NASA's Deep Impact Mission: Decision Making

Brian Muirhead

APPENDIX B: INTERVIEW SHEET

Question: Please tell us about your involvement with the Deep Impact mission and your thoughts about optimizing the data being received during the impact of Comet 9P/Tempel 1 in July of 2005.

Interview of: Brian Muirhead
Job Title: Deep Impact Project Manager
Institution: Jet Propulsion Laboratory
Interviewer: John Ristvey
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Conducted by phone at Jet Propulsion Laboratory in Pasadena, California

Brian Muirhead
Deep Impact Project Manager

As project manager for Deep Impact, I am responsible for the development of the spacecraft and the design and operation of the mission. Together with the principal investigator, I am responsible for the overall success of the mission. This includes managing most of the budget and ensuring that the technical performance will meet the science objectives. I also manage the work that is done at JPL and Ball Aerospace so that the mission is on time and on budget. The most critical time of this mission is at the time of encounter with comet 9P/Tempel 1 on July 4, 2005. The quality of all our decisions will be measured then.

I like doing things that people consider impossible missions. Landing on another body is very rarely done. It is very challenging to land and interact with a non-earth-like body's surface. Missions that encounter objects in the solar system stimulate interest in the project team as well as the general public. I was the project manager and spacecraft manager for the Mars Pathfinder mission. There were many people that thought we would not be able to land on Mars. The public was highly involved in following the Mars Pathfinder and the Sojourner rover in 1997.

The Deep Impact mission is the first of its kind; impacting a comet has never been done before. I like working with people who get excited about these seemingly mission impossible projects. Comets are the most mysterious bodies in the solar system. My first job at JPL was working on a mission to Halley's comet. I have worked on several comet missions since then. Deep Impact represents the most daring comet mission that the United States has ever done.

One of the challenges of a deep space mission is returning data from the spacecraft to Earth. We have special radios onboard the spacecraft that transmit data at various data rates back to Earth. The Deep Space Network (DSN) antennas that are located around the world pick up the signal. The three locations for these antennas, are Goldstone, California; Madrid, Spain; and Canberra, Australia. Having these locations ensures that no matter where the Earth is in its rotation, a set of antennas can always "see" the spacecraft. The strength of the signal and the volume of data we can get from a spacecraft are important considerations during the design of the spacecraft and the planning of the mission. For Deep Impact, the radios and antennas on board were designed to communicate with Earth with data rates of about 175,000 bits per second. This is between 3 to 10 times greater than the rate your modem would work on your computer. The reason for this high data rate is because of the short time for communicating after impact. We want to get as many pictures down as fast as we can. A big challenge is that there is only one chance to get these data after impact. With Deep Impact there may be only one opportunity to send down data. If the Deep Impact spacecraft is hit with comet particles, we may not have the opportunity to send it down again.

Because it is so important for us to get this information down in a very short and critical time frame, we want to have two of our Deep Space Network stations able to receive data from Deep Impact. Sometimes things go wrong on the ground. For instance, there may be electrical or mechanical problems with the antenna. More often there are potential weather problems. We may not get a second chance to send this data to Earth, that is why at the time of impact and shortly thereafter, we are planning on having the spacecraft visible from two DSN stations.

Making a decision on which DSN stations and Earth-based observatories to use needs to be based on data about the location of the spacecraft, and the location of the antennas on the ground. Past weather statistics need to be considered at both DSN stations and potential observatories. Like many decisions, there is no one crystal clear answer; there are always conflicting factors. What we have to do is pick the optimal solution. The decision to use two DSN stations would limit some of the best Earth-based astronomical observatories. The principal investigator and I have determined that, at this time, having redundant ground stations is more important than having the most optimum Earth-based observatories. This is not a decision that is final. We can keep that decision open until just before the launch of the spacecraft. We could change our strategy based on new evidence that would suggest that our initial decision was not the best.

The highest quality data are going to come from the spacecraft. The environment around the comet is unknown; we have models but it could be very risky for the spacecraft. From a mission success point of view, what counts is getting images and data back from the spacecraft. Any risk that would hinder getting those data to the scientists is a risk that needs to be managed. The Earth-based observing would be great because it would give us a wider spectrum of information. We have multiple Earth-based possibilities. The Hubble Space Telescope, and other Earth-orbiting facilities, have advantages as well.

The value of Hubble is that it can observe the impact unobscured by clouds or atmosphere. The quality of the cameras is outstanding, but I don't know how the resolution of Hubble compares with that of the best Earth-based observatories. Hubble is limited in the wavelengths it can detect. One consideration for using the Hubble Space Telescope is the fact that scientists have to make a proposal for access to Hubble that includes the object to be viewed, the viewing time, and the justification of the science objectives. There is no doubt that the science of the Deep Impact mission would meet the requirements for obtaining viewing for Hubble. The Space Infrared Telescope Facility (SIRTF) http://sirtf.jpl.nasa.gov/ will also be up at this time, but we are not sure if it will be in position to observe the impact. The Chandra X-ray observatory http://chandra.harvard.edu/ is another possibility for observing the impact from Earth's orbit.

It is important to note that as a result of the decisions we make here about timing the mission to get optimal data from the impact, there will be other decisions that will need to be made throughout this mission. Because of the limitations of data rate at the time of the impact, the challenge that the science and project team has will be to prioritize and get the most important data down to Earth as quickly as possible. There will be a lot of decisions made about which pictures, what type, and how many of each picture we want to best meet our science objectives.