

IBM Center for  
The Business of Government

2016

Improving Performance Series

# Leadership, Change, and Public-Private Partnerships

## A Case Study of NASA and the Transition from Space Shuttle to Commercial Space Flight



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Public-Private Partnerships:  
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## Foreword

On behalf of the IBM Center for The Business of Government, we are pleased to present *Leadership, Change, and Public-Private Partnerships: A Case Study of NASA and the Transition from Space Shuttle to Commercial Space Flight* by W. Henry Lambright, Professor of Public Administration, International Affairs, and Political Science at the Maxwell School of Citizenship and Public Affairs at Syracuse University.

This report continues the IBM Center's long interest in leadership, transformation, and the use of innovative public-private partnerships. It explores how NASA leaders have leveraged public-private partnerships to replace the space shuttle, while developing new policy mechanisms to enable private companies to take over cargo and astronaut transport to the International Space Station (ISS). The author focuses on the evolution of this partnership strategy, from its formulation and adoption during the George W. Bush Administration to its augmentation and fulfillment under the Obama Administration.

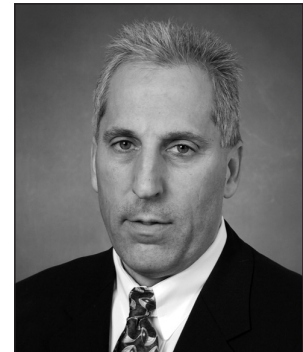
In the past decade, NASA has seen the shuttle retirement, completion of the ISS, the start of a commercial cargo and crew service to the ISS, the end of one major rocket development program, and the decision to develop a different, giant rocket capable of taking astronauts and cargo to deep space—the Moon, an asteroid, and eventually Mars. Indeed, viewed historically, NASA and its political masters have initiated and sustained a transformative decision-making process for human spaceflight exploration, with Mars as a destination.

A prime reason that NASA has sought innovative public-private partnerships in the evolution of the shuttle program involves current fiscal realities. Ultimately, NASA wants to concentrate its limited resources on deep-space exploration and cede lower-Earth orbit to a burgeoning commercial space sector. Achieving these two goals requires transformational change. The shuttle successor partnership with the private sector can initiate such change. This is indeed a case about transformative change—a radically new way of performing an existing government task.

The report documents and analyzes how leaders from both executive and legislative branches worked together to achieve



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transformational change in spaceflight. From this effort to launch a transformative mission for NASA, the report draws key lessons learned on such diverse yet interconnected disciplines as leadership, change management, and public-private partnerships. Key lessons include:

- Engage and align key actors early
- Understand the nature and degree of change
- Establish a complementary leadership team
- Recognize that transformation takes time
- Adopt a general strategy of what needs to be done

*Leadership, Change, and Public-Private Partnerships: A Case Study of NASA and the Transition from Space Shuttle to Commercial Space Flight* is the seventh report prepared by Professor Lambright for the IBM Center. In 2012, Professor Lambright identified two outstanding government leaders, Robert Gates and Dr. Francis Collins, who both led transformation initiatives in their organizations. Lambright's research for the IBM Center also includes leadership case studies of three recent administrators of the National Aeronautics and Space Administration: Dan Goldin (2001), Sean O'Keefe (2005), and Michael Griffin (2009).

We hope this new report will provide insights to present and future government leaders seeking to transform their organization through the pursuit of public-private partnerships and other new initiatives to address changing missions.



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# Executive Summary

This report explores how NASA leaders have used innovative public-private partnerships to develop a replacement for the space shuttle while developing new policy mechanisms to enable private companies to take over cargo and astronaut transport to the International Space Station (ISS). This report focuses on the evolution of this partnership strategy, from its formulation and adoption during the George W. Bush Administration to its augmentation and fulfillment under the Obama Administration. The report documents and analyzes how leaders from both executive and legislative branches working together, as well as sometimes at cross purposes, sought to achieve transformational change in spaceflight. It is from this effort to launch a transformative mission for NASA that this report draws key findings and lessons learned on such diverse yet interconnected disciplines as leadership, change management, and public-private partnerships.

The Columbia Accident Investigation Board (CAIB) called the absence of a shuttle successor “a failure of national leadership.” After the Columbia shuttle disaster of 2003, there was almost universal recognition that the space shuttle had to be replaced. Start and stop projects to develop a shuttle successor before 2003 had left the nation without an alternative. In 2004, President George W. Bush directed NASA to build a shuttle successor as part of an overall “vision” to explore deep space. Then-NASA Administrator Sean O’Keefe raised the possibility of launching cargo and eventually crew to the ISS through private commercial means on the NASA agenda. An office was established to search for “non-traditional” ways to accomplish NASA missions, especially the shuttle’s role. In 2005, Michael Griffin, O’Keefe’s successor, established a program—Commercial Orbital Transportation Services (COTS)—to do just that. Ideally, the shuttle successor role (cargo and crew) would be “privatized” and a new U.S. industry of commercial spaceflight launched, marking the true beginning of commercial space as an industry that would serve multiple customers, from the ISS to fostering space tourism.

In 2010, President Obama accelerated this commercial space program and proposed a multi-billion dollar commercial crew policy. By 2013, commercial cargo supply had been successfully demonstrated by SpaceX and Orbital Sciences. These companies subsequently have serviced the ISS operationally. While, for many reasons, controversy has continued over commercial crew, development work has been going ahead. Despite congressional and budgetary pressures, NASA chose two companies as its suppliers of transport services: Boeing and SpaceX. Boeing received \$4.2 billion and SpaceX \$2.6 billion, with both companies having to meet the same requirements.

Bolstering the pursuit of a commercial crew program involves reducing U.S. dependence on Russia to send astronauts to the ISS. The U.S. pays Russia \$81.7 million per seat under its most recent agreement for its astronaut transport. Along with gaining independence from Russia, the fiscal realities of the day represent another prime reason to seek innovative public-private partnerships. Ultimately, NASA wants to concentrate its limited resources on deep-space exploration and cede lower-Earth orbit to a burgeoning commercial space sector. Achieving these two goals requires transformational change. The shuttle successor partnership with the

private sector can initiate such change. This is indeed a case about transformative change—a radically new way of performing an existing government task.

How did this commercial space strategy for shuttle succession get on NASA's agenda? Why was it adopted by the Bush White House and continued under the Obama Administration? Why and how did the Obama Administration modify the approach it inherited? What lessons does this experience have for government leadership in policy innovation, generally?

## Understanding the Policy Process

To answer these questions, it is helpful to view policy innovation as occurring in stages:

- **Stage One: Agenda-setting.** An issue (a problem or opportunity) emerges for governmental decision, often triggered by an event or influential person.
- **Stage Two: Formulation.** Options for responses to an issue are forged.
- **Stage Three: Adoption.** Decision makers choose a particular response and turn it into a formal policy.
- **Stage Four: Early implementation.** Decision makers organize a program and provide it resources to carry out the policy.
- **Stage Five: Evaluation/reorientation.** Decision makers determine either to maintain or alter an ongoing program based on initial results or a shift in political environment.
- **Stage Six: Later implementation to institutionalization.** An organization carries the program forward to its conclusion, and an innovation is incorporated into the operational routines of an organization and ceases to be perceived as new.

While abstract, and more linear and rational than real-world decision making, this process model provides a helpful roadmap. Programs involving technical and policy innovation do go through stages over time. The stages may overlap and repeat themselves. Often, a process is terminated short of completion. That was the fate of attempts to create a shuttle successor prior to the case reviewed in this report. As indicated, there have been two overlapping policy processes:

- **Transporting cargo.** It was initiated under Bush and institutionalized under Obama.
- **Transporting crew.** Put on the agenda in the Bush years, it became a program reality under Obama. Being implemented at the time of writing, it likely will reach institutionalization under Obama's successor. The political dynamics of cargo have shaped the crew experience, and vice versa.

The process is not autonomous. Who moves decisions forward? There are specific individuals who do so. They provide leadership and form "advocacy coalitions" of like-minded people and organizations.

The focus here is on administrative advocacy in NASA. If major changes in technologies and institutional arrangements are to move forward from concept to operation, the NASA administrator ideally plays a leadership role. If he or she does not do so, someone else in authority must take his or her place. Leaders build internal and external support for change, often in the face of opposition or indifference. Where transformational change is involved, the process takes a long time. Hence, a sequence or relay of NASA advocates must be involved in the context of successive elections. It is no wonder that major change is rare. As leaders change, contexts alter, and so also must strategies. Indeed, styles of advocacy may vary as a novel program goes from concept to reality.



## Lessons Learned

Based on the case study of how NASA achieved transformational change in spaceflight, the report draws the following lessons on such diverse, yet interconnected, disciplines as leadership, change management, and public-private partnerships:

- **Lesson One:** Engage and align key actors early
- **Lesson Two:** Understand the nature and degree of change
- **Lesson Three:** Establish a complementary leadership team
- **Lesson Four:** Recognize that transformation takes time
- **Lesson Five:** Adopt a general strategy of what needs to be done
- **Lesson Six:** Build support for a new mission and neutralize opposition
- **Lesson Seven:** Foster competition and pursue innovative ways to make transformation happen
- **Lesson Eight:** Recognize the importance of stability
- **Lesson Nine:** Leadership must evolve to meet the demands of a transformational change

### Acronyms Used in This Report

ASAP	Aerospace Safety Advisory Panel
ASD	Alliance for Space Development
ATK	Alliant Techsystems
C3PO	Commercial Crew and Cargo Program Office
CCDev	Commercial Crew Development
CCiCap	Commercial Crew Integrated Capability
CCTCap	Commercial Crew Transportation Capability
COTS	Commercial Orbital Transportation Services
CRS	Commercial Resupply Services
CSF	Commercial Space Federation
FAR	Federal Acquisition Regulation
GAO	Government Accountability Office
ICCS	ISS Commercial Crew Services
ISS	International Space Station
JSC	Johnson Space Center
KSC	Kennedy Space Center
OSP	Orbital Space Plane
OSTP	White House Office of Science and Technology Policy
PPP	Public-private partnership
RpK	Rocketplane Kistler
SLI	Space Launch Initiative
SpaceX	Space Exploration Technologies Corporation
USA	United Space Alliance
VSE	Vision for Space Exploration

# Setting the Stage: 1992–2009

## Dan Goldin and the X-33/VentureStar

While efforts to get a shuttle successor took place earlier, the experience in the 1990s was most notable in terms of leadership and public-private partnerships. Dan Goldin, NASA administrator from 1992–2001, stands out for his many attempts at transformative change. He spent close to \$1 billion in an early shuttle successor effort that entailed a public-private partnership. It was called the X-33/VentureStar program. Planned in the early 1990s, it was adopted by the Clinton Administration in 1996. NASA's strategy was to work under a "cooperative agreement" with Lockheed Martin on a shuttle successor. NASA would develop the prototype (X-33) and Lockheed Martin the commercial version (VentureStar). Lockheed Martin spent hundreds of millions in its partner role.<sup>1</sup>

The program was abandoned at the end of the Clinton years. Goldin was both the advocate of the program and a decision maker in its adoption. He also became a decision maker for its termination. One reason for cancellation was technological overreach. NASA and its industrial partner sought a technological breakthrough in reusable rocketry that they could not achieve with the money and time they had. Another factor for cancellation was that Lockheed did not see an adequate market to continue investment when NASA dropped out of the partnership. Critics of the decision claimed that a failure of administrative and political will was to blame. Others say NASA erred in relying on one partner; competition in companies and technical approaches, they say, would have been better. Whatever the reason, the X-33/VentureStar failed in early implementation. Goldin then launched the Space Launch Initiative (SLI), a general technology advancement program. Instead of going directly to building a shuttle successor, NASA would move back to research and development.

## Sean O'Keefe on Setting a New Course

Sean O'Keefe was NASA administrator from 2001–2005. He found SLI too diffuse and replaced SLI with an Orbital Space Plane (OSP) development plan in 2002. It would be a smaller complement to the shuttle for taking astronauts to the ISS. He intended to upgrade the shuttle and keep it in service until at least 2020.<sup>2</sup> But a tragic event curtailed this strategy: the Columbia shuttle disaster of February 2003 that killed seven astronauts.

The formal, independent inquiry that followed, along with congressional hearings, made it clear that the shuttle was getting old, had serious flaws and should be replaced. High-level meetings among NASA, other agencies, and White House staff that followed Columbia throughout 2003 concentrated mainly on the choice of destinations and how to get there.

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1. W. Henry Lambright, *Transforming Government: Dan Goldin and the Remaking of NASA* (Wash., D.C.: IBM, 2001), 22, 23, 24, 26.  
2. W. Henry Lambright, *Executive Response to Changing Fortune: Sean O'Keefe as NASA Administrator* (Wash., D.C.: IBM, 2005), 16.

There was some attention to alternate ways of sending cargo and crew to low Earth orbit and the ISS, including private sector approaches.

President George W. Bush's Vision for Space Exploration (VSE), announced January 14, 2004, called for a new mission: exploration of the Moon, Mars, and beyond. Bush declared that the shuttle would be retired upon completion of the ISS in 2010. This shuttle retirement made it urgent to develop a new way to get to low Earth orbit, particularly the ISS. Bush appointed an independent advisory committee to consider *how* to implement VSE. With the ISS completed, the panel said, there would no longer be a need for the shuttle's construction role, a function that required transport and assembly of very large hardware. Much smaller and simpler spacecraft could carry cargo and crew to the ISS. The shuttle successor did not have to be a technically sophisticated space plane as envisioned in the X-33/VentureStar program. The panel, also known as the Aldridge Commission, called on NASA to "recognize and implement a far larger presence of private industry in space operations with the specific goal of allowing private industry to assume the primary role of providing services to NASA, and most immediately in accessing low Earth orbit."<sup>3</sup>

To implement Bush's VSE, NASA Administrator Sean O'Keefe created a new Exploration Systems Directorate. Conscious of NASA's limited budget, O'Keefe saw the need for a new division of labor between NASA and industry, with NASA concentrating on "exploration" and the private sector taking over "repetitive" efforts such as servicing the space station.<sup>4</sup> NASA planned a government system for exploration, called Constellation, and also sought out ideas about how better to enlist the commercial sector in replacing the shuttle's low Earth orbit (LEO) functions.

NASA's Ames Research Center in California was already linking with neighboring Silicon Valley firms in ways new to NASA. It was increasingly accepted that the shuttle successor did not have to be like the existing system, but it could have attributes involving known technology that the private sector could supply. The issue was how to transfer the cargo and crew tasks, formerly performed by the government, to the private sector.<sup>5</sup> A small, but vocal, group of entrepreneurial firms emerged and lobbied for a role under the VSE.

In early 2005, O'Keefe left NASA to become president of Louisiana State University, but he and his team put commercial space transportation on the NASA agenda. O'Keefe and his team left a legacy of new ideas about "non-traditional" public-private partnerships and even had established a nascent activity, the ISS Commercial Cargo Services (ICCS) program, to put some of these ideas into action. The process of policy innovation had barely begun, however. What happened next depended on NASA's new leader.

