



## Transforming solar system exploration: The origins of the Discovery Program, 1989–1993



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### ABSTRACT

The Discovery Program is a rarity in the history of NASA solar system exploration: a reform program that has survived and continued to be influential. This article examines its emergence between 1989 and 1993, largely as the result of the intervention of two people: Stamatis “Tom” Krimigis of the Johns Hopkins University Applied Physics Laboratory (APL), and Wesley Huntress of NASA, who was Division Director of Solar System Exploration 1990–92 and the Associate Administrator for Space Science 1992–98. Krimigis drew on his leadership experience in the space physics community and his knowledge of its Explorer program to propose that it was possible to create new missions to the inner solar system for a fraction of the existing costs. He continued to push that idea for the next two years, but it took the influence of Huntress at NASA Headquarters to push it on to the agenda. Huntress explicitly decided to use APL to force change on the Jet Propulsion Laboratory and the planetary science community. He succeeded in moving the JPL Mars Pathfinder and APL Near Earth Asteroid Rendezvous (NEAR) mission proposals forward as the opening missions for Discovery. But it took Krimigis’s political skill and access to Sen. Barbara Mikulski in 1993 to get the NEAR into the NASA budget, thereby likely ensuring that Discovery would not become another one-mission program.

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As space policy analyst Stephanie Roy noted in 1998, the Discovery Program, which features relatively small, cost-constrained spacecraft, is a rarity in the history of NASA solar system exploration. Similar

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<sup>1</sup> Stephanie A. Roy, “The origin of the smaller, faster, cheaper approach in NASA’s solar system exploration program,” *Space Policy* 14 (1998), 153–71. For the context of the creation of the Discovery Program see John E. Naugle and John M. Logsdon, “Space Science: Origins, Evolution, and Organization,” in *Exploring the Unknown: Volume V: Exploring the Cosmos*, edited by John M. Logsdon (Washington, DC: NASA, 2001), 1–15, esp. 14–15; Howard E. McCurdy, *Faster, Better, Cheaper: Low-Cost Innovation in the U.S. Space Program* (Baltimore: Johns Hopkins University Press, 2001), esp. 55–57; and Amy Page Kaminski, “Faster, Better, Cheaper: A Socio-technical Perspective on Programmatic Choice, Success, and Failure in NASA’s Solar System Exploration Program,” in *Exploring the Solar System: The History and Science of Planetary Exploration*, edited by Roger D. Launius (New York: Palgrave Macmillan, 2013), 77–101. It is noteworthy that none of the above discusses the origins of Discovery more than in passing. The accounts that do exist are primarily focused on the role of the Johns Hopkins Applied Physics Laboratory (APL): Howard E. McCurdy, *Low-Cost Innovation in Spaceflight: The Near Earth Asteroid Rendezvous (NEAR) Shoemaker Mission*, NASA Monographs in Aerospace History, no. 36 (NASA SP-2005-4536) (Washington, DC: NASA, 2005), 7–15, which is based on the accounts of participants, notably Stamatis M. Krimigis and Joseph Veverka, “Foreword: Genesis of Discovery,” *Journal of the Astronautical Sciences* 43 (Oct.–Dec. 1995), 345–47, and Robert W. Farquhar, who subsequently published his memoir: *Fifty Years on the Space Frontier: Halo Orbits, Comets, Asteroids and More* (Denver: Outskirts Press, 2010), see esp. 137–42. The Jet Propulsion Laboratory’s side of the Discovery origins story is briefly covered in Peter J. Westwick, *Into the Black: JPL and the American Space Program, 1976–2004* (New Haven: Yale University Press, 2007), 210–18.

reform programs proposed in the 1970s and 1980s failed to cut ballooning spacecraft sizes and budgets. Subsequent attempts at transformative programs like New Millennium, one might add, have also come and gone. But a crisis in NASA’s program in the early 1990s forced a transformation in how the agency did business, at least in part and at least in this area of space science. While proclamations that big, expensive “flagship” missions are dead have proven premature, the Discovery Program has continued to fund innovative small spacecraft that have allowed much more frequent access, particularly to the smaller bodies of the inner solar system. Moreover, its success has encouraged the extension of its Principal-Investigator-centered, cost-contained model to other programs, including New Frontiers, which funds medium-sized missions to the outer solar system. Even the Explorer program for Earth-orbiting science spacecraft, the original model for Discovery, has been modified to make it more like the Discovery competition process.<sup>1</sup>

This article examines how the Discovery Program emerged between 1989 and 1993, largely as the result of the intervention of two people: Stamatis M. “Tom” Krimigis of the Johns Hopkins University Applied Physics Laboratory (APL) in Laurel, Maryland, who was Chief Scientist before 1991 and Head of the Space Department afterward, and Wesley T. “Wes” Huntress, who became Division Director of Solar System Exploration in 1990 and the Associate Administrator for Space Science in 1992. Krimigis drew on his leadership experience in

the space physics community and his knowledge of its Explorer program to propose in mid-1989 that it was possible to create new missions to the inner solar system for a fraction of the existing costs. He continued to push that idea for the next two years, but it took the influence of Huntress at NASA Headquarters to put it on to the agenda. Huntress explicitly decided to use APL to force change on the Jet Propulsion Laboratory (JPL) and the planetary science community. He succeeded in moving the JPL Mars Pathfinder and APL Near Earth Asteroid Rendezvous (NEAR) mission proposals forward as the opening missions for Discovery. But it took Krimigis's political skill and access to Sen. Barbara Mikulski in 1993 to get the NEAR into the NASA budget, thereby forestalling the possibility that Discovery would become another one-mission program.

## 1. Origins of Discovery

At the end of the 1980s, there was a widespread perception in the planetary science community that NASA's solar system exploration program was in trouble. Because the disruptive effects of the space shuttle overruns and delays of the late 1970s and early 1980s, and then of the *Challenger* accident of January 1986, no planetary spacecraft were launched between 1978 and 1989. The spectacular, if short-lived, Voyager 1 and 2 encounters with the outer planets provided almost the only new data in the 1980s. The Mars Observer program, started in the mid-1980s as the first in a line of what was to be lower-cost Observer missions based on an Earth-orbiting spacecraft bus, was running considerably over original projections. The underestimation of the technical difficulty of adapting an Earth-orbit satellite bus, plus instrumentation that proved more challenging than anticipated, broke the original budget estimates. The overrun was exacerbated considerably by NASA Headquarters' decision to postpone the mission from the 1990 to 1992 launch opportunities and change the booster from the shuttle to a Titan III, both as a result of the *Challenger* disaster. The prospect of future Observer missions slowly evaporated. A widespread perception in the planetary science community and JPL was that low-cost planetary missions were a chimera.<sup>2</sup>

