A Look Back at the Beginning:
How the Discovery Program Came to Be

The Earliest Notions

In 1989, the Solar System Exploration Division (SSED) at NASA Headquarters initiated a series of workshops to define a new strategy for exploration through the year 2000. The panels included a Small Mission Program Group (SMPG) that was chartered to devise a rationale for missions that would be low cost and allow focused scientific questions to be addressed in a relatively short time. The second meeting of the SMPG resulted in a recommendation that small spacecraft should be used to implement limited-scope missions. This was quite different from NASA’s normal approach of conducting very large missions that take many years to organize, carry a large suite of instruments, and sometimes cost more than one billion dollars.

The proposal was greeted with widespread skepticism. NASA had already attempted to implement a low cost Planetary Observer program beginning with Mars Observer, which grossly overran its budget and schedule. One member of the SMPG, Tom Krimigis (who went on to head The Johns Hopkins University Applied Physics Laboratory’s (JHU/APL) Space Department from 1991 – 2004), was involved with NASA’s Explorer Program which had served the needs of the space physics community by providing relatively easy access to space since the late 1950’s. Dr. Krimigis pointed out to workshop participants that Explorer should be the model for small, focused, low cost missions, not Planetary Observer. After more thorough briefings on the Explorer concept, workshop participants were persuaded this was indeed a good model and asked the SSED to study this approach for inclusion in their long range plan.

A number of things began to happen. A fast-paced study for a potential mission was requested and funding arrangements were made. A Science Working Group was established to further define the low cost concept. This group met in late 1989 and again in May 1990, and reviewed a number of concepts that could be implemented as low-cost programs. They didn’t recommend any specific missions, but they did propose that the new program be called Discovery.

Later in 1990, the SSED Director, Dr. Wesley Huntress, asked the working group to focus on a specific mission and evaluate studies from both JHU/APL and the Jet Propulsion Laboratory (JPL) on the feasibility of the Discovery approach. The group quickly converged on the Near Earth Asteroid Rendezvous (NEAR) mission that had previously been looked at by NASA as a possible Planetary Observer mission (in fact, since the end of the Apollo missions in the 1970’s, planetary scientists such as Gene Shoemaker had felt the next logical step was to explore an asteroid, the nearest neighbor to Earth).

Ideas Become Reality

The JHU/APL and JPL studies were completed in May 1991, and their presentations to the Science Working Group revealed different findings. JHU/APL concluded such a mission was doable for approximately $110 million, while JPL suggested it was improbable to carry out the first Discovery mission for less than $150 million. The Science Working Group and other senior NASA managers found the JHU/APL approach to be preferable and made this recommendation to the SSED Director. Dr. Huntress decided to include the Discovery Program as an element in the 1991 SSED Strategic Plan, with NEAR as the first mission to be implemented.

The FY-1992 appropriations bill passed by Congress in the fall of 1991 directed NASA to prepare “a plan to stimulate and develop small planetary or other space science projects, emphasizing those which could be accomplished by the academic or research communities.” NASA prepared the requested report and submitted it to Congress in April 1992. For various programmatic reasons, JPL’s MESUR-Pathfinder mission to Mars was named as the first Discovery mission, with NEAR as the second.

In the fall of 1992, Bob Farquhar at JHU/APL identified an exciting opportunity to send a NEAR spacecraft to asteroid 433 Eros, the largest near-Earth asteroid, with a launch in February 1996. NASA proposed in its FY-1994 budget request to Congress that both MESUR-Pathfinder and NEAR be initiated as new starts that year, and Congress concurred. The funding for NEAR arrived at JHU/APL on December 1993, and the spacecraft was shipped to the Kennedy Space Center 24 months later.

The Discovery Program missions, in order of selection:

Sojourner Arrives on Mars *(Discovery Program Mission #1)*
Mars Pathfinder launched on December 4, 1996, demonstrating a number of innovative, economical, and highly effective approaches to spacecraft and planetary mission design such as the inflated air bags that allowed the Sojourner rover survive the descent. After arrival on Mars on July 4, 1997, Sojourner spent nearly 90 days analyzing rocks, taking measurements and sending back thousand of images. The engineering design far exceeded expectations, with the lander operating nearly three times longer than its design lifetime of 30 days, and the rover operating 12 times its design lifetime of seven days. The mission ended on September 27, 1997.