## Michael Griffin Launches the Commercial Orbital Transportation Services (COTS) Program

In April 2005, Michael Griffin became NASA administrator. This was Griffin's second stint at NASA; he served in the early 1990s under Goldin and was a strong proponent of deep-space

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3. President's Commission on Implementation of United States Space Exploration Policy, *A Journey to Inspire, Innovate, and Discover* (Wash., D.C.: USGPO, 2004), 7.

4. Comments to author by Sean O'Keefe, October 1, 2014.

5. The material in this section on COTS is based primarily on an unpublished report the author wrote for NASA entitled "Creating a New Space Transportation System: NASA, Industry, and COTS" (Wash., D.C.: NASA, 2014). An article based on this report appeared in the December 2015 issue of *Space Policy*. Further material on COTS used in this section is available in detailed history prepared by the Johnson Space Center. It is: Rebecca Hackler, *COTS: A New Era in Spaceflight* (Houston, Texas: NASA Johnson Space Center, 2013).

## 1996–2008 Timeline

### 1996

- Clinton Administration adopts NASA Administrator Goldin's X-33/VentureStar program

### 2001

- X-33/VentureStar program terminated

### 2003

- Columbia shuttle disaster

### 2004

- President Bush announces Vision for Space Exploration (VSE), a return to the Moon by 2020, with further exploration beyond
- Decision to end shuttle by 2010, upon completion of the International Space Station

### 2005

- NASA Administrator O'Keefe explores possibility of transferring repetitive low Earth orbit (LEO) activities to private sector
- NASA Administrator Griffin formulates and gets adopted Commercial Orbital Transportation Services (COTS) program

### 2006

- COTS implementation begins with cargo supply
- Space Exploration Technologies Corp. (SpaceX) and Rocketplane Kistler (RpK) selected as NASA partners

### 2007

- NASA terminates RpK partnership.

### 2008

- NASA chooses Orbital Sciences Corp. as its second partner (replacement for RpK)
- SpaceX and Orbital Sciences selected for Commercial Resupply Services (CRS) program
- Barack Obama elected president

exploration.<sup>6</sup> In addition, he had thought and written about commercial space prior to becoming administrator. NASA staff briefed him on the ideas and efforts that began in the O'Keefe regime. Various commercial space advocates also asserted their claims directly to him. Griffin made it clear to commercial space enthusiasts they had a supporter in him.<sup>7</sup>

Indeed, he wanted to go well beyond what he found on NASA's agenda. His vision was to build a new commercial space industry. His question was how to use NASA to build a space industry that was broader and more competitive, which could serve not only NASA, but also other customers and do so at less cost to the government. This meant bringing new companies into aerospace and transferring technical knowledge to them so they could take over shuttle tasks.

6. For a study of Michael Griffin's overall role as NASA administrator, see W. Henry Lambright, *Launching a New Mission: Michael Griffin and NASA's Return to the Moon*, (Wash., D.C.: IBM, 2009).

7. Interview with Michael Griffin, November 7, 2013.

In his first couple of weeks on the job, Griffin asked his general counsel how he could use NASA's procurement authority to stimulate commercial development.<sup>8</sup> The problem he faced was that the usual way government dealt with industry was via the Federal Acquisition Regulation (FAR). FAR was a voluminous set of rules and regulations that government procurement officers and contractors followed, ostensibly to protect both parties against charges of malfeasance and unfairness. Big contractors such as Lockheed Martin and Boeing had a substantial staff of lawyers and accountants to help them wade through FAR. Smaller companies—certainly the newer, entrepreneurial firms that had arisen in recent years and lobbied Griffin—found themselves at a disadvantage in dealing with NASA.<sup>9</sup>

Griffin received the go-ahead from NASA legal staff to use the original Space Act of 1958 to stimulate the growth of industry in the nation's interest, as long as that interest was not connected too closely to a specific NASA need. The Space Act provided flexibility for NASA to perform transactions other than through FAR. It would be necessary to avoid the usual situation in which government specified requirements and obligated contractors to meet them, closely directing their work through large staffs of overseers. Under the Space Act, companies would propose designs, milestones, and payment schedules. Where technologies to be developed were exceedingly advanced, NASA usually used cost-plus-fixed-fee contracts because it directed substantial changes as learning took place. But with technology relatively known, fixed price contracts could be used, with companies taking a greater risk.

The idea of catalyzing industrial development for the nation's benefit was relatively rare for NASA, but not new. Precedents could be found back to the 1960s and NASA's nurturing of a communications satellite industry. What was truly new was the strong, personal priority the NASA administrator gave it, and Griffin's decision to elevate the Space Act Agreement to a chosen policy mechanism. What was also new in Griffin's mind was the use of the ISS as a stable market once it was finished. The ISS was expected to be completed in 2010 and it would need a steady supply of cargo. If commercial firms could deliver cargo, they could also someday deliver crew.

Griffin talked to many others besides his lawyers about the Commercial Orbital Transportation Services (COTS) program, as his initiative was eventually called. He discussed the funding dimension with the White House Office of Management and Budget (OMB), for example. OMB was very positive toward the idea as a way to implement aspects of the president's Vision for Space Exploration (VSE). Its support for the concept of commercial cargo and crew went back years. Bolstered externally, Griffin made his decision to launch COTS using the public-private partnership (PPP) approach in his first month as administrator.

After getting informal approval from the White House and Congress, Griffin announced the new program on June 21, 2005, at a meeting of the Space Transportation Association. He made it clear that he was still developing a government rocket/spacecraft system that would succeed the shuttle. It was part of an overall government system called Constellation, initiated by his predecessor, but Griffin intended to modify it significantly.

Constellation's purpose was to assure the U.S. access to low Earth orbit and enable deep-space exploration to the Moon and beyond. The shuttle successor element of Constellation would come to be called Ares 1/Orion, with Ares 1 being the rocket and Orion the space capsule for astronauts. Griffin insisted that the U.S. government had to have assured access to space. He emphasized, however, he would prefer to rely on the private sector for LEO trans-

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8. Interview with Mike Wholley, NASA Chief Counsel. Interviewed by Rebecca Hackler, March 19, 2013.

9. James Q. Wilson, *Bureaucracy* (NY: Basic Books, 1989), 126–127.



port. The challenge was for commercial firms to show they could actually provide cargo and astronaut services. He initiated COTS as an experiment, a possible backup to Ares 1/Orion.<sup>10</sup>

In September 2005, he moved forward with both the government system and privately-oriented COTS. He announced Constellation would have four basic elements: in addition to Ares 1 and Orion, there would be a heavylift rocket, called Ares 5, and a moon lander, called Altair. Together they would be the hardware response to Bush's VSE. Griffin referred to the design as "Apollo on steroids."

At the same time, Griffin advanced COTS by placing the new program under the Exploration Directorate. He assigned technical management to the Johnson Space Center (JSC) in Houston. The ICCS activity initiated during O'Keefe's tenure was space station-focused. It was subsumed and broadened under COTS. The name of the management office at JSC was Commercial Crew and Cargo Program Office (C3PO).

As planning took place in the fall, COTS represented phase one of capability development. The second phase was Commercial Resupply Services (CRS). The objective of the first phase was commercial space for the nation. The work performed under COTS would be done under the Space Act Agreement, an industry driven public-private partnership. The second phase was under a traditional FAR contract, and it would be institutionalized within the ISS budget line. While NASA as an organization was indifferent, at best, to the COTS initiative, the advocacy coalition that formulated COTS was small but influential with Administrator Griffin leading the way. NASA veterans expected COTS to fail, as previous commercial space attempts had. Also, it was understood, and clearly stated by Griffin, that cargo had to be demonstrated before transport of crew would be attempted. It was crew that was central to NASA's interests.

## Making COTS a NASA Program

Formal adoption of COTS came with President Bush signing the NASA Authorization Act of 2005 into law. The legislation directed the NASA administrator to "work closely with the private sector, including by: encouraging the work of entrepreneurs who are seeking to develop new means to launch satellites, crew, or cargo; and contracting with the private sector for crew and cargo services, including to the International Space Station, to the extent practicable."<sup>11</sup>

The adoption came with virtually no debate, or even much attention. OMB was a long-standing advocate of commercializing space to move expenditures away from government. The White House Office of Science and Technology Policy (OSTP) had interests in pushing technology-based economic development. These offices were supportive and willing to help in protecting the COTS funding. The president and Congress were focused on Constellation, a high-profile program costing billions, and the small COTS program flew under the radar of most decision makers.

Implementation of COTS began in early 2006 with a program announcement, not the usual request for proposals.<sup>12</sup> The announcement was broad, flexible, and asked industry to propose how it would provide various technical capabilities. It did not mention the ISS specifically because associating too closely with NASA needs would violate the letter and spirit of the Space Act approach. But everyone knew that the ISS was a user. NASA was interested in

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10. Interview with Mike Griffin, November 7, 2013.

11. Information provided to author by Lynn Harper, June 3, 2014.

12. Hackler, 36, 40-41.

industry ideas for a particular capability—crew transport, called “COTS D”—but had no intention of funding this element. Cargo came first.

Many companies, mostly new aerospace entrants, applied. NASA selected Space Exploration Technologies Corporation (SpaceX), based in California, and Rocketplane Kistler (RpK), in Oklahoma, dividing the \$500 million Griffin allotted between the firms. Implementation proceeded, and NASA worked closely with the two COTS firms, transferring knowledge in ways forbidden under FAR contracts. In mid-2007, RpK ran into financial problems. Under its agreement, it had to raise money to match NASA's contributions, but it could not do so. NASA wanted two firms for competition; it did not want to be locked into one company as it had been with Lockheed Martin under X-33/VentureStar. After several extensions, NASA terminated RpK.<sup>13</sup> This was a crisis for COTS. NASA announced a Round Two competition under COTS. On February 19, 2008, it chose Orbital Sciences Corporation as a new second COTS company. Orbital was an established, billion-dollar firm with ample funds to more than match NASA's contribution. It did not propose a crew option, instead focusing on NASA's priority: cargo.

By this time (2008), COTS was gaining political visibility and Congress gave it another endorsement in legislation passed that year. Also, the Space Act mechanism was proving efficacious in ways critical to the program's progress. As NASA made decisions on which partners to support, and one (RpK) to terminate, those decisions were contested by losing firms. The prime decision-making body in these cases was the Government Accountability Office (GAO). In every instance, GAO sided with NASA, pointing out that NASA's actions were in accord with the flexible Space Act agreements. Under FAR, NASA likely would have faced more challenges and delays.

## Growing Interest in Commercial Space

The biggest problem NASA then faced was the gap between shuttle retirement (2010) and the advent of Ares 1/Orion, the government successor. When Griffin became administrator, the gap was stated as four years. He said he would try to close it to two. But that required more money than the Bush Administration or Congress provided. Instead of tightening to 2012, the gap was instead lengthened to 2015. COTS—what Griffin had called “a \$500 million bet”—was gaining more visibility as the government system lagged. Griffin was steadfast on behalf of COTS, and OMB-OSTP joined Griffin in defense of COTS, even at the expense of some space and Earth science programs. Replacing the shuttle was a presidential, not just a NASA, priority.

To hedge its COTS bet, NASA arranged with Russia to supply cargo through 2011. The COTS partners complained that the more NASA relied on the Russians, the less confidence private investors would have in its ability to make a profit. Also, Congress and the White House were restive about over-reliance on the Russians. NASA responded to both criticisms by deciding to end its dependence on Russia for cargo after 2011. The potential dependence on Russia for crew would continue, however, as COTS was not developing a crew option.

The cutting of ties with Russia and delays in Ares 1/Orion made it more imperative for the ISS cargo that COTS succeed. On April 14, 2008, NASA issued an RFP for cargo transportation services under CRS. CRS entailed much more money than COTS, over \$3 billion. Hence, the user pull provided a much enhanced incentive for COTS firms to speed up, more aggressively seek, and maintain venture capital money, in addition to succeeding technically. This was a major decision and it sent a message to all observers that NASA as an organization was serious

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13. Brian Berger, “RpK Competitors Urge NASA to Pull Firm's COTS Funding,” *SpaceNews* (August 6, 2007), 18; Hackler, 57.

about this program. Industry, Russia, the White House, Congress, venture capitalists, and media took note of the money.

Under FAR rules, the competition was open to all comers, but SpaceX and Orbital obviously had the inside track and won. The decision was announced December 23, 2008. Orbital received \$1.9 billion for eight servicing flights. SpaceX would get \$1.6 billion for 12 flights. The period of service ran from January 2009 to December 2016. While neither SpaceX nor Orbital had demonstrated delivery capability, support for NASA's COTS and CRS actions existed not only because of growing interest in commercial space, but also due to a heated controversy that had erupted over the government system, particularly the Ares 1 rocket and its alleged defects.

A presidential election took place in November 2008, and Barack Obama was to succeed Bush. It was assumed that most likely, Obama would want a new NASA administrator who was his own appointee. What that would mean for COTS, commercial space, and shuttle succession remained to be seen, but serious policy change was in the air and Obama's transition team was at work.

### **“It’s Going to Happen Anyway”**

In December 2008, debate intensified about Ares 1 and its progress. Griffin, his allies at NASA, and industry spoke up in its defense. Lockheed Martin and Boeing lobbied for their rockets as possible replacements for Ares 1, which was being built by rival Alliant Techsystems. Brett Alexander, president of the Commercial Space Federation (CSF) and formerly of the Office of Science and Technology Policy (OSTP) in the White House, led the charge on behalf of newer commercial space interests. He met with Griffin and urged him to embrace publicly the COTS D (crew transport) option and get commercial crew quickly underway. “It’s going to happen anyway,” he told Griffin, and “if you want it to be your legacy, you should fund it while you’re still here.”<sup>14</sup> Griffin refused. He stuck to his strategy: cargo first, then crew. Also, the possible viability of commercial crew had become a threat to Ares 1/Orion.

Obama's space transition team was led by Lori Garver, who had run NASA's policy office under Administrator Goldin in the late 1990s. She was close to Goldin and understood and shared his belief that low Earth orbit should be ceded to the private sector so NASA could focus on exploration. After NASA, she became a Washington consultant and worked on the Obama campaign as his chief space policy advisor. Garver wanted to expand space activity well beyond the existing contractor base, spoke of a NASA industrial complex, and was quite interested in COTS and its prospects for disrupting the status quo.

One of Garver's first actions was to “look under the hood” of the Constellation program, she later told *The Wall Street Journal*.<sup>15</sup> She didn't like what she found. The program was years behind schedule and over budget, she said, and she had doubts about its long-term prospects. On November 24, 2008, the Garver transition team sent Griffin a long list of questions. One was about how much money could be saved by canceling Ares 1 and scaling back Orion. She also asked about whether COTS could be speeded up to fund demonstrations of vehicles capable of transporting crews to the ISS.<sup>16</sup>

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14. Interview with Bretton Alexander. Interviewed by Rebecca Wright, March 18, 2014.

15. Andy Pasztor, “Feud over NASA Threatens America's Edge in Space,” *The Wall Street Journal* (April 14, 2010), <http://www.wsj.com/articles/SB10001424052702304159304575184362846131730>.