In contrast to this rather gloomy picture, the then-Associate Administrator for Space Science and Applications (OSSA), Lennard Fisk, remembers the late eighties as a buoyant period of expansion. Thanks to a 1984 promise of Administrator James Beggs to the Space Science Board that science would get twenty percent of the NASA budget, and the expansions of the agency's appropriation thanks to the pro-space attitudes of Presidents Ronald Reagan and George H. W. Bush, including a two-billion dollar supplemental for a replacement shuttle orbiter, Fisk's budget was doing very well, doubling to \$3 billion by 1991. He instituted a strategic planning process, which he claims was a first at NASA, to choose the missions and long-term objectives for the Office of Space Science and Applications (OSSA). The much-delayed launches of the Magellan Venus radar mapper, Ulysses International Solar/Polar mission, Galileo Jupiter orbiter/probe, and Hubble Space Telescope in 1989/90, plus several flagship missions on the horizon, promised a new golden age for space science, in Fisk's view.<sup>3</sup>

All of that was to change after mid-1990, when a combination of the Hubble mirror embarrassment, the political fiasco of Bush's Space Exploration Initiative (SEI) for new human Moon–Mars

exploration, a U.S. economy going into recession, the savings-and-loan scandal, the Gulf War and the sudden end of the Cold War, resulted in a rapid transition from rising to flat NASA budgets. But that was in the future when Discovery began in 1989/90, so it seems reasonable to speculate that the expansive prospects encouraged the idea of adding small missions to the agenda, but the lack of urgency from the top had something to do with why it took two years for a low-cost program to gather momentum.

The first signs of a new initiative come from spring 1989. On 8 May, Kerry Nock of JPL sent out forty-eight letters to university presidents at the behest of Geoffrey Briggs, head of OSSA's Solar System Exploration Division (SSED), "to assess the capability and interest with the community of universities of a concept he [Briggs] is thinking about for small, university-managed, planetary spacecraft projects." The targets could include the Moon, near-Earth asteroids, "and possibly Mars[,] and the costs should be in the neighborhood of 100–150 million dollars."<sup>4</sup>

All the elements of the later Discovery Program were there, but the idea ran into a wave of opposition at Nock's institution. It appears likely that the JPL Director, Lew Allen, and his staff had not been properly briefed. Notes taken by Tom Krimigis during a 2 June phone conversation, presumably with someone at NASA Headquarters, mention "a lot of finger-pointing at JPL on who was responsible." His informant told him that a "cease and desist" message would go out soon—i.e., that the invitation to universities would be withdrawn.<sup>5</sup> Wes Huntress, who came from Pasadena in 1988 to be deputy director of the Earth Sciences division, assesses the behavior of his old center as firmly defending its turf and its way of doing business. "[T]hey saw this [small missions initiative] as a threat.... They liked the idea of one big mission at a time... and had no concept of how to break them [the JPL organization] up and work them on smaller missions. It was just a threat."<sup>6</sup>

Briggs' initiative seems likely to have begun immediately before the Nock letter.<sup>7</sup> Krimigis believes that it may reflect lobbying he had already made with Briggs, who thinks that is certainly possible. Cornell planetary astronomer Joseph Veverka also asserts that there was lobbying by some scientists for a small spacecraft program. However much that is true, evidence is currently lacking, but the initiative's immediate origins in Fisk's strategic planning process seems fairly apparent. The second strategic planning workshop for the SSED was to be held eight weeks later at the University of New Hampshire, providing another opportunity to present the idea and gather scientific support for inserting it into the plan. One of the presentations at

<sup>4</sup> Nock to Stephen Muller (President, Johns Hopkins), 8 May, copy stamped received by Stamatios M. Krimigis (hereinafter SMK), 23 May, Krimigis Papers, Johns Hopkins University Applied Physics Laboratory (hereinafter SMK/APL), box Krimigis Committees (SSES-SSAAC), file Solar System Exploration Subcommittee.

<sup>5</sup> SMK note 2 June, on message form from SMK to Dudley McConnell/NASA, 25 May 1989, SMK/APL, box Krimigis Committees (SSES-SSAAC), file Solar System Exploration Subcommittee.

<sup>6</sup> Wesley T. Huntress (hereinafter WTH) OHI by Rebecca T. Wright, 9 Jan. 2003, p. 7, copy in NASA History Division (hereinafter NASA HD), HRC 18948.

<sup>7</sup> Unfortunately, the records from NASA Headquarters are almost entirely missing. I surveyed what NASA had transferred to the Suitland Federal Records Center as of summer 2012 and found almost nothing from Science Mission Directorate (SMD) and its predecessors after 1990. The records management function at SMD appears to have collapsed, a problem exacerbated by the switch to electronic records. Inquiries at SMD Planetary Science Division have turned up only some files from Carl Pilcher that Michael New, Discovery Program Lead Scientist, had saved. I had them transferred to the History Division, where they have been cataloged as files HRC 20237 to 20242. But it appears that almost everything from the Briggs era has been lost for the period in question, and the same may be true for Huntress, other than some electronic documents he was able to find in his computer that he provided to me, and some late 1990s presentations preserved in paper form in his files at the Carnegie Institution of Washington. Briggs told me in a phone interview, 10 July 2012, that he had a large pile of documents on his windowsill that one day just disappeared. He does not know if it was discarded or saved. The former is looking increasingly likely.

<sup>2</sup> Ibid., 154–57; Erik M. Conway, "Planetary Observers, Mars Observer," draft chapter 1 of Mars program history, JPL, 2010.

<sup>3</sup> James Beggs/NASA to Thomas Donahue/SSB, 9 May 1984, electronic copy supplied by Lennard A. Fisk, University of Michigan; Fisk oral history interviews (hereinafter OHI) by Rebecca Wright, 8–9 Sept. 2010, [http://www.jsc.nasa.gov/history/oral\\_histories/NASA\\_HQ/Administrators/FiskLA/fiskla.htm](http://www.jsc.nasa.gov/history/oral_histories/NASA_HQ/Administrators/FiskLA/fiskla.htm), accessed 28 Sept. 2012; Fisk phone interview by Michael J. Neufeld (hereinafter MJN), 16 July 2012; William J. Broad, "NASA Moves to End Longtime Reliance on Big Spacecraft," *New York Times*, 16 Sep. 1991, p. A1.

the conference, held 26–30 June, was on the “Planetary Small Missions Program” by corporate consultants presumably hired by Briggs. It featured the Near-Earth Asteroid Rendezvous mission, an idea increasingly popular since the 1980s, as the scientific evidence for the importance of small bodies to the understanding Solar System origins and evolution mounted. As a mission, it had a fairly low energy requirement and relatively short transit time, which meant that it seemed more feasible within a constrained budget.<sup>8</sup>