NEAR is a Go *(Discovery Program Mission #2)*
On February 17, 1996, NEAR became the first mission to launch in the Discovery Program. It exceeded all three principal requirements for Discovery: its cost of $112 million was well within the $150 million cost cap; the 27 month duration from development to launch surpassed the 36 month development cap; launch was with a Delta rocket, as required. NEAR spent one year in orbit around Eros, collecting a tremendous amount of data from its science instruments. It was then directed to a soft touchdown on the asteroid in February 2001, during which it took the highest resolution images ever obtained of an asteroid.

Return to the Moon *(Discovery Program Mission #3)*
Lunar Prospector was the first competitively selected Discovery mission. It launched on January 6, 1998, and was successfully placed into orbit 63 miles above the lunar surface five days later. It was designed to provide insights into lunar origin and

evolution and determine whether or not water ice is present in the Moon's polar regions. The mission ended on July 31, 1999, with a controlled impact that produced no observable signature of water. Overall, the mission provided a tremendous volume of data that scientists will analyze for years to come.

Stardust Captures Cosmic History ***(Discovery Program Mission #4)***
The first space mission dedicated to studying a comet, Stardust launched on February 7, 1999 to collect particles of comet dust and interstellar dust and return them back to Earth for analysis by scientists worldwide. It successfully encountered comet Wild-2 on January 2, 2004, flying within 149 miles of the comet's nucleus. The sample return capsule returned to Earth on January 15, 2006, and the microscopic samples were taken to the curatorial facility at NASA's Johnson Space Center in Houston, Texas. They have been distributed to scientists worldwide for study, and some very surprising findings have been announced.

Genesis Searches for Origins ***(Discovery Program Mission #5)***
Launched on August 8, 2001, the Genesis mission sent a spacecraft on a roundtrip journey one million miles from Earth to collect pieces of the Sun, called solar wind, for detailed analysis. Scientists believe that the outer layers of the Sun are composed of very nearly the same material as the original solar nebula that resulted in the formation of the planets in our solar system. Knowing the chemical content of the Sun may provide significant answers to questions about how the solar system formed and evolved. The captured particles returned to Earth on September 8, 2004, and were taken to a specially built clean room at the Johnson Space Center for analysis. They continue to be studied with the most sophisticated instruments available.

CONTOUR – A Comet Study Lost ***(Discovery Program Mission #6)***
The Comet Nucleus Tour, or CONTOUR, mission launched on July 3, 2002. It was designed to encounter and study two very different comets, Encke and Schwassmann-Wachmann-3 as they made their periodic visits to the inner solar system. Six weeks after launch, after a planned maneuver that was intended to propel it out of Earth orbit and into its comet-chasing solar orbit, the spacecraft was lost. A Mishap Investigation Board concluded the probable cause was structural failure of the spacecraft due to plume heating during the embedded solid-rocket motor burn.

MESSENGER Speeds Toward Mercury ***(Discovery Program Mission #7)***
MESSENGER will conduct the first orbital study of the closest planet to the Sun. Launched on August 3, 2004, it will swing past Venus twice, then fly by Mercury three times before starting a yearlong orbit of the innermost planet in March 2011. MESSENGER's science goals are to provide the first images of the entire planet and collect detailed information on the composition and structure of Mercury's crust, its geologic history, the nature of its thin atmosphere and active magnetosphere, and the makeup of its core and polar materials.

DEEP IMPACT Encounters a Comet ***(Discovery Program Mission #8)***

Deep Impact is the first experiment to probe beneath the surface of a comet. The two-part spacecraft, consisting of a larger "flyby" spacecraft carrying a smaller "impactor" spacecraft, launched on January 12, 2005, for a short six-month cruise to comet Tempel-1. Twenty-four hours before the impact on July 4, the two units separated and the impactor maneuvered into the path of the comet while the flyby observed and recorded the impact with a variety of science instruments. The largest observation campaign ever mounted from ground-based and space-based observatories sent spectacular images back to captivated viewers around the world and provided scientists with data on the debris and interior material that will be studied for years to come.