16. Brian Berger, “Obama Team Seeks Data on Possible Changes to Ares, Orion,” *SpaceNews* (Dec. 1, 2008), 5.

The implications of these questions were obvious and drew a quick retort from Senator Richard Shelby (R-AL), a staunch defender of the interests of NASA's Marshall Space Flight Center in his state. Marshall was in charge of building Ares 1 and Ares 5. As the ranking Republican on the Senate Appropriations Committee's Justice and Science Subcommittee, Shelby had power over NASA's annual budget. He issued this statement: "Without the Ares 1 and the heavylift capability of the Ares 5 rocket, humans will not be able to explore space any further than we can today."<sup>17</sup>

Griffin's stalwart defense of his rocket choices continued into January 2009, when he did in fact depart. Meanwhile, Garver and her team continued to investigate options for less expensive replacements, including commercial crew.

As Obama took office on January 20, 2009, the uncertainty surrounding NASA's future was intense. Gradually, he appointed various administration members, starting with his White House staff. A number of individuals from the transition team were appointed to the White House. From the standpoint of commercial crew policy, the most significant appointment was James Kohlenberger, an advocate, who became chief of staff of OSTP. For NASA, it was widely understood that Garver was slated to become deputy administrator. George Whitesides, who was on Obama's transition team and also a commercial space advocate, would become chief of staff to the NASA administrator. The key question to be determined was who would be the next administrator.

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17. Brian Berger, "Senator Shelby Steering the Course on Ares 1," *SpaceNews* (Dec. 8, 2008), 14.

# Decisions: 2009–2010

## Putting Commercial Crew on the Agenda

In February 2009, President Obama signed into law the American Recovery and Reinvestment Act, known as the Recovery Act, a \$787 billion measure. NASA received \$1 billion in Recovery Act funds. NASA favored putting the money toward Constellation while the White House wanted to accelerate commercial crew by exercising the COTS D option. The White House and NASA settled on \$150 million for commercial crew. The administration encountered pushback from Alabama Senator Richard Shelby, who wanted the money to augment the first phase of Constellation, namely Ares 1/Orion, rather than commence with commercial crew.

The money from the Recovery Act was separate from the regular budget request. NASA received a modest raise to its fiscal year budget, with cuts in the four subsequent years. While this projection was notional, it sent a strong signal of OMB's desire and influence in addressing Obama's directive to get control of the enlarging deficit, a deficit worsened by the Recovery Act. Because the ISS was virtually certain to be extended beyond the existing endpoint of 2016, and NASA had to pay for shuttle flights at least until 2010, cuts would have had to come from components of Constellation.

In putting commercial crew on the agenda, the Obama transition team placed serious scrutiny on the entire Constellation program. In May 2009, the administration announced that an independent, blue-ribbon panel would evaluate options in human spaceflight. It would be headed by retired space industrialist Norman Augustine. Among the charges of the Augustine Committee, as it was called, would be the possibility of "stimulating commercial spaceflight capabilities." Also, the guidance the Augustine Committee received included staying within OMB budget projections, which decreased in succeeding years. It was hard to see how Bush's Moon goal by 2020 could come remotely close to being afforded without a huge funding increase or gutting of non-human spaceflight programs on NASA's plate.

The committee produced a preliminary report in September 2009. Its opening sentence told the story: "The U.S. human spaceflight program appears to be on an unsustainable trajectory. It is perpetuating the perilous practices of pursuing goals that do not match allocated resources." The report further declared: "Commercial services to deliver crew to low Earth orbit are within reach. While this presents some risk, it could provide an earlier capability at lower initial and life-cycle costs than government could achieve. A new competition with adequate incentives should be open to all U.S. aerospace companies. That would allow NASA to focus on more challenging roles, including human exploration beyond low Earth orbit, based on the continued development of the current or modified Orion spacecraft."<sup>18</sup>

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18. Review of U.S. Human Spaceflight Plans Committee, *Summary Report* (Sept. 8, 2009), in NASA History Office Files.



## 2009–2010 Timeline

### 2009

- President Obama takes office
- Recovery Act provides \$50 million for NASA to start commercial crew program
- Augustine Committee named to investigate human space flight and provide future options
- Charles Bolden named NASA administrator and Lori Garver named deputy administrator
- Augustine Committee report favors commercial cargo and commercial crew

### 2010

- FY 2011 budget released calling for cancellation of Constellation and acceleration of commercial crew program
- NASA announces winners of \$50 million commercial crew competition under the 2009 stimulus money (called Commercial Crew Development (CCDev))
- Obama gives speech at Kennedy Space Center to mollify critics
- SpaceX Falcon 9 rocket scores successful launch test
- NASA Authorization Act of 2010 passes
- NASA calls for industry proposals for second round of CCDev (CCDev 2)
- SpaceX successfully launches a test of its Dragon space capsule

The committee's final report solidified what it had stated earlier and went even further.<sup>19</sup> Urging that the ISS officially be extended beyond 2016, it called for NASA to transfer low Earth orbit crew, as well as cargo services, to the private sector. NASA was to then concentrate its resources on deep-space exploration leading to Mars. It recommended an augmentation of the COTS cargo budget and estimated commercial crew would cost \$5 billion over a period of years to go from development to operations. The key question for exploration was not Mars—that was the target—but the interim steps to Mars: Moon versus a “flexible” approach that included various destinations that did not necessarily involve landing. It clearly favored the flexible path. Commercial space interests were utterly delighted with the recommendations the Augustine Committee made.

## NASA's New Leadership: Bolden and Garver

With commercial crew on the agenda, in May 2009, President Obama picked Charles Bolden to lead NASA; Lori Garver from Obama's transition team was, as expected, Bolden's deputy. Bolden was a naval academy graduate, a retired Marine general, and a Vietnam veteran. He served as assistant deputy administrator of NASA in 1992. He had commanded two shuttle missions and was a pilot on two others. One of the missions had Senator Bill Nelson (D-FL) aboard. A close relationship between Bolden and Nelson continued after the shuttle flight.

As chairman of the senate authorization subcommittee that would recommend confirmation of a NASA administrator, Nelson had strongly urged Obama to nominate Bolden. Obama had initially favored another person, but decided to go along with Nelson. Bolden described himself as a “participative” administrator, a decision maker who let others debate positions in his presence. He said he was a “people person” who could get conflicted actors to work together.

19. Review of U.S. Human Spaceflight Plans Committee, *Seeking a Human Spaceflight Program Worthy of a Great Nation*, (Oct. 2009), [http://www.nasa.gov/pdf/617036main\\_396093main\\_HSF\\_Cmte\\_FinalReport.pdf](http://www.nasa.gov/pdf/617036main_396093main_HSF_Cmte_FinalReport.pdf).

He felt comfortable in a “mediator” role. As a military man, he was loyal to his commander-in-chief, but he also cared about his troops and their morale.

Garver had a bachelor’s degree in political science and economics from Colorado College and a master’s degree in space policy from George Washington University. She had served as executive director of the National Space Society, an advocacy organization, and had been an aerospace consultant in Washington, D.C. From 1998 to 2001 she was associate administrator for policy at NASA. She was widely regarded as a Dan Goldin protégé. Like her mentor, she was a change agent in style, combative, and could be sharp-edged in dealing with subordinates.

Bolden and Garver were announced the same day, testified and were confirmed together, and took office at the same time. Both Bolden and Garver were space enthusiasts and well known in the space community. Bolden was more technical and managerial in background and skill, whereas Garver was more of a broad policy wonk and Washington political operator. As noted, Bolden was close to Nelson but did not have significant connections with the White House, including the president. Garver’s connections were to the White House rather than Congress. Specifically, she was close to various individuals around the president rather than to the president himself. Garver was clearly a White House appointment, not a Bolden selection. She came in with an agenda based on her work leading the Obama transition team and working informally with OSTP and OMB prior to taking office.

Bolden and Garver would have a professional, but sometimes tense, relationship. Their styles, as well as attitudes toward commercial space, were different: She was the enthusiast and he the skeptic, at least initially. While both grew and changed over time, working together in harness they remained “a team of rivals.”<sup>20</sup>

With an advocate from the Obama transition team like Garver in a position to influence White House policy for commercial crew, virtually everyone observing space policy in early 2009 suspected that commercial crew was potentially on its way as an Obama initiative—part of a larger change process for human spaceflight. Initially, the administration had encountered resistance, with Senator Shelby threatening to hold up the appointments over the \$150 million Recovery Act money for commercial crew. Shelby and the White House worked out a compromise, shifting \$100 million to Constellation (which already received most of the NASA Recovery Act money) and leaving \$50 million for commercial crew. While the money was miniscule in the total NASA budget, it was significant as a “new start.”<sup>21</sup>

Bolden told an audience of space entrepreneurs and U.S. lawmakers that he was skeptical of the private sector’s ability to assume manned operations in low Earth orbit but was hopeful commercial companies could succeed. Speaking of NASA, he said, “I would be telling you a lie if I told you we’re on board, we’re really excited about things.” He pointed out, “old habits die hard. Many of us who have grown up in the traditional space program, you know we really believe we have all the answers. It has to be our way or no way at all. I don’t believe that. I am becoming more and more convinced every day in this job that there are different ways that we can do this.”<sup>22</sup>

NASA’s managers noticed that the signals they got from Garver were different from those of Bolden. She pushed hard for commercial space rather than hewing to the existing approach. She wanted to transfer the COTS model to commercial crew, declaring that NASA should

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20. Doris Kearns Goodwin, *Team of Rivals: The Political Genius of Abraham Lincoln* (NY: Simon and Shuster, 2005).

21. Jeff Foust, “Shelby Wins Battle on Stimulus Funding,” *Space Politics* (blog) (July 3, 2009), <http://www.spacepolitics.com/2009/07/03/shelby-wins-battle-on-stimulus-funding/>.

22. Amy Klamper, “Bolden Says Commercial Crew a Tough Sell to NASA Old Guard,” *SpaceNews* (Sept. 28, 2009), 7.

outsource where industry was “actively wanting to take over” and willing to invest its own money. “And then NASA has to be willing to step aside and not provide the direct oversight we do when we’re a direct contractor,” she said.<sup>23</sup>

The debate within NASA was intense and mirrored exchanges external to the agency. Various interest groups, including former astronauts, weighed in and expressed opposing positions regarding commercial space. In October 2009, Bolden admitted NASA did not have a consensus view as yet—it was Constellation versus commercial crew. He struggled to accommodate the different views, but the agency clearly favored the path it had already been charting. OMB forced a shift in course by holding NASA budgets down. NASA had to make difficult decisions that would go to the core of the way it does business.

The debate between NASA and the White House intensified in November 2009 as programs and funding had to align in the upcoming budget. Commercial space advocates, particularly in the White House, wanted to push ahead with commercial crew in a big way, building on the commercial crew development (CCDev) \$50 million activity. They wanted transformative change quickly and Garver championed this view, seeing COTS D as a natural way forward. Bolden, in contrast, favored keeping all options on the agenda as long as possible. The White House grew exasperated with NASA as budget deadlines approached. The agency produced Constellation modifications in response to the White House’s requests for non-Constellation plans and options. Reflecting Obama’s priorities, many in the White House wanted to use NASA more for technology-based economic development than pure space missions.

By early December, Bolden saw the writing on the wall and called on the aerospace community to embrace necessary change, saying, “We have tough times ahead. Some of you aren’t going to like me.”<sup>24</sup> Exactly what those changes were, he didn’t say. Obama had yet to conclude decisions about NASA.

## FY11 Budget Jump-Starts Commercial Crew

As the FY 2011 budget was finalized in January 2010, Bolden’s frustrations continued. He was present at top-level budget meetings but was inexperienced in the negotiation process. He deferred to his deputy, especially where commercial crew was at issue. What he cared most about was Mars exploration, and that priority was not selling with the White House at the time, at least when it came to Constellation-type hardware. As Garver later commented, “someone” (presumably at the White House “messaging” political level) decided to incorporate Obama’s space policy changes in the FY 2011 budget rollout, rather than have the president more amply and visibly announce what he was doing in a separate policy statement or the State of the Union Address.

Obama had a range of options from which to choose, varying in how much change they required in NASA priorities. The most extreme change entailed termination of all components of Constellation: Ares 1, Ares 5, Orion, and Altair. Killing his predecessor’s Moon, Mars, and Beyond program would allow money to be diverted to provide a \$6 billion push to jump-start a commercial crew industry, substantially more money for “game-changing” technologies, robust climate change research, and would extend the ISS to 2020. That was the option he selected. He did increase NASA’s budget from \$18.7 billion to \$19 billion for FY 2011. Instead of the cut in out-years OMB had recommended, Obama chose to enlarge NASA’s

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23. Amy Klamper, “Garver: No Change for the Sake of Change,” *SpaceNews* (Sept. 21, 2009), 11.

24. Marcia Smith, “Bolden Calls for Changing Mindset about NASA,” *SpacePolicyOnline.com* (Dec. 9, 2009), <http://www.spacepolicyonline.com/news/bolden-calls-for-changing-the-mindset-about-nasa>.

spending by \$6 billion above OMB's mark over a five-year period. The president was indeed interested in space, but more concerned at the time with reducing the 10 percent unemployment rate and promoting economic development through technological advance. He viewed science and technology across government "through an economic lens."<sup>25</sup> The president became personally engaged as decision making moved forward. He saw little inspiration in Bush's return to the Moon.

Bolden found out about the final presidential budget decision on a Friday, three days before the formal rollout on Monday, February 1. He tried over that weekend to get a shift in budget language from words conveying "termination" to those emphasizing "transition," but to no avail.<sup>26</sup> As word leaked, Constellation supporters issued statements revealing alarm and anger. Senator Bill Nelson (D-FL) said that if reports of the White House plan were accurate, "then the president's green-eyeshade-wearing advisors are dead wrong." Other lawmakers from Florida, Texas, and Alabama, states with many space employees, issued statements. If there was any doubt about the rumors, Budget Director Peter Orszag delivered the message clearly on Sunday: "We are proposing canceling the program (Constellation) not delaying it."<sup>27</sup>

## Rolling Out and Buying In

On Monday, February 1, 2010, the White House arranged a media teleconference for the rollout. It restricted Bolden from speaking "off message." He read a scripted statement that put a positive spin on the decision and did not take any questions. The rationale for explaining the radical shift in policy was left to his deputy and the Office of Science and Technology Policy chief of staff James Kohlenberger.

Constellation, they said, was burdened by a sequence of bad decisions and sunk costs were no reason to keep spending on it. "The fact that we poured \$9 billion into an unexecutable program isn't an excuse to pour another \$50 billion into it and still not have an executable program," said Kohlenberger. "This isn't a step backwards," he added.<sup>28</sup> "Keep in mind," said Garver, "we found out during the Augustine review that we weren't going to the Moon in 2020. The Augustine report made it clear that we wouldn't have gotten beyond low Earth orbit until 2028 and even then would not have the funding to build the lander. So we had lost the Moon, and what the program does is give us back the solar system."<sup>29</sup>

The lack of communication between the White House and NASA meant that the Obama decision lacked detail as to budgetary and personnel impacts and next steps. The decision did not provide a destination, nor did it say when astronauts would fly beyond low Earth orbit, nor when NASA would start constructing the heavy lift rockets necessary to explore deep space—whether that was the Moon, Mars, or elsewhere. The media could not get much information from anyone.