At the conference, Robert A. Brown of the Space Telescope Science Institute was responsible for leading the breakout group to discuss the small missions initiative. It is noteworthy for the existing climate in the planetary science community that he began with the question: “Can a mission be done for under \$500 million?”<sup>9</sup> According to Tom Krimigis and Joe Veverka, who was also present, the idea for such a program was nonetheless “greeted by widespread skepticism. Principal among the criticisms was the view that the planetary community had already attempted such a program, called Planetary Observer—the first of which was the Mars Observer and ‘everybody knows what happened to that low-cost concept.’”<sup>10</sup> Krimigis has called this published summary of the discussion “polite”—some questions were hostile. “[T]hat’s when I said, ‘Look, the Planetary Observer is the wrong paradigm. Why don’t you look at the Explorers? They’ve been going on for decades now. They do focused science in a very cost-constrained environment and they do a good job.’” Challenged on the spot to do a presentation the next morning, Krimigis called his secretary and asked that the viewgraphs APL had recently produced for the Advanced Composition Explorer (ACE) be faxed to New Hampshire.<sup>11</sup>

Krimigis’s intervention was critical and is illustrative of the disciplinary divisions in the space science business. An American born in Greece, he was a 1960s graduate student of the legendary James Van Allen, and had risen by the end of the eighties to a position of considerable prestige in the field of space plasma physics. He was Principal Investigator (PI) on the Low Energy Charged Particle Experiment on Voyager, and also of a joint magnetospheric mission with Germany and Britain. His effective participation in two of the major communities engaged with OSSA—space physics and planetary sciences—gave him a broader perspective seemingly lacking in the mostly geologically trained planetary community. He found it “just amazing” that they “didn’t know much about the Explorers,” a spacecraft series going back to the origins of the space age that supported primarily the space physics and space astronomy communities.<sup>12</sup> Such a series had another advantage: Explorer had a standing line in the federal budget, circumventing the arduous process by which a “new start” for each individual program had to be moved through the Administration and Congress.

On the morning of 29 June 1989, Krimigis presented his talk about ACE, a heliophysics spacecraft that was to be put into an orbit around the L1 Lagrangian point between the Earth and the Sun (it was eventually launched in 1997).

It had all of the ingredients of a planetary spacecraft: it had the rocket engine, it had the instruments, it had the orientation, it had the solar panels. Then, at the end, Joe Veverka, who was chairing the session said, “All right, Krimigis, how much does that cost?”

I said, “You guys seem to be experts in cost. You tell me. What do you think this mission should cost?”

He said, “\$400 million.”

I said, “You’re in the right ballpark for the spacecraft, except you have one zero too many.”

He said, “What are you talking about?”

I said, “The spacecraft is actually \$45 million and the instruments another \$30 million.”

Everybody kind of held their breath and they said, “Well, okay. Maybe we should do a study of this.”

Immediately afterward Geoff Briggs, director of SSED, came up to Krimigis and said: “Hey, how about sending me an unsolicited proposal to do a study at APL.”<sup>13</sup>

Briggs formally launched the Discovery Program at the beginning of the next fiscal year, 1990, in October 1989. In a letter to Krimigis also sent to several others in late September, he described the new program and invited him to become a member of the Discovery Program Science Working Group (DPSWG). Briggs also named Robert W. Farquhar of the Goddard Spaceflight Center, famous for his development of Lagrangian point orbit theory and his diversion of the ISEE-3 spacecraft to intercept a comet in 1985, as Program Manager for Discovery. Krimigis’s cover note to the APL Space Department management stated: “As you know, we are in the process of being funded at the level of \$250K to work with the DPSWG in the spacecraft area.”<sup>14</sup> But that amount of money was never transferred. Farquhar, in his memoirs, discusses a \$100,000 grant to study the NEAR mission, but states that his first meeting with Krimigis did not go well because he told him that “the 1990 funds would go to JPL [for a Pluto study] and there might be a competition for the 1991 study.” Indeed, the latter is what transpired, as APL had to compete with JPL in FY 1991 over the NEAR project. The institutional politics for Briggs as Solar System division director were clear: it was impossible to do anything in the planetary area without the participation of JPL, which vigorously opposed any intrusions on its turf.<sup>15</sup>

During fiscal 1990, the Discovery Program languished and it is not entirely obvious why. The science working group, which was chaired by Robert Brown, held two meetings in different parts of the country in late 1989 and spring 1990, but spent much time on proposed mission to Pluto that strained the definition of a low-cost spacecraft. The one accomplishment attributed to it—picking the name Discovery—cannot be true as Briggs had specified that at the outset.<sup>16</sup> Meanwhile, overall planning for planetary exploration, big and small, had been “abruptly changed,” according to an October 1989 letter from the chair of SSED’s Strategic Planning Group, by President George H. W. Bush’s 20 July 1989 speech that launched SEI. The focus of NASA was to shift to the Moon and Mars, which

<sup>8</sup> SMK OHI by MJN, 22 June 2012; Briggs phone interview by MJN 10 July 2012; Veverka e-mail to MJN, 30 January 2013; “Planetary Small Missions Program” presentation for 26–30 June 1989, by M. Stancati et al., in SMK/PL, box Krimigis Committees (SSES-SSAAC), file Solar System Exploration Subcommittee.

<sup>9</sup> Quote from SMK notes “SSES Workshop II UNH 6/26/89,” in SMK/PL, box Krimigis Committees (SSES-SSAAC), file Solar System Exploration Subcommittee.

<sup>10</sup> SMK and Veverka, “Foreword: Genesis of Discovery,” 345.

<sup>11</sup> SMK OHI by Susan Niebur, 27 August 2009, NASA HD HRC 20229; APL fax to Tom Krimigis, 28 June 1989, in SMK/PL, box Krimigis Committees (SSES-SSAAC), file Solar System Exploration Subcommittee; SMK to Kevin Kelly, 8 July 1993, in SMK/PL, box 1993–1995 SMK Chron/Calendars, folder Chronological File (1993).

<sup>12</sup> SMK OHI by Susan Niebur, 27 August 2009, NASA HD HRC 20229. For more on the biography see SMK OHI by Mame Warren, 10 January 2008, courtesy APL; SMK OHI by MJN, 22 June 2012; and [http://sd-www.jhuapl.edu/CASSINI/SMK\\_Bio\\_Update05-2012.htm](http://sd-www.jhuapl.edu/CASSINI/SMK_Bio_Update05-2012.htm), accessed 1 Oct. 2012.

<sup>13</sup> SMK OHI by Mame Warren, 10 January 2008, pp. 12–13, courtesy APL.

<sup>14</sup> Briggs to SMK, 25 Sep., and SMK memo to Space Department Management Committee, 6 Oct. 1989, SMK/PL, box K. Papers and Correspondence, no folder. In Krimigis’s recollection, Briggs told Farquhar to solicit a NEAR proposal from APL (and possibly also JPL) at the June meeting, so Farquhar’s appointment may have informally begun earlier. SMK OHI by MJN, 22 June 2012.