Dawn Looks Back in Time ***(Discovery Program Mission #9)***

The Dawn mission will travel to the two oldest and most massive asteroids in our solar system, Vesta and Ceres. By observing both minor planets with the same set of instruments, Dawn will provide new answers to questions about the formation and evolution of the early solar system. Launched on September 27, 2007, Dawn will reach Vesta in 2011 and Ceres in 2015, using solar electric ion thrusters to orbit both asteroids in one mission, a feat that has not been attempted before.

Kepler Seeks Earth-Size Planets in Other Solar Systems
(Discovery Program Mission #10)

The Kepler Mission will explore the structure and diversity of planetary systems, with a special emphasis on the detection of Earth-size planets in orbit around stars outside of our solar system. Launched on March 6, 2009, Kepler will monitor 100,000 stars similar to our Sun for nearly four years. The results may help answer the enduring question: are there others like us in the universe?"

GRAIL Seeks to Understand the Moon's Interior
(Discovery Program Mission #11)

The Gravity Recovery And Interior Laboratory (GRAIL) will unlock the mysteries of the Moon. By mapping the lunar gravitational field globally - not just on the nearside - to unprecedented accuracy and resolution, GRAIL will reveal the Moon's internal structure and thermal history and further our understanding of the evolutionary history of the rocky inner planets.

Discovery Program Missions of Opportunity

In 1998, the Discovery Program was expanded to include Mission of Opportunity investigations. These are defined as investigations that fall within the scientific scope of the Discovery Program but are not necessarily part of a NASA Science Mission Directorate investigation. These can be opportunities to fly a scientific instrument on an international mission or to re-purpose an existing NASA spacecraft. The NASA cost cap (or mission life cycle cost) for such missions of opportunity is $35 million. Five Missions of Opportunity have been selected to date:

ASPERA-3 Goes to Mars with ESA

ASPERA-3 is one of seven scientific instruments aboard Mars Express, a European Space Agency mission that launched from Russia on June 2, 2003 and entered into orbit around Mars on December 25, 2003. The main objective of the mission is to search for sub-surface water from orbit. ASPERA-3 will study the interaction between the solar wind and the atmosphere of Mars and characterize the plasma and neutral gas environment in the near-Mars space. Two of the four sensors on the instrument were funded by NASA as a Discovery Mission of Opportunity.

Mapping the Moon's Minerals

The Moon Mineralogy Mapper (M3) is one of two instruments that NASA is contributing to Chandrayaan-1, India's first mission to the Moon that launched October 22, 2008. M3 is a state-of-the-art imaging spectrometer designed to provide the first high-resolution spatial and spectral map of the mineral composition of the entire lunar surface.

EPOXI Takes on Two New Tasks

In 2007, NASA gave the Deep Impact spacecraft a new assignment called EPOXI – to search for planets around other stars and to observe another comet, Hartley 2. EPOXI is a combination of the names for the two components: Extrasolar Planet Observations and Characterization (**EPO**Ch) and **D**eep **I**mpact e**X**tended **I**nvestigation (DIXI), the comet flyby. The planet search took place in 2008, while the comet Hartley 2 encounter is set for November 4, 2010.

Stardust-NExT To Reveal Comet Tempel 1

The Stardust-NExT mission re-uses the Stardust spacecraft to make a return visit to comet Tempel 1, the location of Deep Impact's bold cratering experiment. The flyby on February 14, 2011, will reveal the changes to the comet's surface since the 2005 encounter and its recent closest approach to the Sun. The spacecraft instruments will measure dust properties and compare them with the 2005 measurements and photograph features previously discovered, such as jets, layers and flow features. The great hope is to see the crater excavated by Deep Impact.

Strofio Studies the Atmosphere to Learn about the Surface

Strofio is a unique mass spectrometer that is part of the SERENA instrument package that will fly on board the European Space Agency's BepiColombo/Mercury Planet Orbiter spacecraft. The SERENA instrument has two Neutral Particle Analyzers, Strofio and ELENA. Strofio will determine the chemical composition of Mercury's surface, providing a powerful tool to study the planet's geological history.