Little effort had gone into building support for the radical change implied by the president's decision. Cancellation of Ares 1 had been anticipated, but the Augustine panel called for the need for a heavy lift rocket and spacecraft for deep-space exploration. Adoption of presidential

25. Jeffrey Mervis, "Science Spared from Domestic Spending Freeze—For Now," *Science* 327 (Feb. 5, 2010), <https://www.sciencemag.org/content/327/5966/628.short?related-urls=yes&legid=sci;327/5966/628>.

26. Interview with Charles Bolden, September 16, 2010.

27. Ethan Sacks, "Lost in space: President Obama's proposed budget scraps NASA's planned manned missions to the moon," *The Daily News* (Feb. 1, 2010), <http://www.nydailynews.com/news/politics/lost-space-president-obama-proposed-budget-scraps-nasa-planned-manned-missions-moon-article-1.196064>.

28. Amy Klamper and Brian Berger, "Obama's 'Game-Changing' NASA Plan Folds Constellation, Bets Commercial," *SpaceNews* (Feb. 8, 2010), 1, 4.

29. *Ibid.*

policy required more than the president's proposal; it required congressional assent. Getting assent would be hard and implementation required NASA acceptance. An organization can always resist and drag its feet. Moreover, who would sell the change? A White House staffer and deputy administrator could only do so much. The NASA administrator was supposed to be the chief salesman on the president's behalf. The rollout put Bolden on the sidelines and weakened his authority with those who had to be persuaded. Skeptical lawmakers asked who was in charge of NASA. Senior NASA managers quietly asked why they should go along with the new policy if Bolden himself was not (apparently) in favor of it. They drew their conclusions from the dominant role Garver played in the rollout.

The new administration had imposed too much change on a Congress and agency that had not been adequately prepared for what was to come. Cargo transport to the ISS had yet to be demonstrated. Critics asked: Where was the evidence that commercial crew would work? The critics—including NASA as an institution, contractors, lawmakers, astronauts, and NASA's independent Aerospace Safety Advisory Panel (ASAP)—pushed back. ASAP had advised Bolden in January against abandoning Ares 1, which had been “designed from the beginning with a clear emphasis on safety” in contrast to unproven commercial alternatives.<sup>30</sup> Commercial space policy interest groups and specific firms argued their cases, but their voices were overwhelmed. Also, thanks to Senator Shelby, NASA's latest appropriation bill, now law, carried language requiring congressional agreement to any major change in Constellation. In this contested atmosphere, amidst a cacophony of protest, the Commercial Crew Development Program struggled to get underway.

The selling of commercial space fell largely to Deputy Administrator Garver in the weeks following the rollout. On February 13, Garver spoke to a space transportation conference and enthusiastically declared that the administration planned to “decisively transform our relationship with the private sector. “Administrator Bolden and I fully support the president's decision. NASA is going to implement a public-private partnership that brings the best of both private industry and the U.S. government to the table,” she said.<sup>31</sup> She also took the lead in announcing that the administration would add \$300 million to COTS in the FY 2011 budget to give SpaceX and Orbital Science extra incentives to speed up their program. “As we realize how dependent we are on the success of the commercial cargo, it was felt that more resources would be helpful in both reducing the risk and hopefully accelerating the timeline,” she said.<sup>32</sup>

Garver served as the point person for commercial crew advocacy and as such she became a lightning rod for criticism of the policy. The coupling in the rollout of Constellation termination with commercial crew initiation created a political schism between the two programs. As the administration's most visible spokesperson for crew, she drew the ire of Constellation forces. Bolden defended her. He insisted that the president's policy was also his policy and he took up the cause. Moreover, as administrator it was he whom Congress wanted to testify, not his deputy, even though his critics accused him of letting others run NASA.<sup>33</sup> If Congress was generally hostile, pointing out that it had twice authorized Constellation (in 2005 under Democratic control and in 2008 under Republican control), the media was more quizzical. The decision was a surprise in its comprehensive scope, and the media covered the legislative pushback. It wanted details and NASA had few to give.

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30. Amy Klamper, “NASA's Safety Advisers Urge U.S. to Stick with Ares 1,” *SpaceNews* (Jan. 25, 2010), 6.

31. “Remarks by NASA Deputy Administrator Lori Garver at the 13th Annual FAA AST Space Transportation Conference,” *SpaceRef* (Feb. 13, 2010), <http://www.spaceref.com/news/viewsr.html?pid=33479>.

32. Amy Klamper, “NASA Raises Bet on Commercial Cargo,” *SpaceNews* (Feb. 22, 2010), 1.

33. Kenneth Chang, “Under Fire, Administrator Defends NASA's New Direction,” *The New York Times* (Feb. 25, 2010), <http://www.nytimes.com/2010/02/26/science/space/26nasa.html>.



NASA, left out of the decision process, had not developed a plan for execution. When NASA's leadership sought to develop a plan of action, their efforts were met with hefty resistance among NASA's senior managers.<sup>34</sup> They believed that Constellation was sound technically and all they needed was more money. The public-private partnership model was a work in progress for cargo, but would it work for crew? They were extremely wary of relinquishing their control of contractors, via the Space Act Agreement, where astronauts and their safety were involved. They detected different signals from Bolden and Garver and waited to see what would happen.

The media and Congress wanted details on the plan's where, how, when, and employment impacts, but NASA did not have that information at first. Thus, Bolden could not mount a particularly strong defense. *SpaceNews* made a point that others echoed: "Scrapping Orion and Ares 5... goes beyond Augustine's recommendations, leaving NASA with no discernible plan for what the panel characterized as meaningful exploration."<sup>35</sup> *Aviation Week and Space Technology* opined: "The first rule of wing-walking is: never let go of what you have until you have a firm grip on the next thing." It wrote of NASA's "scrambling" in the wake of the Obama decision and replacing its White House appointee in charge of public relations.<sup>36</sup>

What NASA needed was not a new public affairs director, but the president himself to get behind the decision to better explain what he wanted to do; his critics were many and powerful and his supporters few and relatively weak. It is noteworthy that the new commercial firms were not especially experienced at lobbying, but the traditional firms associated with Constellation were. Lockheed Martin, in charge of Orion, was especially aggressive. What most hurt the president with the public was an attack on his decision from various Apollo astronauts, particularly Neil Armstrong, the first man on the Moon.<sup>37</sup>

If the president did not get the message from his staff that he personally had to get involved in selling his policy, he surely got it from Senator Nelson, a fellow Democrat and head of the key space authorization subcommittee in the Senate. In March 2010, the White House announced Obama would be going to the Kennedy Space Center in Florida the following month to present his new vision of space policy. Once Obama decided to go to Florida, Bolden and others sought to influence what he would say.

Thanks to the rollout imbroglio, there was much more interaction taking place between the White House and NASA. Bolden realized his previous passivity had contributed to the problems he now faced and he sought to be more aggressive. Bolden's main argument inside and outside NASA was that Obama's new policy had no clear destination. Without a destination, the public could not understand it. It looked like Obama was giving up on human spaceflight, and that was how the opposition framed the decision.

Bolden wanted the president to make Mars the destination, but he was OK with "flexible" interim goals, such as an asteroid, which emerged from NASA as a non-Moon destination. But Bolden wanted an explicit statement about Mars as a goal. He was one among many who hoped to influence the president. Obama's style was to rely primarily on close White House

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34. Interview with Phil McAlister, May 26, 2015.

35. "Change Springs Eternal," *SpaceNews* (Feb. 8, 2010), 16.

36. "A Cloudy Vision," *Aviation Week and Space Technology* (Feb. 8, 2010), 50; "Choose Your Words," *Aviation Week and Space Technology* (March 8, 2010), 20.

37. John M. Logsdon, "Retiring the Space Shuttle: What Next?" Roger Launius, John Krige, and James I. Craig, eds. *Space Shuttle Legacy: How We Did It and What We Learned* (Reston, Va.: American Institute of Aeronautics and Astronautics, Inc., 2013), 330. On May 12, 2010, Armstrong went before a Senate hearing and told lawmakers of his doubts about relying on commercial space companies instead of the government, "Neil Armstrong Criticizes Obama Space Plan," *NPR* (May 12, 2010), <http://www.npr.org/templates/story/story.php?storyId=126775979>.

advisors for ideas and the actual words in his speech. Those advisors stood firm on commercial crew, as did Garver within NASA. Bolden's impact on the president was mainly indirect, but the president gave him what he wanted, namely a decision on Mars. The president also indicated that he would address Bolden's concerns and underscored that he would be kept in the communication loop. He also said, as Bolden recalled, "I don't mind cleaning up a mess, but do mind when it is a mess we helped create."<sup>38</sup>

Obama traveled to the Kennedy Space Center on April 15, 2010, to offer an olive branch to quell the protest and use presidential capital to persuade critics of his point of view. The White House had hurriedly assembled an audience of legislators, industry executives, NASA officials, and Kennedy Space Center employees. The bulk of the president's speech pertained to how he was modifying his February decision and where he was holding firm.

The president brought back two key elements of Constellation, but on his terms. Orion would be developed as a crew rescue vehicle (not the larger crew exploration vehicle of Constellation). The heavy lift rocket (Ares 5) was part of his revised space policy. But he insisted that there be a research and development program to produce an advanced design (not Griffin's "Apollo on steroids" model). That meant a decision to actually build it would be postponed until the end of his term. Where he stuck to his earlier decision steadfastly was the replacement of Ares 1 with commercial crew.<sup>39</sup>

The speech did not go far enough for most of Obama's critics, but the partial retreat weakened the position of those in the White House and NASA advocating the original policy. There was a new political dynamic in play and the harshest critics were the Republican senators. Senator Shelby's reaction was that Obama's policy "abandons our nation's only chance to remain the leader in space and instead chooses to set up a welfare program for the commercial space industry." Senator Kay Bailey Hutchison (R-TX) stated: "The emphasis to the tune of \$6 billion into a very fledgling commercial capability I just think is not sound and it's certainly not going to be reliable." She did not see firms like SpaceX or Orbital as "ready" for astronaut flights. Indeed, Shelby called the \$300 million extra the president wanted to give for cargo a reward for being "behind schedule." These commercial providers could not "even carry the trash back from the space station, much less carry humans to and from space safely," he charged.<sup>40</sup> Even entrepreneurial firms found fault with Obama's April retrofit. They argued that a crew rescue vehicle would be competition for what they were developing.

There was almost no influential lawmaker to champion Obama's policy. The way that the policy had been put forward in February had ruffled the feathers of many in Congress—like Senator Barbara Mikulski—who otherwise might have supported the president. Senator Mikulski, chair of the appropriations subcommittee responsible for funding NASA, had signaled her misgivings in a letter she had sent Nelson in February. She made it clear that her committee would look to the authorizers (i.e. Nelson's committee) to make repairs in the president's policy. After the president's April talk, she declared her continued frustration: "We cannot reinvent NASA every four years."<sup>41</sup> Nelson indicated more work would be done on an authorizing bill that would constitute a compromise and that the president would have to move closer to Congress's position.

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38. Interview with James Kohlenberger, June 30, 2015; Interview with Charles Bolden, June 30, 2015.

39. Kenneth Chang, "Obama Vows Renewed Space Program," *The New York Times* (April 15, 2010), <http://www.nytimes.com/2010/04/16/science/space/16nasa.html>; Tobassum Zakaria, "Obama on the Moon: 'been there' (done that)," *Reuters* (April 15, 2010), <http://blogs.reuters.com/talesfromthetrail/2010/04/15/obama-on-the-moon-been-there-done-that/> [6/10/2015 4:19:30pm].

40. Amy Klamper, "Obama's NASA Overhaul Encounters Continued Congressional Resistance," *SpaceNews* (April 28, 2010), 1, 4.

41. Kenneth Chang, "Obama's NASA Blueprint Is Challenged in Congress," *The New York Times* (April 22, 2010), <http://www.nytimes.com/2010/04/23/science/23nasa.html>.

## The Compromise

Senator Nelson took the lead within Congress to find a compromise that Congress and Obama could adopt. Over the months that followed, Nelson worked with his legislative colleagues and the top political level of the White House to mold an agreement. Rob Nabors, a senior advisor to Obama and Chief of Staff Rahm Emanuel for legislative affairs, took the lead for the White House. The negotiations were not easy and took time.

At NASA, Bolden sought to satisfy two masters: Congress and Obama. He was in a difficult position. Congress insisted on his continuing to implement Constellation, even as Obama pressed him to get commercial crew under way. Funding for commercial crew was part of the ongoing negotiations Nelson and Nabors were leading. Bolden, given his relationship with Nelson, saw Congress as an important constituent. He opted to be a “mediator.”<sup>42</sup>

He extended his mediator role to his own agency and the astronaut community, seeking consensus. “Look to the future, not the past,” he would tell his agency and astronauts. He conveyed that message especially to a highly resistant Johnson Space Center. “For you to go to members of Congress, the media, and the American public with contradictory information about the road ahead and the need to move on beyond the Constellation program is not helpful and detracts from our ability to accelerate the needed development programs and innovation technologies that will enable us to reach our deep space goals,” Bolden said during an all-hands meeting at the Houston Center.<sup>43</sup> But discontent at JSC continued. In May, Bolden reassigned the head of Constellation at JSC, Jeff Hanley, who still actively promoted the Constellation program. Bolden understood Hanley’s desire to protect his people, but he had to enforce the president’s policy even as he awaited the Nelson-Nabors compromise.<sup>44</sup>

SpaceX greatly helped Bolden in June. On June 4, 2010, Falcon 9, SpaceX’s rocket, soared successfully into orbit and performed important maneuvers relevant to later space station tasks. Although two years behind schedule, Falcon 9 worked. SpaceX founder Elon Musk was delighted and relieved. He said there had to be subsequent, more demanding demonstrations, but this test was critical. It boosted morale of space commercialization supporters everywhere and probably dismayed their opponents.<sup>45</sup> It may have helped in the negotiations underway between Nelson and the president’s agent, Nabors.

The negotiations produced a policy compromise to replace the president’s February 2010 decision. Under the agreement, the president would get commercial crew and Ares 1 would be cancelled. Commercial crew would proceed under rigorous safety rules. The shuttle would have an extra flight and be retired in 2011, rather than in 2010. The extra year gave more time to COTS companies to get ready to deliver cargo, and it would help with shuttle employee transitions.

The president’s desire to do advanced technology research was accepted, but not his desire to wait until later in his term for a heavy lift rocket design and development decision. Instead, the president agreed to start work on a heavy lift rocket (an Ares 5 or its equivalent) immediately (i.e. FY 2011, not FY 2015 as Obama proposed). Also, in line with the congressional perspective,

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42. Michael J. Keegan, “Reaching New Heights and Revealing the Unknown: A Conversation with Charles F. Bolden, Jr., NASA Administrator,” *The Business of Government* (Winter 2015), 9, <http://www.businessofgovernment.org/article/conversation-charles-f-bolden-jr-nasa-administrator>.

43. “Bolden Urges Work Force to Back NASA’s New Direction,” *SpaceNews* (May 3, 2010), 8; Marcia Smith, “Bolden Urges JSC Workers to Look to the Future, Not the Past,” *SpacePolicyOnline.com* (April 29, 2010) <http://spacepolicyonline.businesscatalyst.com/news/bolden-urges-jsc-workers-to-look-to-the-future-not-the-past>.

44. “NASA Reassigns Head of Constellation Program,” *SpaceNews* (May 31, 2010), 8.