<sup>15</sup> SMK e-mail to MJN, 17 Oct. 2012; Robert W. Farquhar, *Fifty Years*, 137; SMK OHI by MJN, 22 June 2012.

<sup>16</sup> SMK and Veverka, “Genesis,” 346; McCurdy, *Low-Cost Innovation*, 9; Briggs to SMK, 25 Sep. 1989, SMK/PL, box K. Papers and Correspondence, no folder.

might threaten its new flagship program, twin, large Mariner Mark II spacecraft for Comet Rendezvous/Asteroid Flyby and the Cassini mission to Saturn (a program known as CRAF/Cassini).<sup>17</sup> Political uncertainty as to whether SEI would go forward and NASA's budget would be greatly increased for human exploration was likely a major distraction at OSSA, which may well explain why Briggs' attention was elsewhere than Discovery. One thing is clear: the intense political pressure on NASA to reform its supposedly bureaucratic and spendthrift ways would not build up to a crescendo until after the late June 1990 public revelation of the Hubble mirror flaw, reinforced by several embarrassing shuttle launch delays, and estimates that sending humans to Mars could cost hundreds of billions of dollars. Before then, a push for smaller, cheaper spacecraft had little political traction.

In August 1990, Geoff Briggs, who had served as SSED director for seven years, was replaced by Wes Huntress, who moved over from Earth Sciences to take on a job he had been groomed for. He set three objectives: a revival of the Discovery Program, a mission to Pluto, and a program to fund astronomical search for extra-solar planets. To accomplish the first, he put Joe Veverka in place of Brown, who would move over to a new committee for the third objective, and he created a parallel Discovery Program Cost and Management Team of engineer program managers chaired by Jim Martin of the Langley Research Center, who had managed the Viking Mars missions in the 1970s. Huntress states: "I picked two tough guys who would make this happen.... You got to tell me if this is possible or not and if it is, what kinds of things we can do. I want to know in a year or two and so they took this new activist charter and off they went."<sup>18</sup>

Tom Krimigis, for one, was still frustrated at the pace of change. On 27 September 1990 he gave testimony to a panel of the Augustine Committee, a body set up to review the entire NASA program in the wake of the Hubble fiasco. He criticized the "New Start Syndrome" that tied up OSSA's resources in the search for the approval for a few large programs, contributing to an "imbalance" between large and small space science projects. Using examples from the Explorer program, he also attacked what he saw as overbearing NASA bureaucracy that ate up time and resources with endless documentation requirements and reviews. He thought that systems management requirements imported from the human spaceflight program were unnecessary in the robotic program. He was articulating an embedded culture at the Applied Physics Laboratory, one that minimized paperwork in small, face-to-face, in-house teams. Michael Griffin, an APL veteran who later became NASA Administrator, has noted that this culture would produce clashes with the space agency's paperwork-heavy methods of operation.<sup>19</sup>

## 2. The competition

At the beginning of FY 1991 in October, Huntress was able to give Farquhar the go-ahead for funding the competing NEAR studies at APL and JPL. Probably as a concession to NASA's official planetary center, or because JPL was going to subcontract spacecraft studies to

industry, Pasadena got more than twice as much: \$250,000 *versus* \$115,000 for APL Space Department. Only a few weeks after Farquhar sent out the letters, he got a call in late October inviting him to join the staff of APL and take a prominent role in the study. Farquhar, who had been looking to move, happily accepted, but as he admits in his memoirs, he felt that turning around and spending the money he had just allocated was a bit dubious ethically.<sup>20</sup>

Huntress's logic for the dual awards, as he later remembered it, was to force competition on Pasadena, "because I did not feel that JPL had any incentive to keep their costs down." As NASA's own Ames Research Center in northern California had not built a small interplanetary spacecraft since the late 1970s, he had little confidence in it. In his view, there were only two organizations that were relevant: APL and the Naval Research Laboratory in Washington, DC.<sup>21</sup> But the NRL ultimately only carried out one deep space mission, Clementine, launched in 1994 and funded by the Strategic Defense Initiative Organization (SDIO), and does not seem to have responded to Huntress with much interest. APL Space Department (which it should be noted, was then only about 350–400 people in a mainly Navy-funded center of about 3000), had been even more heavily funded by SDIO to carry out a series of space intercept and missile-defense-related missions since the mid-1980s. These had been very successful, but Tom Krimigis, who became the head of the department on 1 January 1991, saw that the end of the Cold War made the future of SDI doubtful and military funding problematic. As a scientist who had done most of his work on NASA missions, he was also less enthused by his department's military dependence. The Discovery Program was an opportunity to shift the balance of funding towards NASA, thereby sustaining and even increasing his employment base (he would eventually receive permission to expand it to about 600). The Laboratory director and the University president were able to provide little help with that strategy, but as it succeeded and brought favorable public attention to a place that had a very low profile, they were pleased.<sup>22</sup>

Huntress had a second reason for his interest in APL. Despite JPL's public reputation for carrying out historic scientific missions, "scientists all had this love/hate relationship with JPL, because JPL treated scientists as if they were a pain in the butt.... [JPL engineers] treated science as a risk to their spacecraft." This attitude was developed over decades of struggling with challenging projects where just getting to the target body successfully was hard. APL Space Department's culture, as he observed it, was the opposite. "They started with the science. The science was the reason for doing the mission." In the 2009 oral history interview in which he made these remarks, Huntress did not explain why that was the case at APL, but it appears to have been rooted in a long tradition of Earth-orbiting scientific spacecraft that the laboratory had built for NASA and the Navy.<sup>23</sup>

After a winter and spring developing their proposals, the dueling NEAR teams met for a mid-May showdown in Pasadena before Joe Veverka's DPSWG and Jim Martin's technical committee. The meeting has become legendary in APL Space Department lore. The JPL study leader, John Beckman, made a presentation that stunned the non-JPL members of the audience, stating in one

<sup>17</sup> WTH OHI by Susan Niebur, 13 Mar. 2009, NASA HD HRC 20229; Niehoff/SAIC, "SSES Strategic Planning Update," 13 Oct. 1989, in SMKP/APL, box Krimigis Committees (SSES-SSAAC), file Solar System Exploration Subcommittee; Thor Hogan, *Mars Wars: The Rise and Fall of the Space Exploration Initiative* (Washington, DC: NASA, 2007), NASA SP 2007-4410.

<sup>18</sup> WTH OHI by Susan Niebur, 13 Mar. 2009, NASA HD HRC 20229 (quote), and Report of the "Discovery Program" Cost and Management Team, 10 July 1991, HRC 20237; WTH OHI by Rebecca Wright, 9 Jan. 2003, pp. 5–6, NASA HD, HRC 18948; WTH OHI by Mame Warren, 25 Mar. 2008, courtesy APL.

<sup>19</sup> SMK presentation to Augustine Committee, 27 Sep. 1990, in SMKP/APL, box SMK Messenger SMK-1991 papers, no folder; Griffin OHI by Mame Warren, 7 May 2008, courtesy APL.

