Not only next in terms of time, but it's got a capital "-N-E," small "X," capital "T," so tell us about that.

**KG:** *That name means it's the New Exploration of Tempel 1. Tempel 1 is another comet, so really this mission, the Stardust mission, and NExT, it's really a tale of 3 missions because after we flew by, collected particles, while we were on our way back to Earth to drop the capsule, meanwhile there was another spacecraft, Deep Impact, that met Tempel 1. It dropped something right on the nucleus to create an explosion and to break through the top layer of the nucleus. So that was the experiment of that spacecraft.*

**DLN:** And this graphic is?

**KG:** *That's a photo of the impact on the comet nucleus Tempel 1. So that mission, the spacecraft is flown by there and took some images as it went by. Now we've got Stardust, no capsule any more, but it's still out orbiting the sun and has fuel, has a great camera, and two other particle instruments on it, so without even relaunching or building anything, we can start a whole new mission.*

**DLN:** That's always stunning. People design the spacecraft and then it's used for missions that weren't even conceived when the people were originally designing it.

**KG:** *Right. We call that a mission of opportunity. When something like this comes up, it's ultimate recycling with a spacecraft that's ready to go, we're able to get going.*

**DLN:** Speaking of ready to go, we know that this is flying around in space. What does it take to launch?

**KG:** *Well, talk about spacecraft, and really the spacecraft is just a tiny part of launch. We have a photo of the rocket that launched. This is a delta rocket. The spacecraft is just a tiny part of this at the very top in the nose cone, or what we call the fairing, is where Stardust is. Around the bottom of the rocket, you see four solid rocket boosters. Those burn out first. The main part of the rocket is filled with liquid fuel. It takes all of this energy, and tons, and tons, and tons of fuel just to escape the gravity of Earth. You were talking about the physics of it. Well, to escape the gravity of Earth, we've got an awful lot pulling on us here so we have to create an immense amount of force to push away. So Newton's third law, we're pushing against the Earth and an equal and opposite reaction is the launch.*

**DLN:** So even for a relatively small piece of equipment to get into orbit takes a huge amount of thrust.

**KG:** Yes.

**DLN:** So we have this rocket, and it's basically a big semi-truck loaded with cargo that's taking things to space?

**KG:** *Yes, or to continue a flying analogy, the spacecraft's about 1,000 pounds. The size, as I said before, is about the size of a grand piano, in 1,000 pounds. But what it takes to get from the surface of Earth into space would be the equivalent of putting that piano on a 747.*

**DLN:** So now that it's in space- you don't have an astronaut driving it around, there's no joystick involved or steering wheel- so how do you steer this?

**KG:** *We can't joystick the control. For one reason, sometimes it's very, very far away. It's hundreds of millions of miles away. So instead of controlling it as if it's a video game, what we do in our operations center in Denver is we put together lists of instructions and times that we want the instructions to execute. We put those in a command file on a computer, package that up as a file that we can then send to the spacecraft. Here's the amazing thing- it's hundreds of millions of miles away sometimes, so when we take this data file and send it, it goes from our mission control center to an antenna- an antenna at what we call the Deep Space Network. The antennas are huge. You think about maybe like a Dish Network thing on the side of your house that are about this big. The antenna we use are 100 feet across. There are some that are more than 200 feet across, and that's the antenna we use to send the data to the spacecraft.*

**DLN:** When you send something, what's the lag time before it receives it?

**KG:** *Depending on where it is, it can be more than twenty minutes- at the speed of light- before that signal gets to the spacecraft. Then, when the spacecraft is sending us data, another twenty minute delay. You think about cell phone coverage where you don't have enough bars? Our spacecraft hundreds of millions of miles away sends a signal that is so tiny in terms of the power that we're still able to pick it up and that's why it takes such a huge antenna.*

**DLN:** I'm just trying to think, if you were giving someone driving instructions but they were already in their car and you were giving them instructions twenty minutes in advance for them to turn- what a huge technical challenge.

**KG:** *Yes. So the instructions better be right. So the instructions that we send to the spacecraft- or the command files we send- many times we test them over and over and we come up with ways to try to make the set of commands fail or try other conditions to see if we can't break it. That's how much we test it.*