45. Amy Klamper, “Falcon 9 Reaches Orbit in Debut,” *SpaceNews* (June 7, 2010), 1, 14; “The Challenge Ahead for SpaceX,” *SpaceNews* (June 14, 2010), 18.

Orion would return as a larger crew exploration vehicle rather than Obama's crew rescue vehicle. The space station would be extended to 2020 and there would be other adjustments to accommodate the respective interests of the president and Congress. On August 9, 2010, the NASA Authorization Act passed the Senate.<sup>46</sup> It was then on to the House. Unfortunately, Congress adjourned for August, and NASA's extreme uncertainty continued.

In September, Congress returned to Washington with a palpable sense of urgency and worry that there was no telling what might happen to NASA in the next Congress. The biggest difference between what the House committee wanted and the Senate bill was over commercial crew. There was strong sentiment in the House for keeping Ares 1, but if that was not possible, there was no love for commercial crew (called corporate welfare by its critics). With Senator Nelson and others lobbying hard, the Democrat-controlled House went along with the Senate bill despite reservations about commercial crew, mainly about safety. As for money objections, the authorization act, after all, was not the final word; the appropriations process was ahead. The NASA Authorization Act of 2010 passed 304–118 and Obama signed the bill into law October 11, 2010.<sup>47</sup>

Constellation, as a program, was gone, specifically Ares 1. Orion was back with a slightly different name, Orion Multipurpose Crew Vehicle. Ares 5, or at least heavy lift, was back with the name Space Launch System, or SLS. Commercial crew was given the go-ahead. The money for commercial crew was cut back, but Nelson informally promised the White House he would try to make amends over a six-year period, rather than the president's five. The ISS was extended to 2020.

For Bolden and Garver, there was satisfaction and relief that this part of the decision-making process was over. Garver especially felt vindicated. "Obviously the president proposed a fairly dramatic shift in policy and investments," she declared. "Less than nine months later, a basic policy shift and a significant amount of the proposed restructuring had been adopted in bipartisan legislation and signed into law." But she warned an audience of commercial spaceflight supporters October 21 that "this is just the beginning." The appropriations process lay ahead—after the election.<sup>48</sup>

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46. Marcia Smith, "Senator Nelson Outlines Possible Compromise on Obama Plan," *SpacePolicyOnline.com* (June 15, 2010), <http://www.spacepolicyonline.com/news/senator-nelson-outlines-possible-compromise-on-obama-plan>; Kenneth Chang, "Senate Committee's NASA Plan Cuts Moon Program," *The New York Times* (July 16, 2010), <http://www.nytimes.com/2010/07/16/science/space/16nasa.html>.

47. Marcia Smith, "House Authorizers Write to House and Senate Appropriators," *SpacePolicyOnline.com* (Oct. 11, 2010), <http://www.spacepolicyonline.com/news/house-authorizers-write-to-house-and-senate-appropriators>; Amy Klumper, "Passage on NASA Authorization Bill Still Leaves Questions Unanswered," *SpaceNews* (Oct. 4, 2010), 1, 4.

48. Amy Klumper, "NASA Deputy Recounts Fight for Commercial Crew Backing," *SpaceNews* (Oct. 25, 2010), 15.

# Reassessing the 2010 Compromise: 2011–2012

## Soliciting Companies for CCDev 2 Proposals

Whatever NASA senior career managers thought of commercial crew, and most did not like it, they felt the pressure of servicing the ISS without the shuttle. Without Ares 1 they would have to rely on a commercial space flight, or on the Russians, with the Space Launch System (SLS) the distant backup. On October 25, NASA solicited CCDev 2 proposals from industry. The authorization act set \$312 million for the next fiscal year. Because NASA did not have an appropriation, it could not actually fund any proposals. It also could not be sure how much money it would actually have, so it worked with a lesser figure, \$200 million.

NASA wanted research on astronaut-relevant subjects such as life-support systems, launch abort systems, and emergency detection systems. It hoped to announce awards in March, when the continuing resolution under which it was operating would presumably be replaced with an actual appropriation. Nothing was certain, but Garver announced NASA would try to fund four companies. Less money meant fewer, but Garver insisted NASA would “keep competition in the system.”<sup>49</sup>

In November 2010, as expected, Republicans took the House and promised they would give priority to budget cutting. NASA prepared for sub-optimal funds for CCDev 2. Meanwhile, it worked internally on how to merge the COTS Space Act approach with the need for astronaut safety. There was considerable debate within NASA about safety. The tensions became public when Wayne Hale, formerly NASA's shuttle manager and now a consultant, complained that he saw a “trainwreck” coming between NASA and industry over CCDev 2. The requirements NASA laid on industry were too many, said Hale. “Somewhere along the line,” he said, “we have crossed over the optimum point to ensure safety and just added cost and delay.”

Phil McAlister, Acting Director of CCDev, countered publicly, saying NASA was giving industry “the flexibility to meet the requirements in innovative ways.”<sup>50</sup> There was no question that there were officials within NASA who leaned in opposite directions on how much flexibility to give industry, with most NASA veterans emphasizing control. McAlister was trying to satisfy various interests, but he himself leaned in the direction of trusting industry. Bolden, a former astronaut and extremely safety conscious, seemed gradually to be coming around himself to favoring more of a COTS approach than a traditional one. He told his agency to reserve judgment on industry. “Let’s be fair. These [commercial space workers] are people who used to be NASA employees and NASA contractors. It’s not in their DNA to do things on the fly,” he said.<sup>51</sup>

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49. Amy Klamper, “NASA Solicits Bids for Multiple 2011 CCDev 2 Awards,” *SpaceNews* (Nov. 1, 2010), 10.

50. Debra Werner, “Former Shuttle Manager Decries NASA Human-rating Recruitments,” *SpaceNews* (Nov. 22, 2010), 20.

51. “Commercial Experience,” *Aviation Week and Space Technology* (Dec. 6, 2010), 41.

## 2011–2012 Timeline

### 2011

- Bolden reorganizes NASA headquarters, merges exploration and operations directorates
- NASA gets an appropriation to carry out 2010 Authorization Compromise
- NASA announces four CCDev 2 awards

### 2012

- NASA announces round three of CCDev will be under Space Act Agreement, calling for industry proposals
- SpaceX launches a Dragon cargo craft to the ISS and it returns safely to Earth
- NASA decides on two full awards, to Boeing and SpaceX, and a half award to Sierra Nevada
- SpaceX begins regular cargo operations to the ISS

## Commercial Crew Progress Amidst Turmoil

What Bolden needed to further bolster his own and others' confidence in commercial crew was a striking and unequivocal commercial space success. He got it December 8, 2010, when Space X's Dragon capsule was launched. After a set of maneuvers to simulate a rendezvous with the ISS, it splashed down in the Pacific. Media reports were glowing and the arrival of commercial space was proclaimed. Musk asked NASA to let him combine his two remaining demonstration tests under COTS into one that would actually go to the ISS. He wanted to transfer from COTS to CRS, the operational phase of cargo delivery, and then to CCDev 2 as soon as possible. He declared: "People sometimes assume that to take a cargo spacecraft and put a crew into it requires this enormous amount of magical pixie dust or something. This is not the case. If there had been people sitting within the Dragon capsule today, they would have had a very nice ride."<sup>52</sup>

In a January 17, 2011, interview, Bolden said NASA was adjusting to "leaner times" through the public-private partnership approach. "With access to low Earth orbit, I have handed that off to the commercial entities and I am devoted to that and committed to that, and my job is to do the best that I can to facilitate their success. Because we used them, they need us—it's a partnership that benefits the country."<sup>53</sup>

In February 2011, Obama issued his budget request for federal agencies, and it surely signaled "leaner times" for NASA. He asked for less the FY 2012 than he had for the still-not-funded current year (FY 2011, \$18.7 billion). Nelson took one look at the proposed budget and its spending for SLS/Orion vs. commercial crew, and he did not like what he saw. "The president's budget does not follow the bipartisan NASA law Congress passed late last year," he stated. "The Congress will assert its priorities in the next six months."<sup>54</sup>

Trying to start a new commercial crew program in this kind of bitter political environment was daunting, but Bolden kept pushing ahead, helped by his "apolitical" image. Accomplishment, however, was contingent on getting money and legitimation in the current year's appropriations bill, which was several months late. Hoping for progress on commercial crew, on February 14,

52. Brian Berger and Amy Svitak, "Musk Confident Dragon will Visit Station on Next Mission," *SpaceNews* (Dec. 13, 2010), 4; Irene Klotz, "Sheer Magic," *Aviation Week and Space Technology* (Dec. 13, 2010), 22–23.

53. Profile, Charles Bolden, "We Are a Can-Do Agency," *SpaceNews* (Jan. 17, 2011), 22.

54. Amy Svitak, "Proposed \$18.7 Billion NASA Budget Draws Early Fire from Capitol Hill," *SpaceNews* (Feb. 21, 2011) 1, 5.



2011, NASA contacted eight companies and asked them to go to the Johnson Space Center in Texas to discuss their proposals for CCDev 2. The companies were: Alliant Techsystems (ATK), Blue Origin, Boeing, Excalibur Almaz, Orbital Sciences, Sierra Nevada, SpaceX, and United Space Alliance (USA).

At the beginning of March 2011, Bolden decided on an organization to implement CCDev. Bolden merged exploration systems with space operations. Kennedy Space Center (KSC) would provide technical management for CCDev, with Johnson Space Center as its backup. This was a shift from COTS. Bolden decided that KSC needed a high profile and growing program to replace the shuttle. JSC had Orion, and Marshall had SLS. It did not hurt that KSC had Senator Nelson as a champion, and the president wanted to show interest in Florida, an electorally critical state.

There was thus progress in spite of the political turmoil. On April 14, 2011, Congress agreed on an omnibus appropriation that kept the government running that fiscal year. NASA received \$18.45 billion, slightly less than the \$19 billion Obama had requested. The appropriation generally followed the NASA Authorization Act of 2010. It ended Constellation officially, amply funded Orion and SLS, and provided \$269 million to commercial crew. It also augmented COTS funding by \$300 million. Soon after the appropriation passed, NASA announced four CCDev 2 awards:

- Blue Origin, \$22 million
- Sierra Nevada, \$80 million
- SpaceX, \$75 million
- Boeing, \$92.3 million

The inclusion of Boeing brought credibility to commercial crew in the eyes of many in NASA and Congress. It signaled that a traditional (i.e. “old space”) firm was entering the competition and taking commercial space seriously.

## Implementing Commercial Crew

With the passage of an appropriation, NASA finally started implementing CCDev in earnest. The goal of CCDev was to nurture a commercial industry that could fly crew to the ISS by approximately the midpoint of this decade. The second round of CCDev would be to mature technologies that could evolve into a full-scale system. Creating a full-scale system would be the third-round goal of CCDev 3, which would be made possible with the \$850 million appropriation requested for FY 2012. NASA leadership expected the partners to put in 10 to 20 percent of overall costs for CCDev 2.<sup>55</sup>

There was no question that the fate of commercial crew was tied to the success of COTS. However, critical lawmakers who were asked to authorize funds for CCDev 3 questioned why the government was augmenting money for COTS under the appropriation act. It still had not lived up to its cargo goals, they complained. NASA officials responded that they were optimistic that SpaceX and Orbital would do so and the demise of Constellation made it all the more important to make sure the commercial companies succeeded in cargo delivery and crew. The extra \$300 million appropriated for cargo was to reduce “the overall risks.”<sup>56</sup> Also, NASA (and

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55. Frank Moring, Jr., “The New Space Race,” *Aviation Week and Space Technology* (April 25–May 1, 2011), 24–27.

56. “House Lawmakers Seek Reassurance on NASA Commercial Cargo Plans,” *Aviation Week Aerospace Daily and Defense Report* (May 27, 2011), Vol. 238, Issue 41.

especially Bolden) felt a greater sense of urgency considering the last shuttle flight launched July 8, 2011. SpaceX and Orbital were both behind schedule.

In late July, NASA leadership met with industry to discuss the CCDev program and possible changes to its acquisition strategy. For the upcoming full-development CCDev 3 phase, NASA explored a shift from a Space Act Agreement to FAR. The Space Act Agreements might not be suitable for an integrated transportation system, which comprised a rocket and a crew-carrying vehicle that NASA would then need to certify as safe for ferrying astronauts to the ISS. As part of the certification process, NASA would have to clearly specify safety design requirements that its industry partners would have to meet. NASA could not do that under a Space Act Agreement. NASA could suggest options as reference points but not dictate specific designs. Commercial industry representatives complained and challenged NASA that this contractual change was absolutely necessary. The FAR system gave the traditional companies an advantage. The “new space” companies did not want to be burdened with heavy oversight and paperwork. They also did not want to hire additional legal and accounting personnel. As the entrepreneurial companies pointed out, Space Act Agreements leveled the playing field. NASA indicated it would do its best to have contractual flexibilities even under FAR.<sup>57</sup> There was continuing debate within NASA all the way up to Bolden about Space Act vs. FAR. NASA safety officials favored FAR, as did outside safety advisors.

In late July, Garver, a stalwart Space Act proponent, spoke at the annual conference of the Space Frontier Foundation. She explained that the NASA culture was “evolving.” NASA was trying to help companies “leverage that [NASA] money to bring in more private investment, more innovation, open new markets, reduce costs and provide economic gain.” She mentioned SpaceX as a model and voiced the need for more companies like it. But it was challenging for some groups in NASA to relinquish their former roles. Garver stated that the cargo program was working successfully because NASA had avoided excessive requirements, and that CCDev needed that approach also. But she said industry had to understand that CCDev and COTS were different. Astronaut safety was a very emotional issue at NASA. It was “the heart and soul of NASA.” That was what made it so hard for some in NASA to turn the job of building commercial crew vehicles over to industry without maintaining traditional managerial oversight that FAR provided, she emphasized.<sup>58</sup>

The NASA-industry relationship was indeed “evolving” and the conflicts over acquisition within NASA were mirrored in debates externally. In addition, there was White House-congressional debate over the other programs of human spaceflight—SLS and Orion. The commercial crew issue could not be separated from questions about these deep-space systems. The conflict had to do with money and which program used what budget.

## The Compromise Revisited

The NASA Authorization Act of October 2010 had called for NASA to get started right away on a heavy lift rocket, SLS. Congress had even specified technical details. In June, Bolden chose the design for this rocket. He then sent it to the White House for review. Approval of the design was, in effect, the decision to build hardware.

Members of Congress, especially Nelson and other senators who had helped craft the compromise, were restive when July and August came with no news from the White House. Restiveness

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57. Dan Leone, “NASA Shifts Procurement Plan for Upcoming Round of CCDev,” *SpaceNews* (July 25, 2011), 4, 16.

58. Debra Werner, “Garver: NASA Must Evolve the Way It Works with the Private Sector,” *SpaceNews* (July 29, 2011), <http://spacenews.com/garver-nasa%E2%80%82must-evolve-way-it-works-private-sector/>.

turned to frustration that the White House—particularly the Office of Management and Budget, which was looking at cost estimates independent of NASA—was deliberately dragging its feet. Congress threatened Bolden with a subpoena to get information on his design decision.