<sup>20</sup> SMK OHI by MJN, 22 June 2012; SMK memo to Sen. Barbara Mikulski via Kevin Kelly, 23 May 1991, in SMKP/APL, box SMK Messenger SMK-1991 papers, no folder; Farquhar, *Fifty Years*, 138.

<sup>21</sup> WTH OHI by Mame Warren, 25 Mar. 2008, courtesy APL; WTH OHI by Susan Niebur, 13 Mar. 2009, NASA HD HRC 20229.

<sup>22</sup> SMK to Gary Smith/APL Director, 29 June 1993, in SMKP/APL, box Krimigis, file FY 94 Budget Correspondence; SMK OHI by MJN, 22 June 2012.

<sup>23</sup> WTH OHI by Susan Niebur, 13 Mar. 2009, NASA HD HRC 20229. For an overview of APL Space Department history, see the illustrated popular book constructed out of oral history excerpts: Helen E. Worth and Mame Warren, *Transit to Tomorrow: Fifty Years of Space Research at The Johns Hopkins University Applied Physics Laboratory* (Laurel, MD: APL, 2009).

viewgraph that it was “IMPROBABLE” that an effective asteroid mission could be done for the target number of \$150 million. Instead he laid out a plan for three spacecraft. The first would merely be an asteroid flyby with one instrument for that amount, then the second might rendezvous with two instruments for \$149 million, then another with three instruments for \$137 million. The net result would be spending \$436 million over ten years, plus at least \$150 million for boosters and more for operations, thereby monopolizing the Discovery budget for a decade. Krimigis thought it was “very insulting.” According to him, Jim Martin was furious and yelled: “You people think we are stupid, don’t you.”<sup>24</sup>

The APL team, led by project manager Thomas Coughlin, then made its presentation, laying out a program for a complete spacecraft for only \$110 million. It drew the opposite reaction from some members of the audience: “not so much skepticism as amusement,” says APL NEAR project scientist Andrew Cheng. The number seemed too low and indicative of an organization that had never conducted a mission beyond Earth orbit and did not understand the costs. Nonetheless, Tom Krimigis, in a memo to Maryland Sen. Barbara Mikulski’s office immediately afterward, asserted that the Science Working Group definitely came out in APL’s favor. The relatively new director of JPL, Edward Stone, asked for an extra meeting day, and on 17 May apologized for their presentation and asked for a second chance to present.<sup>25</sup>

Wes Huntress, who was not present, decided to grant that possibility. He gave JPL only a month and reached down into the organization to get a project manager known as a maverick, Anthony Spear, to produce a new proposal based on data from the first. Spear, who had saved the Magellan Venus radar-mapping mission from numerous, potentially disastrous software glitches, delivered a credible study to a new meeting on 17 June 1991, sketching out a mission for the 150 million dollar target. But Huntress’s mind may already have been made up. Doug Stetson, another JPL detailee working at SSED at the time, says that the division director “had already decided that he wanted APL to have that responsibility... in order to give this message to JPL”—namely that it needed to take low-cost missions seriously.<sup>26</sup> Huntress told an interviewer in 2008 that:

I could have predicted the result. I did predict the result. JPL’s was way too expensive, and APL’s was quite reasonable.... What’s interesting is [that] the first JPL proposal was pretty sloppily done. We rejected it, and they asked for a second chance... but even after the second chance, while their proposal was feasible, it was much more expensive than APL’s, which was also feasible. Slam dunk. APL gets the mission. JPL was shocked, absolutely shocked. They just had trouble fathoming the idea that NASA would give a planetary mission to anybody other than JPL, and second, that a former JPLer would do that to them. But I had to deliver a message: You don’t get it.”<sup>27</sup>

<sup>24</sup> McCurdy, *Low-Cost Innovation*, 10–11; Beckman viewgraph presentation “Discovery Program Status,” parts 1 and 2, 18 and 14 May 1991, copy of pages courtesy Howard McCurdy (“IMPROBABLE”); SMK to WTH, 23 May 1991, in SMKP/APL, box Krimigis Papers and Correspondence, no folder; SMK OHI by MJN, 22 June 2012 (SMK quotes); SMK OHI by Susan Niebur, 27 August 2009, NASA HD HRC 20229.

<sup>25</sup> APL Discovery presentation, May 1991, in NASA HD HRC 20237; Cheng quoted in McCurdy, *Low-Cost Innovation*, 12; SMK memo to Sen. Barbara Mikulski via Kevin Kelly, 23 May 1991, in SMKP/APL, box SMK Messenger SMK-1991 papers, no folder; McCurdy, *Low-Cost Innovation*, 11–12; SMK OHI by MJN, 22 June 2012; John Dasoulas/APL memo to WTH, 20 June 1991, copy in SMKP/APL, box Krimigis Papers and Correspondence, no folder.

<sup>26</sup> Stetson OHI by MJN, 4 May 2012 (quote); JPL Discovery Presentation 17 June 1991, JPL Archives electronic document D-15957; WTH phone interview by MJN, 10 July 2012; Spear OHI by MJN, 4 May 2012.

<sup>27</sup> WTH OHI by Mame Warren, 25 Mar. 2008, courtesy APL.

In his decision document, drafted in about August 1991 for presentation to Fisk, Huntress noted that the APL proposal would leave a \$40 million margin for overruns and was to be done in three years, while the Spear proposal was right up against the Discovery dollar cap and took six months longer.

However, resolution of the issue is determined mainly by two other discriminators: 1. concern over JPL’s ability to achieve the necessary cultural change in order to manage a successful low-cost program, and 2. concern over the external perceptions of a selection of JPL for the first Discovery mission, based on JPL’s poor cost performance in recent projects, with resulting loss of Division credibility and attendant loss of agency, OMB [Office of Management and Budget] and Congressional support for Discovery.