On September 7, 2011, congressional frustration turned to fury when an article in *The Wall Street Journal* appeared citing Space Launch System (SLS) cost estimates of \$62.5 billion for development, although Congress had pegged it at \$18 billion. Senator Nelson and his ranking Republican colleague, Kay Bailey Hutchison (R-TX), blasted the White House for a leak they called an attempt to undermine the October 2010 deal. They called the number “wildly inflated.” Hutchison was not only the senior Republican on Nelson’s committee, but she was also the ranking Republican on the NASA Appropriations Committee. They and their allies let the president know their anger in no ambiguous terms.<sup>59</sup>

The result was a meeting the next day which included OMB Director Jacob Lew, Assistant to the President for Science and Technology John Holdren, and Bolden. While the meeting was triggered by the explosion on Capitol Hill, it entailed an additional need to be absolutely clear on NASA’s top priorities in view of the larger debate between the White House and Congress on the overall federal budget. The three decision makers agreed that NASA’s priorities (which combined administration and congressional desires) were:

- ISS
- James Webb Space Telescope (JWST)
- SLS/Orion

Funding these programs was a “political imperative,” Holdren emphasized. Nelson, Hutchison, and Shelby wanted SLS/Orion while Mikulski insisted on JWST (which was experiencing a massive overrun), and the president required ISS. The president also wanted advanced technology and commercial crew. They agreed that these latter programs directly or indirectly underlay the top three. Commercial crew was essential to ISS, for example. They reached an agreement on priorities not that much different from the October 2010 legislative compromise, but it reinforced and clarified understanding among the key principals and paved the way for SLS. On September 14, Nelson, Hutchison, Bolden, and various other legislators and executive branch parties attended a press conference in which Nelson and Hutchison announced that the decision had been made to go ahead with SLS in line with Bolden’s earlier design choice. The rocket would be evolvable; when completed it would be capable of taking Orion-based astronauts to Mars.<sup>60</sup>

## Coping with Competing Priorities

The dilemma for NASA, as before, was too many priorities, and differences between the White House and Congress over priorities. On November 21, Congress passed the government and NASA’s budget, with the overall number coming in at \$17.8 billion, down from the previous year. Obama had requested \$850 million for commercial crew and Congress provided less than half, just \$406 million. Moreover, Congress showed continuing distrust of the White House by ordering that \$100 million of the sum be withheld until Bolden gave House and Senate appropriators a written notice that NASA was formally proceeding with SLS acquisition. Obama signed the legislation November 18, 2011.

59. Dan Leone, “Obama Administration Accused of Sabotaging Space Launch System,” *SpaceNews* (Sept. 12, 2011), 1, 17.

60. Interview with Charles Bolden, Dec. 6, 2011; Frank Morring, Jr. “Stepping Up,” *Aviation Week and Space Technology* (Sept. 19, 2011), 47–50; Kenneth Chang, “NASA Unveils New Rocket Design,” *The New York Times* (Sept. 14, 2011), <http://www.space.com/12941-nasa-unveils-giant-rocket-space-launch-system.html>.

This budget decision had a number of impacts on NASA's commercial cargo and crew program. For cargo, it raised the stakes for COTS success. NASA had granted Musk's request that the final two cargo demonstrations be combined, thereby hastening the day when SpaceX would be able to transition from COTS to operations. On December 9, 2011, Garver announced the SpaceX final demonstration would be in February 2012.

While NASA accelerated COTS, it slowed expectations for CCDev. Bolden stated NASA would push the start of commercial crew operations from 2016 to 2017, and the agency would rely on Russia that much longer. The budget shortfall had three significant impacts: stretching out the program, cutting back on competing firms, and staying longer with the Space Act.

In late December, NASA announced that it could save money and fund more contractors by staying with the Space Act a while longer. Each contractor had its own design approach and NASA wanted to see which was optimal. However, the chairman of the House Committee on Science, Space, and Technology (Republican Ralph Hall of Texas) pressed Bolden to use FAR and to reduce the number of contractors all the way down to one.<sup>61</sup>

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61. Dan Leone, "Budget Uncertainty Alters NASA's Commercial Procurement Strategy," *SpaceNews* (Dec. 19, 2011), 1, 16.

# Turning Point: 2012–2013

## Evaluation and Later Implementation—CCiCap: The Third Round

At the beginning of 2012, NASA announced the CCDev 3 would be called Commercial Crew Integrated Capability (CCiCap) and would be scaled down to the money the agency had—\$300 million to \$500 million for proposals. It would involve competing designs for a fully integrated system, and it would be under the Space Act acquisition rules. This Space Act decision was extremely controversial within NASA. Bolden listened to the arguments and decided to stay with the Space Act. He said he would take personal responsibility for the risks NASA saw in it.<sup>62</sup>

In evaluating the public-private partnership and announcing the decision to adhere to the Space Act, NASA said that the next step beyond CCiCap, a fourth and final stage of development, would definitely be under FAR and NASA would specify safety requirements necessary for certification. NASA was not sure how many companies it could afford to support but indicated it would want at least two in the final stage.

On February 7, 2012, NASA called for new commercial crew proposals under CCiCap. The proposals were to range from \$300 million to \$500 million and cover 21 months of work ending in May 2014. NASA desired a fully integrated commercial crew transport system. A few days later Obama released his budget proposal. Under enormous pressure to contain the deficit, he set \$17.7 billion for NASA, slightly below that year's spending plan. He requested \$830 million for commercial crew.

The commercial crew funding proposal drew immediate criticisms from SLS/Orion backers. "The administration remains insistent on cutting SLS and Orion to pay for commercial crew, rather than accommodating both," Hutchison said. Shelby complained that the money was going to "speculative 'commercial' providers" who would "overpromise and under deliver." He predicted Congress would "force the administration to invest in a real exploration program that adequately funds SLS."

When Bolden testified in Senate budget hearings in March, Hutchison criticized him soundly, saying she was "floored" by the cuts to Orion/SLS to pay for commercial crew. Bolden pointed out that NASA was trying to end U.S. dependence on Russia and have a "balanced" program. The cuts to commercial crew caused the delays in ending the Russian dependence, he charged. Nelson allied with Hutchison. While expressing sympathy for Bolden's plight and need for more money for commercial crew, he declared: "We certainly don't want to take it out of the big rocket or Orion."<sup>63</sup>

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62. Interview with Charles Bolden, June 30, 2015.

63. Frank Moring, Jr. "NASA Commercial Crew Effort Faces Uphill Fight in Congress," *Aviation Week Aerospace Daily and Defense Report* (March 8, 2012), Vol. 241, Issue 45; Dan Leone, "Bolden, Lawmakers Lock Horns Over Commercial Crew, Orion," *SpaceNews* (March 12, 2012), 6.

## 2013 Timeline

- Orbital successfully launches Antares rocket in COTS test
- NASA announces fourth and final round of CCDev, to begin in 2014
- Garver steps down as deputy administrator to direct Airline Pilots Association
- Congress continues to appropriate less for commercial crew than Obama requests
- Orbital launches cargo capsule to the ISS, completing required test and demonstration flights and signaling end of COTS cargo program

In April, the Senate appropriations subcommittee for NASA, influenced by Shelby, cut commercial crew by \$300 million and transferred most of the money to SLS. Later that month, the House appropriations subcommittee for NASA adopted language to force NASA to go down to two or even one company. It was obvious that the political tide was turning against the Obama Administration's policy for commercial crew. Michael Lopez-Alegria, head of the Commercial Space Federation, noted that because the cancellation of Constellation was coupled with the push for commercial crew, there had been a "line between 'old space' and 'new space.'" Old space seemed to have the political advantage; new space needed something significant to shift momentum.<sup>64</sup>

## A Turning Point: SpaceX Succeeds

On May 22, 2012, at 3:44 a.m. SpaceX's Falcon 9 blasted off from Cape Canaveral carrying an unmanned version of Dragon. There had been one postponement after another, but at this moment, all went well. "Falcon flew perfectly!!" SpaceX leader Musk wrote on Twitter. "Feels like a giant weight just came off my back."

"It's a great day for America. It's a great day for the world," Bolden told reporters afterward. "There were people who thought that [NASA] had gone away [with the 2011 retirement of the space shuttle]. But today says, no we've not gone away at all. We've got the SpaceX-NASA team, and they came through this morning with flying colors."

There was virtually universal acclaim. Even Ralph Hall, chair of the House Science Committee, a detractor, lauded what had taken place. He declared: "I have long supported the development of commercial cargo spacecraft, and while we still have a long way to go before American astronauts can fly aboard commercial spacecraft, I hope SpaceX can build upon this success." Griffin, who had initiated COTS, had to feel vindicated, although he had strongly opposed Obama's commercial crew policy. He stated: "This morning we witnessed a landmark accomplishment in spaceflight: the successful launch of the first privately developed cargo delivery vehicle."<sup>65</sup>

SpaceX delivered cargo safely and then returned to a splashdown in the Pacific. It was a complete success, ending the Commercial Orbital Transportation Services (COTS) program for SpaceX and allowing it to graduate to the operational phase of deliveries. The feat quickly

64. Frank Moring, Jr., "National Space Symposium Overlaps Big Changes in U.S. Program," *Aviation Week Aerospace Daily and Defense Report* (April 17, 2012), Vol. 242, Issue 13; Warren Ferster, "Garver: Funding Cut Would Only Delay Commercial Crew Effort," *SpaceNews* (April 23, 2012), 11; Irene Klotz "Michael Lopez-Alegria, President, Commercial Spaceflight Federation," *SpaceNews* (May 21, 2012), <http://spacenews.com/michael-lopez-alegria-president-commercial-spaceflight-federation/>.

65. "SpaceX Launches for Space Station—Like 'Winning the Super Bowl,'" *National Geographic News* (May 23, 2012), <http://news.nationalgeographic.com/news/2012/05/120522-spacex-launch-falcon-9-international-space-station-science/>.



strengthened the hand of commercial crew advocates. This was a true milestone. SpaceX had a measure of solid credibility for the first time. Bolden noted there were more believers in commercial spaceflight since the SpaceX launch. Observers in NASA felt the SpaceX success brought Bolden himself fully aboard the advocacy coalition. The space and general media evinced a new optimism. *SpaceNews* commented that thanks to SpaceX's success and Musk's audacity, greater federal investment in commercial crew was likely.<sup>66</sup>

## A NASA-Congress Bargain

On May 31, the same day SpaceX completed its demonstration to the ISS, Bolden and Congressman Frank Wolf, chair of the House subcommittee responsible for NASA appropriations, reached a deal on commercial crew. Wolf wanted to go to one contractor but NASA preferred to keep as many contractors as it could afford, with a budget adequate to the task. Now that SpaceX had proved its case by its performance, it would be hard to eliminate the firm. Wolf and Bolden worked out a compromise.

On June 4, Bolden wrote Wolf confirming their agreement. The next day, Wolf publicly announced the major points of concurrence. Wolf said he had backed away from his insistence that the agency proceed immediately with the selection of a single contractor. He agreed to proceed with CCIcap at a funding level at or near the Senate Appropriations Committee's approved amount, \$525 million. The amount would give NASA sufficient funds to support 2.5 partners under that Space Act, i.e., two full awards and one partial award.<sup>67</sup>

The CCIcap awards would fund a 21-month effort to take the competing concepts through critical design review and would be "the final phase of general development funding" for commercial crew contenders. Any follow-on money would be provided only for FAR certification and service contracts. In his letter Bolden emphasized servicing the ISS as the primary goal of CCDev.<sup>68</sup>

The compromise, presumably cleared with the White House, won praise both from supporters and detractors of commercial crew. There was a general sense that the SpaceX technical success and this political compromise marked the key turning point in CCDev. The administration would not get as much money for commercial crew as it wanted, but it would get more than it would have received minus this agreement, and the pressure to end competition would be eliminated, at least for a while.

A number of firms vied for CCIcap. They were: Boeing, SpaceX, Sierra Nevada, ATK Aerospace, Spacedesign Corp., Space Operations, and American Aerospace. On August 3, NASA announced the winners:

- Boeing would receive \$406 million
- SpaceX would receive \$440 million
- Sierra Nevada would receive \$212.5 million

NASA indicated that Sierra Nevada came in third for the partial award because of concerns about whether its proposed vehicle (more complex than the others because it had wings) could be achieved with the time and money NASA had available. NASA also remarked that

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66. "SpaceX Delivers," *SpaceNews* (June 4, 2012), 18.

67. Brian Berger and Dan Leone, "Congress, NASA Compromise on Commercial Crew Acquisition Plan," *SpaceNews* (June 11, 2012), 1, 12.

68. *Ibid.*

Boeing and SpaceX both rated highly on technical grounds, with SpaceX showing the greatest commitment in terms of the business investment, and Boeing being more conservative about its investment.

On August 8, 2012, NASA stated it would provide relatively small (\$10 million) contracts under FAR to the winning companies so it could direct them sooner and more explicitly toward certification standards. These contracts would run in parallel with the Space Act Agreements guiding CCIcap. Joseph Dyer, chairman of the independent Aerospace Safety Advisory Panel, criticized what NASA called a “hybrid” approach. He termed it a parallel development/certification approach that was a “workaround” and probably would not produce the desired safety, especially given budget pressure.<sup>69</sup>

On October 7, 2012, SpaceX launched Dragon on the first of its 12 operational flights to the ISS. This enabled SpaceX to receive \$1.6 billion in Commercial Resupply Services money. SpaceX was also doing well with other customers, both government and private. The major reason was that it charged less (\$59 million per launch) than other companies given its “vertical” structure. It performed most of its work in-house rather than through subcontractors. It gave every indication of becoming an exceptional success story for NASA’s industrial policy goal.<sup>70</sup>

In his letter confirming his compromise with Congressman Wolf, Bolden stated that “the primary objective of the commercial crew program is achieving the fastest, safest, and most effective means of domestic access to the [space station], not the creation of a commercial crew industry.”<sup>71</sup> While Bolden emphasized that the immediate purpose of the commercial crew program was to service the ISS, Garver made it clear that developing a private human spaceflight industry in the U.S. was an important motivation for the commercial crew program. “Yes, in fact that is one of our absolute goals,” she declared. Whatever their differences in emphasized objectives, Bolden and Garver both agreed that there was a new momentum to commercial crew as the November elections took place and 2012 drew to a close. Michael Lopez-Alegria, then head of the Commercial Spaceflight Federation, spoke of this change in atmosphere. He saw 2012 as an “inflection point” in history. As for Garver, she stated, “I can’t help thinking we’re in the midst of something big.”<sup>72</sup>

## Positive Momentum and Money

Space X’s achievement created positive momentum and underscored the potential of the commercial crew program, but its success did not end conflict. Certain lawmakers still favored funding SLS/Orion over commercial crew. NASA’s chief safety officials remained wary of commercial crew, as did the Aerospace Safety Advisory Panel (ASAP), which issued statements of caution about the lack of NASA oversight under the Space Act Agreements for commercial crew firms.<sup>73</sup> That said, the reality of SpaceX performance couldn’t be ignored. SpaceX had initiated operational cargo runs and there was the expectation that Orbital would follow suit. The biggest problem facing commercial crew wasn’t private sector capability, but rather its funding. The November 2012 election had put Republicans in charge of the Senate as well as

69. Dan Leone, “Commercial Crew Safety Certification to Run in Parallel with Spacecraft Development,” *SpaceNews* (Aug. 13, 2012), 6; Frank Moring, Jr., “In the Works,” *Aviation Week and Space Technology* (Oct. 1, 2012), 38–41.

70. Ashlee Vance, *Elon Musk: Tesla, SpaceX, and the Quest for a Fantastic Future*, (NY: Harper Collins, 2015); David Brooks, “Temerity at the Top,” *The New York Times* (Sept. 20, 2012), [http://www.nytimes.com/2012/09/21/opinion/brooks-temerity-at-the-top.html?\\_r=0](http://www.nytimes.com/2012/09/21/opinion/brooks-temerity-at-the-top.html?_r=0).

71. Dan Leone, “Garver: Fomenting Commercial Spaceflight Industry Is a Top NASA Priority,” *SpaceNews* (Oct. 22, 2012), 10.

72. Clara Moskowitz, “Private Spaceflight Industry at Big Turning Point, Advocates Say,” *SpaceNews* (Oct. 29, 2012), 14.

73. Marcia Smith, “NASA Safety Panel Worries about Commercial Crew Planning-Funding Disconnect,” *SpacePolicyOnline.com* (Jan. 10, 2013), <http://www.spacepolicyonline.com/news/nasa-safety-panel-worries-about-commercial-crew-planning-funding-disconnect>.

the House, and they preached budget deficit reduction. Across the board cuts were virtually guaranteed.

On March 21, 2012, Congress passed legislation that funded the government for the remainder of the fiscal year, a matter of only six months. NASA received \$16.6 billion for FY 2013. Commercial crew got \$489 million. While this was less than the \$830 million Obama requested, it was better than the \$406 million the previous year—and was at least a sign of movement in the right direction for advocates. Bolden argued that commercial crew would not become available in 2017 without a budget at the \$800 million level.

On April 15, Obama proposed his next year's budget, with \$17.7 billion for NASA and \$821 million of that for commercial crew. A few days later, April 21, Orbital successfully launched its Antares rocket. This was the test preceding the final test that would demonstrate actual cargo delivery to the ISS. *SpaceNews* celebrated the accomplishment. Together with SpaceX, Orbital was "making the case for outsourcing astronaut-related operations in low Earth orbit," the trade journal proclaimed.<sup>74</sup>

In May, Wayne Hale, former shuttle program manager, testified that it was difficult for his generation to change its "mental model," which favored the Apollo approach as the way to explore space. He said NASA and the commercial sector had to leverage one another's resources because NASA simply did not have the kind of money it had in the 1960s.<sup>75</sup> More and more, NASA seemed to be speaking of using a "hybrid" model, with Space Act Agreements for development and traditional contracting for operations—not only for commercial cargo and crew, but for other ventures.

In July, NASA announced that the fourth and final round of CCDev would begin in summer 2014. In that round, firms would create an overall space transportation service by 2017. The program would be called Commercial Crew Transportation Capability (CCtCap). It would require a test flight to the ISS in 2015 or 2016 as part of a certification process. NASA reiterated that traditional acquisition practices would apply, with the number of firms to be supported dependent on available funds.

At the end of July and beginning of August, congressional committees took action on NASA appropriations for the upcoming year. The House Appropriations Committee approved \$500 million for commercial crew, while the Senate approved \$775 million. Both were below Obama's \$821 million request, but the compromise was expected to be at the highest figure yet. There was real optimism among advocates, as the three firms involved in CCiCap were all making technical progress.

## Garver Steps Down and COTS Ends

In August 2013, Lori Garver, the Obama Administration champion for commercial space, announced she was stepping down as NASA deputy to become head of the Airline Pilots Association. Garver had become one of the most visible and influential NASA deputy administrators in history. Called a "lightning rod" for criticism because of her advocacy, she believed commercial crew was now assured of going forward and no longer needed her, which it had before. Bolden himself had taken on more of the advocacy role.

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74. "Antares Hits the Mark," *SpaceNews* (April 29, 2013), 14.

75. Marcia Smith, "Hale: Logistics Key to Deep Space Human Exploration and Commercial Space is the Answer," *SpacePolicyOnline.com* (May 20, 2013), <http://www.spacepolicyonline.com/news/hale-logistics-key-to-deep-space-human-exploration-and-commercial-space-is-the-answer>.

Scott Pace, head of George Washington University's Space Policy Institute and a former senior official of NASA under Griffin and Bush, called Garver the most "visible face" of Obama's space policy. For that reason, she got much of the blame for Constellation's cancellation, he noted.<sup>76</sup> At Garver's farewell, Bolden publicly stated that he was not a "believer" about commercial crew at first, but she had made a difference in his own attitude and that of others. She "persisted," he said, adding you've got to "give Lori credit."<sup>77</sup>

As for herself, Garver said: "I actually do feel that so much of what I set out to do is being accomplished."<sup>78</sup> As if to underline her point about progress, on September 18, 2013, Orbital launched its cargo capsule to the ISS. Subsequent delivery and egress all went well for this required demonstration flight. This meant Orbital would follow SpaceX in graduating from COTS. The next launch for Orbital would be operational. COTS, a line-item NASA program, would then end. Commercial cargo transport would be moved under the ISS budget, an action signifying it had completed development and was being institutionalized in agency routines. Commercial crew, meanwhile, still had a way to go.

## The Fourth Round of CCDev

On November 25, 2013, NASA issued an RFP for the final phase of CCDev (CCtCap). Unlike the earlier phases, CCtCap required companies to develop hardware and services. Companies would be directed to complete a successful crewed flight to the ISS to earn a NASA safety certification. While any company could apply, the three firms already working under CCiCap clearly had the inside track. Moreover, NASA had spent \$30 million extra on "Certification Product Contracts" so it could discuss safety requirements legally with them under FAR certification requirements.

The Aerospace Safety Advisory Panel (ASAP) issued a report declaring: "NASA is being perceived as sending a message that cost outranks safety in the [Commercial Crew Program] RFP." Donna Edwards (D-MD) and Eddie Bernice Johnson (D-TX), members of the House Committee on Science, Space, and Technology, wrote to Bolden expressing worry that safety was not being given enough attention. They got reassurance from Bolden, but their concerns were widely shared.<sup>79</sup>

As 2014 began, Congress passed a spending bill covering the federal government for the remainder of the fiscal year. NASA received \$17.6 billion, about \$100 million below Obama's original request, but \$700 more than the budget NASA had in 2013. Included was \$696 million for CCDev, less than the \$821 million Obama had sought. Bolden realized he needed a stronger argument for commercial crew. With Garver gone, Bolden had moved fully into her lead advocacy role and was becoming far more forceful.

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76. Brian Berger, "With Garver's Departure, NASA Loses Strong Change Advocate," *SpaceNews* (Aug. 12, 2013), 6.

77. Interview with Lori Garver, May 21, 2015.

78. Berger, "With Garver's Departure."

79. Eddie Bernice Johnson, "NASA's Plan Shorts Safety," *Aviation Week and Space Technology* (Feb. 3–10, 2014), 82.

# Moving Forward and Falling Back: 2014–2015

## Bolden and the Russian Card

In February 2014, Russia intervened in Ukraine, annexing the Crimean region. This geopolitical event actually provided Bolden with leverage to use with Congress. On March 4, 2014, President Obama released his proposed 2015 budget. With an overall request of \$17.5 billion, NASA asked for \$848 million for commercial crew. In discussing this budget, Bolden pointed out that the Crimean crisis made it more imperative than ever that the U.S. end its dependency on Russia and get commercial crew the money it needed to succeed.

In congressional hearings on the budget in March and April, Bolden hammered home his point about Russia and money for CCDev. Bolden sharply criticized congressional cuts, accusing Congress of forcing NASA to rely on Russia. Congress complained about Russian reliance, he said, but did not give NASA the money to extract the agency from that dependence. “You can’t have it both ways,” Bolden told Congress.<sup>80</sup> Congressional critics countered. In May, the House committee funding NASA said that NASA could solve its money problem by going down to one CCDev firm, and it urged Bolden to do so for CCDev 4.

In June 2014, the Senate produced a bill approving \$17.9 billion for NASA and providing \$805 million for CCDev. The House had recently appropriated \$785 million for CCDev. While those amounts were the best yet for commercial crew, they were below what Obama and Bolden had requested. Still, the trend was positive. A combination of need for a shuttle replacement, the success of COTS, and deterioration in Russian relations had shifted the political calculus increasingly in favor of commercial crew. The most divisive issue was the number of firms to be supported. Others were safety and the degree of NASA oversight.

The challenges—budgetary, legislative, and bureaucratic—continued, but in summer 2014, NASA moved toward a final decision as to who would build the commercial crew transportation system. It continued to adhere to its two-company strategy, and Congress acquiesced.

## The Decision and Possible Setback

On September 16, 2014, NASA announced that Boeing and SpaceX were the winners. They would share awards totaling \$6.8 billion. Boeing received \$4.2 billion and SpaceX received \$2.6 billion. The combination of an old space and new space company was seen by many observers as politically astute. Bolden announced the decision at the Kennedy Space Center in Florida. “Today, we are one step closer to launching our astronauts from U.S. soil on American spacecraft and ending the nation’s sole reliance on Russia,” stated Bolden.<sup>81</sup> Much of the

80. Marcia Smith, “Bolden Reassures on ISS, Defends ARM, Insists on Commercial Crew,” *SpacePolicyOnline.com* (March 28, 2014), <http://www.spacepolicyonline.com/news/bolden-reassures-on-iss-defends-arm-insists-on-commercial-crew>.

81. Kenneth Chang, “Boeing and SpaceX to Take Americans to Space Station,” *The New York Times* (Sept. 17, 2014).

## 2014–2015 Timeline

### 2014

- Congress provides more money for commercial crew program but presses NASA to limit support to one company
- NASA announces Boeing and SpaceX are winners in fourth and final round of CCDev
- Bolden sets 2017 as target for ending CCDev and shifting commercial crew into operations
- Orbital unmanned rocket explodes on liftoff from Virginia pad

### 2015

- SpaceX rocket for resupply to the ISS explodes
- Orbital (now Orbital ATK) uses an Atlas five rocket to deliver cargo to the ISS
- Congress gives substantial raise in omnibus appropriation to fund government and commercial crew gets the requested \$1.243 billion

money would go to meeting NASA's certification requirements for performance and safety. Each company was obligated to conduct a flight test with at least one astronaut. Once certified, as part of the contract each company could have at least two missions with the possibility of four additional missions. The goal for getting to operations was 2017, but meeting that deadline depended on funding.

The congressional reactions to the decision were positive, but guarded. House Science Committee Chair Lamar Smith (R-TX) said that Congress would monitor implementation to make sure vehicles were "safe and reliable."<sup>82</sup>

Sierra Nevada protested the decision as soon as it was made. On October 3, NASA told Boeing and SpaceX to hold off getting started until GAO decided. A few days later, on October 9, 2014, NASA rescinded the "stop work" order, claiming that delay would pose a risk to the ISS crews and U.S. commitments to other nations using the ISS. Sierra Nevada sued to reinstate the order. The U.S. Court of Federal Claims became involved. Sierra Nevada argued its case primarily on its bid being lower than Boeing's, but NASA contended that price was only one criterion for the decision, and other factors such as technical quality and experience gave the nod to Boeing.

While the NASA-Sierra Nevada dispute played out in the appeal process, a significant setback hit commercial space in late 2014. On October 28, an Orbital unmanned rocket exploded moments after liftoff from its Wallops Island pad in Virginia. No one was hurt. Then, just days later, on November 1, a space plane built by Virgin Galactic, the aspiring space-tourist company launched by entrepreneur Richard Branson, crashed. It was a test flight with regular tourist flights scheduled as early as spring 2015. One pilot was killed, and a co-pilot bailed out.

Although these two events did not involve NASA, Boeing, or SpaceX, they cast an ominous cloud over actions relating to commercial crew. They brought home to commercial space enthusiasts the reality that space flight was a dangerous enterprise. The key driver for public-private partnerships was to lower the cost to government of space access. Safety had to be

82. Jeff Foust, "NASA Commercial Crew Awards Leave Unanswered Questions," *SpaceNews* (Sept. 22, 2014), 1, 4.



guarded too, because accidents happen, and one major accident involving people could wreck plans for both government and industry.

By the beginning of 2015, the legal and administrative challenges Sierra Nevada had pursued came to an end. NASA, Boeing, and SpaceX moved fully into the final round.

## Pushing Toward Institutionalization

The FY 2016 budget proposed an overall NASA budget of more than \$18.5 billion. This was a \$519 million increase over the previous year. Commercial crew was slated for a 50 percent increase over the \$805 million it received in FY 2015. At more than \$1.2 billion, that would be the top year of spending, with subsequent funding falling. As had come to be the norm, the White House reduced funding for Orion and SLS compared to FY 2015. The expectation was that Congress would reduce commercial crew to add money to SLS/Orion. Bolden worked assiduously to protect commercial crew from that fate, spending a great deal of time on the Hill.

For a man who began his tenure at NASA eschewing “politics,” Bolden had evolved to be a serious advocate. He talked to Republicans as well as Democrats, courting rank and file lawmakers on and off the space authorization and appropriations committees. He even had astronauts on the ISS make the case that NASA needed the full appropriation to stay on track.<sup>83</sup>

If commercial crew received the funding requested, then the two contractors promised to get vehicles developed by the end of 2017. Boeing’s CST-100 would reach milestone tests in 2017. The first crewed mission with one Boeing pilot and one NASA astronaut was scheduled to take place in July 2017. Boeing set its first operational mission to the ISS for December 2017. SpaceX was scheduled to have an unmanned flight in late 2016 and a crewed flight in early 2017. Both companies could charge \$58 million per seat, in contrast to Russia’s then \$76.3 million. Obama had provided incentives for the companies in 2014 by extending the ISS life to 2024. Bolden spoke of it lasting as a commercial market to 2028.

To reach operational status, the vehicles had to be certified by NASA, declaring a vehicle ready for regular repetitive flights carrying human beings. NASA promised it would oversee contractor performance very carefully. It wouldn’t just be NASA and its safety office watching for contractor compliance to agency requirements, but also NASA’s Aerospace Safety Advisory Panel (ASAP).

ASAP had been critical of commercial crew since its advent, focusing on the lack of government oversight under the Space Act Agreement. Although the fourth round was under FAR, ASAP nevertheless was wary. ASAP Chairman Joseph Dyer also complained to Bolden that his panel could not get the information it had requested from NASA. Bolden told him he would correct the situation and apparently did so. On February 27, 2015, Dyer told a House committee that the agency was becoming more transparent about its commercial crew contracts. “We are beginning to see the early stages of making that turn,” he stated.<sup>84</sup>

On June 28, 2015, SpaceX’s seventh commercial resupply mission to the ISS ended abruptly when it exploded shortly after launch. Along with that, a Russian supply ship had failed to

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83. Casey Dreier, “An Extraordinary Budget for NASA in 2016,” *The Planetary Society Blog* (Dec. 18, 2015), <http://www.planetary.org/blogs/casey-dreier/2015/12/16-nasa-gets-an-extraordinary-budget-in-2016.html?referrer=https://www.google.com/>.

84. “Commercial Crew Info Now Flowing, House Panel Told,” *SpaceNews* (March 2, 2015), 12.

dock on April 28. While NASA had plenty of supplies on the ISS, these events—particularly the SpaceX loss—sent advocates of commercial space into some soul-searching.