JPL’s performance record is excellent for implementing technologically challenging, long-lifetime planetary projects, but JPL also has a management approach and culture that is not conducive to small, low-cost projects. JPL’s poor cost performance on the Mars Observer project alone precludes JPL as a credible choice for the first Discovery mission.<sup>28</sup>

The rest of the document discusses his strategy for creating a new project to foster change in Pasadena. It refers to the Woods Hole, Massachusetts, OSSA final strategic planning workshop that took place at the end of July and the beginning of August, a meeting that Huntress described elsewhere as “grueling and debilitating” for its in-fighting over a NASA space science budget suddenly turning flat. At Woods Hole, Lunar Observer was a casualty of the cutbacks and Mars Observer overruns, but Discovery had been approved. He proposed a new “Lunar Scout” Discovery-class mission to replace Lunar Observer and “partially satisfy the science community’s disappointment,” as well as providing a basis for JPL to attempt a low-cost project. In mid-August he had Tony Spear detailed to work directly for NASA Headquarters, with the task of studying possible Discovery and Lunar Scout missions at JPL.<sup>29</sup>

### 3. Enter Mars

The Moon project did not last long because of the arrival that August of Mike Griffin as the Associate Administrator for Exploration, a new directorate for reviving the ill-fated Space Exploration Initiative. He had left APL in the mid-1980s, and after serving in SDIO and other defense and intelligence organizations, had arrived as a candidate of the Vice President Dan Quayle’s National Space Council, which was disillusioned with NASA management. The Council wanted innovative, cost-saving methods and technology from SDI and the military imported into the agency. Huntress issued welcoming words for the new associate administrator in an SSED newsletter to the planetary science community, but soon found himself less than happy. Griffin argued to NASA Administrator Richard Truly that, in support of human exploration, Lunar Scout be transferred to Code X, as his division was known. Huntress said recently: “He got Truly to agree. Which really pissed me off.”<sup>30</sup>

<sup>28</sup> WTH, “Discovery Decision,” c. Aug. 1991, draft Microsoft Word document, courtesy WTH.

<sup>29</sup> *Ibid.*; WTH, “Solar System Exploration Division Newsletter,” late summer/early fall 1991, draft Microsoft Word document, courtesy WTH (“grueling...”); WTH phone interview by MJN, 10 July 2012; Spear OHI by MJN, 4 May 2012, Erik M. Conway, “Mars Wars and Sample Return,” draft chapter 2 of Mars program history, JPL, 2010; Spear to Huntress, fax 15 Aug. 1991, and attached Routing Slip, NASA HD, HRC 20237.

<sup>30</sup> WTH OHI by Susan Niebur, 13 Mar. 2009, NASA HD HRC 20229. For the impact of Quayle’s Council and SDI on the planetary program, esp. JPL, see Westwick, *Into the Black*, 215–27.

Huntress and Fisk grew concerned that Griffin would next take Mars away from OSSA. Therefore it was necessary to start a new program and “cut him off at the pass.” At that point successor programs to Mars Observer, which was to launch in September 1992, were “nebulous.” A multi-billion-dollar Mars sample-return project was already a casualty of the sudden change in the budgetary climate. NASA Ames had a plan for a Mars Environmental Survey (MESUR) network of landers and a proposal for a MESUR Pathfinder mission to try out a new low-cost landing system using air bags. But Wes Huntress had little confidence in Ames’ planetary exploration capability, as earlier noted. He drafted a letter at the end of October, from Fisk to JPL Director Stone, transferring MESUR to Pasadena. Fisk sent a version of it after he visited Ames and found the Director unwilling to support MESUR. Huntress told Stone to use Tony Spear’s team, the only one he had confidence in to do a low-cost mission, to work on MESUR instead of Lunar Scout.<sup>31</sup>

The future budget picture for OSSA worsened further that winter; NASA’s top priority was saving the Space Station; budget growth for space science had to be cut back again. In preparing the fiscal 1993 budget, Fisk and Huntress found themselves having to cancel the Comet Rendezvous/Asteroid Flyby part of CRAF/Cassini, to the loud protests of the scientific community. The astrophysics program also took large cuts. As for starting the Discovery line, that was a year away at the earliest, so the program was as yet cheap. However, Fisk and Huntress had to decide what to do about funding “Phase A” preliminary studies that would provide a foundation for the program.<sup>32</sup>

It was at this point that Huntress integrated MESUR Pathfinder (later Mars Pathfinder) into Discovery—like Lunar Scout, its earlier status was undefined. On 3 March 1992, he drafted a memo to Fisk about the cutbacks in the OSSA budget and the need to rethink the strategic plan laid out only eight months before at Woods Hole. He noted the continuing threat that Griffin would launch a new Mars mission initiative in competition to OSSA. Among his recommendations were:

- fly a microrover on the MESUR tech demo mission to intensify public interest, and to reinforce the mission as a tech demo.
- fly the MESUR tech demo as the first Discovery mission. Gets an early new start for Discovery, and helps to deflect criticism that MESUR is jumping the queue in the context of the OSSA Strategic Plan.
- the Administration is highly supportive of both small planetary programs and Mars missions. This approach kills two birds with one stone. “Discovery to Mars!”.
- Near Earth Asteroid Rendezvous relegated to the second Discovery mission. Helps to solve the JPL vs. APL dilemma; both get a Discovery mission, MESUR/demo to JPL and NEAR to APL. Maryland is included but not out in front as with a first Discovery mission to APL (the President’s desires are out in front!).<sup>33</sup>

Thus, after having been selected for NEAR on the assumption that it would be the first mission of the program, APL suddenly was second because Mars had more appeal to the Congress and the Administration, and because Pathfinder would be an internal

mechanism to reform JPL and fend off Code X. In parts of the memo, Huntress even floated the idea of a comet mission that would displace NEAR to third.<sup>34</sup>

Fisk apparently decided against that, as on 20 March he officially awarded Phase A contracts to APL and JPL. Before the letter to Krimigis about NEAR went out, however, Fisk called him to say that APL would be second, which meant a delay in starting NEAR. According to the Space Department head, Fisk even said that “the first Discovery mission must be done at JPL,” presumably for internal and external political reasons. That naturally did not please Tom Krimigis at all. Thanks to his excellent connections, “Maryland”—Huntress was alluding to the power of Sen. Mikulski as the chair of the Senate appropriations subcommittee that controlled NASA’s budget—would not be so easily displaced. Krimigis was behind the subsequent request from Mikulski’s committee for a report on the Discovery plan, which Huntress then wrote, mentioning both Pathfinder and NEAR. A subsequent NASA press release put the Mars launch in 1996, but NEAR not until 1998, a year later than APL had planned. With the support of OMB, which liked the idea of an innovative, small-spacecraft program line, Huntress and Fisk put ten million dollars into the fiscal 1993 budget for JPL and APL’s Phase A studies. But the “new start” for Discovery would only come in the next fiscal year, so any battle over how much Pathfinder and NEAR would be funded, and which had priority, was postponed a year.<sup>35</sup>

Immediately after the letters went out, Daniel Goldin, an executive from TRW, replaced Truly as NASA Administrator on 1 April 1992, with an explicit agenda from Quayle’s National Space Council to shake up the bureaucracy. One of the things he did, six months later, was to break up OSSA by splitting off the earth sciences and the life and microgravity sciences, kicking Len Fisk upstairs to the empty job of NASA Chief Scientist. Fisk would finally depart in summer 1993 after, by his account, unsuccessfully trying to get Goldin fired by the incoming Clinton Administration. Wes Huntress unexpectedly found himself Associate Administrator for Space Science when he got a call at a Munich conference in October 1992: Goldin said: “‘I’m firing Len. You’re the guy,’ which really scared me [Huntress]. I mean, I had no ambitions to be an AA.”<sup>36</sup>

The Discovery Program had likely played a role in his promotion. Getting rid of huge spacecraft Goldin dubbed “Battlestar Galacticas,” after a TV science-fiction show, and pushing smaller ones, was high on the Administrator’s agenda, so he was pleased when Huntress had told him such a program already existed in the planetary division.<sup>37</sup> Discovery became a marquee project in Goldin’s “better, faster, cheaper” campaign, but it is noteworthy that he had nothing to do with its origin to that point, nor did he have much of a role in

<sup>34</sup> Ibid.

<sup>35</sup> Fisk to SMK, and Fisk to JPL, 19 Mar. 1992, JPL Archives, Stone Papers, Box 16, Folder 185; SMK OHI by Susan Niebur, 27 August 2009 (quote) and WTH OHI by Susan Niebur, 13 Mar. 2009, both NASA HD HRC 20229; SMK e-mail to MJN, 17 Oct. 2012; NASA “Small Planetary Mission Plan, Report to Congress, April 1992,” Microsoft Word document, courtesy WTH; NASA News, “NASA Announces Plans for Small Planetary Missions,” 8 May 1992, NASA HD, HRC 8722; Westwick, *Into the Black*, 211; Steven Isakowitz (former OMB branch chief for NASA budget) phone interview by MJN, 19 Oct. 2012.

<sup>36</sup> Fisk OHIs by Rebecca Wright, 8–9 Sept. 2010, [http://www.jsc.nasa.gov/history/oral\\_histories/NASA\\_HQ/Administrators/FiskLA/fiskla.htm](http://www.jsc.nasa.gov/history/oral_histories/NASA_HQ/Administrators/FiskLA/fiskla.htm), accessed 28 Sept. 2012; Fisk phone interview by MJN, 16 July 2012; Liz Tucci, “Goldin Shifts Managers as Ban on Changes Lifts,” *Space News* 4, no. 11 (15–21 Mar. 1993), 3, 21; WTH OHI by Susan Niebur, 13 Mar. 2009, NASA HD HRC 20229; WTH OHI by Rebecca Wright, 9 Jan. 2003, NASA HD, HRC 18948 (quote).

<sup>37</sup> “Discovery: A Program of Small Planetary Flight Missions,” viewgraph slides dated “Goldin 5/12/92,” in folder “Discovery-GoldinBrief93,” JPEG image files courtesy WTH; WTH OHI by Susan Niebur, 13 Mar. 2009, NASA HD HRC 20229; WTH OHI by Rebecca Wright, 9 Jan. 2003, pp. 5–6, NASA HD, HRC 18948. It should be noted that Fisk and Huntress were also successful in thwarting Goldin’s attempt to kill JPL’s large Cassini “flagship” mission to Saturn with the Europeans.

<sup>31</sup> WTH phone interview by MJN, 10 July 2012 (“cut him...”, “nebulous”); WTH OHI by Susan Niebur, 13 Mar. 2009, NASA HD HRC 20229; WTH OHI by Mame Warren, 25 Mar. 2008, courtesy APL; Fisk to Stone, draft 28 Oct. 1991, Microsoft Word document courtesy WTH; Spear OHI by MJN, 4 May 2012; Erik M. Conway, “Mars Wars and Sample Return,” draft chapter 2 of Mars program history, JPL, 2010.

<sup>32</sup> C. C. Kilgus memo to SMK, 20 Feb. 1992, on OSSA Advisory Committee meeting with congressional and OMB staff members, SMK/APL, box Krimigis Committees (SSS-SSAAC), file SSAAC Status Report Update—May 1, 1992; Huntress draft memo to Fisk, 3 Mar. 1992, Microsoft Word document, courtesy WTH.

<sup>33</sup> WTH draft memo to Fisk, 3 Mar. 1992, Microsoft Word document, courtesy WTH.

the subsequent political moves leading to its formal creation. His major contribution turned out to be not getting in the way.

#### 4. End game

In November 1992, the Discovery Program had a very successful workshop in San Juan Capistrano, California, in which innovative ideas for missions were solicited from the scientific community. The fact that there seventy-three proposals, many of which seemed credible, helped legitimize the creation of a program that would, after the first two assigned missions, be competed openly with principal investigators in the lead.<sup>38</sup> The challenge now would be to install it as a permanent line in the NASA budget that would allow SSED to stage a competition about every other year once the first two missions were past their funding peaks.

Before that precedent could be established, however, it was necessary to sort out how the program would begin. Shortly after San Juan Capistrano meeting, the Solar System Exploration Subcommittee had confirmed the primacy of Pathfinder. But Tom Krimigis was by no means satisfied by that, or how that had come about. He had already instructed Bob Farquhar as NEAR mission design leader to look at a range of asteroid encounters, both for the official goal of a 1998 launch and for other options. The 1998 opportunity was for a not very interesting minor planet less than a kilometer in size. But in September 1992, Farquhar found that it was possible, through an encounter with the Earth, to reach the much larger and more important 433 Eros, but that required a launch in early 1996. Subsequently, a Science Working Group on small bodies chaired by Joe Veverka endorsed the Eros encounter as scientifically very interesting. But to reach Eros meant that NEAR would have to be funded in fiscal 1994 and the spacecraft development time compressed to little more than two years. But that was a plan that remained only a plan unless Huntress had the money to support the increased budget, which he did not. His original fiscal 1994 budget request was \$55.2 million for Pathfinder and nothing for APL's NEAR. The latter would begin in fiscal 1995 with \$14.5 million, while Pathfinder's budget would go to \$81.3 million to fund peak development.<sup>39</sup>

When the 1994 NASA budget was marked up in Congress in spring 1993, the House bill appropriated \$63.1 million for Discovery without mentioning a specific mission. The primacy of Pathfinder and that amount meant, however, that only it could be funded. The House Committee on Science, Space and Technology, headed by George Brown of California, singled out the Mars project in its report. As for Dan Goldin, he was enthused by exploration of the Red Planet and by its appeal to the politicians and the public. In Huntress's view, he perceived Discovery at that point as mostly a low-cost mission to Mars, rather than a long-term program. The Administrator apparently knew or cared little about NEAR.<sup>40</sup>

<sup>38</sup> Discovery Program Handbook, NASA HD, HRC 7029, and NASA News Release 93-027, "NASA Selects 11 Discovery Mission Concepts for Study," 11 Feb. 1993, in HRC 20238; Leonard David, "NASA Culls Discovery Missions while Seeking Program Funds," *Space News* 4, no. 8 (22–28 Feb. 1993), 17.

<sup>39</sup> Farquhar, *Fifty Years*, 138–42, and Documents 8-5 and 8-6 (Veverka to Huntress, 24 May, and Lunine to Huntress, 10 August 1993), 360–63; Jim Bell and Jacqueline Mitton, eds., *Asteroid Rendezvous: NEAR Shoemaker's Adventures at Eros* (Cambridge and New York: Cambridge University Press, 2002), 10; SMK OHI by MJN, 22 June 2012; SMK to H. McCurdy/American U., 28 Oct. 2002, in SMPK/APL, box MP3-134 Dr. Krimigis (Misc.), folder Correspondence SMK; WTH, "NEAR'94 Budget," c. early 1993, Microsoft Word document courtesy WTH (which shows a budget allocation of \$12 million, much less than required for a 1996 launch). OSSA FY 1994 Preliminary Budget viewgraphs, c. early 1993, in NASA HD, HRC 20237, file Discovery Correspondence and Handbook.

<sup>40</sup> Veverka to Mikulski, 24 May 1993, and attached APL NEAR fact sheet, and Krimigis fax to Coughlin and Farquhar, 17 June 1993, with attached pages of House report, both in SMPK/APL, box Krimigis, file FY 94 Budget Correspondence; WTH OHI by Mame Warren, 25 Mar. 2008, courtesy APL.

Tom Krimigis was not about to accept that outcome without a fight. He had been politically involved since his youth in Greece, had strong personal connections to Maryland senators and to the Democratic Party, and had expertly worked Congress and OMB since the 1970s in support of APL space programs. He unleashed a lobbying campaign in May 1993, enlisting Veverka and other scientists to write to Congress in favor of an early start that would allow an Eros encounter, and worked closely with Mikulski's Senate subcommittee staff director, Kevin Kelly, on language and rationale.<sup>41</sup>

Angered by the parliamentary maneuver that excluded NEAR from funding, Krimigis fed arguments to Kelly that, going by NASA's own statements, Pathfinder should not be a Discovery project at all. (He had probably had made a similar argument in spring 1992, when Mikulski had requested a report, as Kelly and Krimigis had worked together for years). It was not a scientific mission as specified in all Discovery announcements, rather, it was a technology demonstrator. Moreover, it violated the cost cap of 150 million in FY 1992 dollars, as Huntress had added the micro-rover (later called Sojourner) from the technology directorate with an added budget of \$40 million. Not being privy to the internal deliberations of OSSA (now OSS), Krimigis attributed Pathfinder's sudden appearance and priority primarily to pressure from JPL to sustain its planetary exploration monopoly and stop APL. At the same time he and his colleagues had to fight off rumors, presumably circulated by JPL allies, that the APL's spacecraft was technically challenging and already behind schedule.<sup>42</sup>

As a result of Krimigis's carefully executed campaign, Mikulski steered her subcommittee to appropriate \$132 million for Discovery, with \$62 million for NEAR. When the competing versions of the bill went to the conference committee in the fall, it was Mikulski who won. Huntress says: "That made Dan Goldin quite mad, but it made me quite happy." Discovery began as a much better funded program than he had any right to expect.<sup>43</sup>

#### 5. Conclusions

Discovery's origins were certainly complex. A growing sense of frustration in the planetary community, and a growing disillusionment with NASA management in the Bush Administration, set the context for its emergence. But as the above narrative demonstrates, while Geoffrey Briggs deserves credit for initiating the program, two individuals were primarily responsible for making it happen: Stamatios "Tom" Krimigis and Wesley Huntress. Krimigis, who bridged the divide between the space physics and planetary science communities, saw the need in 1989 for a new reform program for small spacecraft and successfully argued for a new attempt based on Explorer. Huntress took up the cause, which was faltering due to a slow-moving committee and lack of urgency, when he took over solar system exploration in summer 1990. He proceeded to

<sup>41</sup> SMK OHI by MJN, 22 June 2012; SMK OHI by Mame Warren, 10 January 2008, courtesy APL; Veverka to Mikulski, 24 May 1993, and other letters and lobbying material, summer 1993, SMPK/APL, box Krimigis, file FY 94 Budget Correspondence.

<sup>42</sup> SMK to Kelly, 8 July 1993, in SMPK/APL, box 1993–1995 SMK Chron/Calendars, folder Chronological File (1993); SMK faxes to Kelly, 12 and 13 July, and E. J. Hoffman memos to SMK regarding conversations with S. Isakowitz/OMB, 13 and 23 July 1993, in SMPK/APL, box Krimigis, file FY 94 Budget Correspondence; SMK OHI by MJN, 22 June 2012.

<sup>43</sup> Veverka to Mikulski, 12 July 1993, with attached APL NEAR fact sheet, in SMPK/APL, box Krimigis, file FY 94 Budget Correspondence; McCurdy, *Low-Cost Innovation*, 15; Liz Tucci, "Senate Funds '96 Eros Asteroid Encounter," *Space News* 4, no. 37 (20–26 Sep. 1993), 8; WTH OHI by Susan Niebur, 13 Mar. 2009, NASA HD HRC 20229 (quote). As of August 1993, SSED was still arguing for Pathfinder's primacy based on the assumption that only one could be funded: "Discovery Program Implementation Plan," 7 Aug. 1993, NASA HD, HRC 20237, file Discovery Correspondence, 1984–2001.

push Discovery with the support of Lennard Fisk and others outside and inside the agency who saw the need for a low-cost program at a time of project overruns, slowing budget growth, and increasing pressure on NASA to become cost-effective.

Due to internal and external imperatives regarding JPL reform and the Mars program, however, Huntress changed the plan for the first Discovery mission from APL's NEAR to the Pathfinder mission in early 1992. Surprised and angered by their demotion to second, the APL team, thanks to the work of Bob Farquhar, discovered a new and better asteroid rendezvous opportunity for a launch before Pathfinder. Largely to Krimigis' political skill and connections, APL was successful in getting NEAR in the FY 1994 budget, along with Pathfinder. While it is certainly possible that NEAR would have been funded in a later year for a less-interesting asteroid encounter, this outcome established Discovery on a larger base and excluded the possibility that it would become just another one-mission line, like the Planetary Observers in the 1980s. In the process of creating NEAR, Krimigis also successfully redirected his Space Department to becoming a mainstay of NASA's planetary exploration efforts.

Discovery went on to be very influential in NASA space science programs, not only producing a number of successful missions like NEAR, Mars Pathfinder, Stardust, Deep Impact and MESSENGER (another APL spacecraft), but also encouraging the imitation of the Principal-Investigator-centered, cost-contained model in other

programs, including New Frontiers, a planetary program for medium-sized missions too big to fit under the Discovery cost cap. Even the Explorer program, Krimigis's model for Discovery, was modified to make it more like the Discovery competition process.<sup>44</sup> As such, it has been a revolutionary program for NASA planetary exploration and for space science generally, one of few reform projects in NASA space science history, at least, to have not only worked, but survived over the long haul.

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<sup>44</sup> WTH, "The Discovery Program," speech text for AIAA Low-Cost Planetary Mission Conference, 28 Apr. 1998, Microsoft Word document courtesy WTH.