There had been a great deal of hype building, especially in regard to SpaceX. Critics said now was the time for realism—space was hard! Nevertheless, NASA argued for staying the course with CCDev. The failure of Space X (and earlier, Orbital) showed the wisdom of NASA's decision to emphasize cargo first before crew. "While it is unfortunate, [cargo] is still recoverable. We can understand what occurred with the SpaceX team, and the information can be really important. As we move forward into the crew designs and flight," Bill Gerstenmaier, Associate Administrator for Human Exploration and Operations, said, "NASA and its partners would be vigilant."<sup>85</sup>

On December 18, 2015, Congress passed an omnibus appropriation for the government that funded NASA and other agencies in FY 2016. The space agency received \$19.3 billion, nearly \$1.3 billion more than the previous year. That sum gave a raise beyond the Obama proposal for SLS/Orion—which was no surprise. But to the shock of many, NASA got precisely what it had requested for commercial crew: \$1.24 billion.<sup>86</sup> That did not guarantee making the 2017 deadline, but it gave NASA and its industry partners what they wanted: a fighting chance!

Orbital (now known as Orbital ATK), meanwhile, delivered cargo to the ISS in December 2015 using an Atlas rocket while its Antares underwent alterations. Then SpaceX returned to flight December 21. It also successfully landed the initial stage of its Falcon 9 rocket. This marked the first time a private company had achieved this feat from an orbital trajectory.

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85. Frank Moring, Jr. and Amy Butler, "SpaceX Stalls," *Aviation Week and Space Technology* (July 6–19, 2015), 22–23.

86. Casey Dreier, "An Extraordinary Budget for NASA in 2016."

# Lessons Learned

This report explores how NASA leaders have used innovative public-private partnerships to develop a replacement for the space shuttle while developing new policy mechanisms to enable private companies to take over cargo and astronaut transport to the International Space Station. This report focuses on the evolution of the partnership strategy from its formulation and adoption during the George W. Bush Administration to its augmentation and fulfillment under the Obama Administration.

The report documents and analyzes how leaders in the executive and legislative branches working together, as well as sometimes at cross purposes, sought to achieve transformational change in spaceflight. It is from this effort to launch a transformative mission for NASA that the report draws lessons learned on such diverse, yet interconnected, disciplines as leadership, change management, and public-private partnerships.

## Lessons Learned

- **Lesson One:** Engage and align key actors early
- **Lesson Two:** Understand the nature and degree of change
- **Lesson Three:** Establish a complementary leadership team
- **Lesson Four:** Recognize that transformation takes time
- **Lesson Five:** Adopt a general strategy of what needs to be done
- **Lesson Six:** Build support for a new mission and neutralize opposition
- **Lesson Seven:** Foster competition and pursue innovative ways to make transformation happen
- **Lesson Eight:** Recognize the importance of stability
- **Lesson Nine:** Leadership must evolve to meet the demands of a transformational change

## Lesson One: Engage and align key actors early

Pursuing change that can transform how an agency meets its mission requires leaders to engage and align key actors (e.g., the White House; Congress; the agency; and relevant interest groups, especially industry) early in the change process. Then-NASA Administrator Michael Griffin did just this when shaping what was to become the Commercial Orbital Transportation Services (COTS) program. Griffin engaged NASA lawyers to find a more effective way to use NASA's procurement authority to stimulate commercial development. He also aligned internal and external parties to build support for the program in its infancy. However, in many instances, pursuing visionary change is fraught with conflict and difficulty. It takes much time and negotiation, as exemplified by the CCDev commercial crew experience. As illustrated in the case study on commercial crew, the White House, Congress, NASA, and industry worked at cross-purposes for an extended time, resulting in delays and the fatigue of political brinksmanship.

The White House drove policy change. It was supportive of Mars as a destination but was unenthusiastic about the Moon goal and Constellation. NASA's Garver was significantly involved in decision making and Bolden was involved to a much lesser degree. The White House saw NASA as an organization resistant to change and excluded it as much as possible as the budget decision process moved to finality. Congress was equally on the sidelines.

Obama was given various options in human spaceflight policy by his advisors. The one he chose was to terminate not only Ares 1 (which was expected), but also Constellation as a whole. The president decided to provide NASA with a raise (but not at the Augustine panel level) enabling it to promote commercial crew as well as cargo delivery to the ISS, and advanced technology to enable game-changing reforms in spaceflight to speed the eventual journey to Mars. The Moon was rejected, but no interim destination was specified in its place. The White House indicated it would extend the life of the ISS to 2020, at least.

The rollout of the new policy came in the proposed NASA budget, announced February 1, 2010. Whatever the positive elements of the policy, they were lost in the glare of Constellation cancellation. There was an immediate pushback from Congress, led by a bipartisan group of senators from "space states"—Florida, Texas, and Alabama. From their perspective, termination of Constellation in the face of shuttle retirement (in 2011) meant thousands of layoffs for NASA and industry. Change was expected, but this was too much change, and its scope came as a shock. Without question, the White House lost the media and public relations fight.

Many questions arise from this experience: What if the Obama Administration engaged Congress early in its pursuit of its vision of commercial space? How important is it to make sure that agency leadership is engaged and aligned with an administration's policy and vision from the beginning? The story detailing the end of the space shuttle and the beginning of commercial space offers a glimpse into these and many other questions.

## Lesson Two: Understand the nature and degree of change

Leaders must understand the nature and degree of change they are pursuing because it influences who they will need to work with and helps them build cohesive support. Changes that appear to be modest typically will not stir much external or internal resistance. Changes that impact an agency's core values will be resisted, often strongly by those who are affected. It is imperative that the leadership of an agency be united in reality and appearance or its overall influence will be diluted. This finding is best illustrated by the Obama Administration's coupling of the Constellation program termination with the commercial crew initiation, which created a schism between the two programs. NASA, left out of the decision process, had not developed a plan for execution. When NASA leadership sought to develop a plan of action their efforts were met with hefty resistance among NASA's senior managers, who believed that Constellation was sound technically and all they needed was more money. They were extremely wary of relinquishing their control of contractors via the Space Act Agreement where astronauts and their safety were involved. They detected different signals from Bolden and Garver and waited to see what would happen.

Moreover, when transformational change involves a decision to terminate, it will face significant obstacles when the program in question is one that has been around several years, spent billions, and has an influential constituency. Just as it takes political skill to initiate a new program, it takes great skill to kill one, particularly one that has had time to build support. An agency with too much on its plate for the money it has may well require some amputation, but the process should be surgically deft.

### **Lesson Three: Establish a complementary leadership team**

An agency leader pursuing transformational change has a choice to remove resisting senior managers or bring them along gradually, turning their resistance into support. The latter takes a long time. On a program leadership level, previous NASA Administrator Michael Griffin removed top managers from the Constellation exploration program, but he did not do that specifically in regard to commercial cargo. Current NASA Administrator Charles Bolden chose to keep his senior managers for all major programs including commercial crew, but he did make a highly selective and visible change with a Constellation program manager.

From an agency leadership perspective, the NASA team of Bolden-Garver may have turned out more complementary than initially conceived. Garver pursued a specific vision of commercial space with singular focus and tenacity. After a few ups and downs, Bolden channeled that focus and ably mediated the political fissures as well as his agency's cultural resistance to realize the administration vision of commercial space.

Leadership is needed throughout a long process of adoption, implementation, evaluation, reorientation, etc. Who leads at what stage—NASA, the White House, or Congress—can vary, but whoever leads needs to build a coalition of support for the decision pursued. Joint decision making has a chance to succeed. Unilateralism usually fails.

### **Lesson Four: Recognize that transformation takes time**

All of this is big change. It does not happen easily or without conflict. Some existing models of policy innovation paint a straightforward, rational process: agenda-setting, formulation, adoption, implementation, perhaps evaluation/reorientation, and institutionalization. Reality is not so straightforward. It is a case of two steps forward, one step backward, and an occasional misdirection. Charles Lindblom was closer to the truth when he used “muddling through” and “disjointed incrementalism” as a description of policy making. There is disagreement about what is the right policy, and a struggle over whose view is best for the country. So it has been in space policy. The stakes are high and there are those who ponder whether and how the U.S. can still do “big things.”

Transformational change may span two or more presidencies and different administrators. This length of time for an innovation to go from concept to institutionalization can be considerable and that has implications for leadership. Leaders in one administration can establish and move an innovative program a certain distance along the continuum from agenda setting to institutionalization. Those who follow will either take up the baton or fail to do so. In the case of commercial cargo, NASA Administrator Michael Griffin got it started; his successor, Charles Bolden, saw it implemented and institutionalized. Griffin delayed commercial crew's start-up. Initially skeptical, Bolden eventually became a strong proponent and implementer of commercial crew. It will be up to his successor under the next president to get commercial crew fully institutionalized.

### **Lesson Five: Adopt a general strategy of what needs to be done**

When pursuing a transformational policy, a leader needs a general strategy at the outset. Having such a strategy is all-important in how it is received. A leader must be willing to adapt that approach as time goes on, depending on events. Leaders should seek a range of advice from outside and inside the organization, and they should listen to that advice. There are strategic and tactical dimensions to any plan of action and some executives are more skilled in one aspect or the other.

Dan Goldin generally held to his strategy, but his tactics were critical in the short term, requiring a number of side trips and delays on his way to NASA's future. Michael Griffin won the tacit support (or at least non-resistance) of the White House, Congress, his agency, and a targeted part of industry prior to formally introducing commercial cargo. He emphasized its non-threatening role as a backup to the mainline government program, Constellation. Commercial cargo was a small program, inexpensive, and low profile.

The pursuit of the commercial crew program from the outset of the Obama Administration had all the opposite attributes. It was substantial, costly, and high profile. Most importantly, it involved astronauts and their safety. Relevant interests in Congress and the agency were not consulted prior to commercial crew's rollout as a presidential initiative. Instead of being sold as a backup to the mainline NASA program, commercial crew was presented as Constellation's replacement. Consequently, Constellation's influential constituency turned against commercial crew.

Lack of clarity on divisive issues (like long-term funding and the future of the space station) can ease the adoption of a program. But those issues will arise eventually and can cause problems in implementation. For a long-term program to succeed requires a delicate balance of stability and change. The stability is needed to accomplish implementation. The change comes with evaluation and reorientation when problems arise or the larger political context alters radically.

## **Lesson Six: Build support for a new mission and neutralize opposition**

New missions that are transformative can be threatening to existing interests and programs in an agency, especially if the overall funds for the agency are not augmented sufficiently to pay for what is new. The administrator should expect opposition, particularly from internal and external actors who feel losses from transformational decisions. One of the strategies for neutralization is cooptation.

The administrator needs the organization enthusiastically on board to succeed. One strategy to enlist internal support is to divide work so various centers of organizational power have ownership of parts of the program. The rhetoric of reassurance is necessary. When the new mission involves new skills and possible layoffs, the administrator can stress the opportunities for retraining existing personnel. However, the administrator must be firm about the need for the organization as a whole to change and the criticality of the new mission to the agency's future.

To mollify a strong opposition, proponents of change may also have to dampen the innovation's most disruptive features. The commercial cargo program ran into little overt opposition in its adoption. Its implementation became primarily a technical, administrative, and budgetary challenge. The budgetary challenge was real due to internal and external pressures to use COTS money elsewhere. The support of the NASA administrator and White House (including OMB) protected the program and it flew under congressional radar. It was seen as incremental change, an experiment that had to run its course. Commercial crew, as presented in the president's FY 2011 budget, was clearly discontinuous change and was rejected by Congress. Its adoption remained an issue for subsequent political resolution. Senator Bill Nelson and Rob Nabors, a senior advisor to President Obama who negotiated on the president's behalf, provided leadership in reaching compromise. The NASA Authorization Act of October 2010 saved commercial crew and salvaged key components of the former Constellation program.



## Lesson Seven: Foster competition and pursue innovative ways to make transformation happen

Leaders of change can use public-private partnerships to make their vision a reality. Some partnerships face greater resistance depending on the nature and extent of the proposed change. The prime aim of the COTS and CCDev programs was to transfer a function previously performed by government and the space shuttle to industry and privately-owned spacecraft. NASA Administrator Griffin used a Space Act mechanism to achieve this goal for commercial cargo. The Space Act, in contrast to traditional Federal Acquisition Regulation (FAR) procedures, put companies in dominant positions in regard to technical designs, milestones, payment schedules, and performance measures. In return, the companies co-invested in developing new vehicles (rockets and space capsules). Griffin wanted companies to put more money than government into the commercial cargo program development stage. They did so as they obtained venture capital funding in addition to their own. Griffin's model required competition among companies—especially newer and “nimble” entrepreneurial companies—to drive down cost, and competition was maintained throughout the program.

NASA used Space Act Agreements to “level the playing field” to enable newer (less expensive) companies to enter aerospace. FAR required substantial accounting and legal staffs the newer entrants did not have. Griffin was aware of potential resistance to commercial cargo by NASA's Johnson Space Center (JSC), which was responsible for and highly protective of the International Space Station (ISS). He located technical leadership at JSC while placing in charge an individual at JSC who shared his policy view and was bureaucratically savvy. He thus used a strategy of cooptation, in which a leader provides an appearance of control without its reality.

The commercial crew program faced far more resistance within NASA. For some time, there were competing camps within the agency on the commercial crew question. Also, elements in Congress and traditional aerospace industry resisted strongly. Commercial crew required far more government investment than did commercial cargo. It also touched on agency core values (e.g. astronaut safety). Bolden did continue Space Act Agreements as a vehicle for change, but over time he developed a “hybrid” approach that made the public-private partnership more acceptable to the agency. Thus, in the earlier stages of technical development, Space Act mechanisms applied, and control over designs and other elements were vested in industry. Later, as development moved toward institutionalization, certain FAR procedures were introduced so the agency could exercise greater control over safety requirements.

For innovative public-private partnerships to work, an agency also needs to show confidence in industrial partners and take chances in investments if those partners are to get private venture capital. NASA decided to provide commercial resupply contracts to SpaceX and Orbital before they had demonstrated success in development under COTS. This was a strong statement that NASA was serious about the public-private partnership approach. That decision may have saved SpaceX at a time when it was most financially vulnerable and kept the commercial space initiative going. Private investors could see a multi-billion dollar market via the commercial resupply contracts.

NASA also made competition a critical principle in COTS and CCDev. It fought for this principle in both programs. It wanted options in case a firm failed, as happened in the case of Rpk under COTS. Also, it had learned from an earlier public-private experience (X-33/VentureStar) that it should not be dependent on one particular company when it is trying to achieve major change.

## Lesson Eight: Recognize the importance of stability

For transformational change, it helps if leaders remain in office for a substantial period. Administrative stability is needed in politically turbulent times. Bolden, who has served as administrator during both Obama terms, was a peripheral player at the outset of the commercial crew program's introduction in 2009 and 2010. Loyal to President Obama, he nevertheless lacked experience in the machinations of Washington and deferred initially to his deputy. But he learned that an agency leader has to lead, especially in matters of transformational change. Once Congress and the White House achieved a political compromise with the Authorization Act of 2010, Bolden moved to become a more central actor as implementer. Gradually, he became better skilled as an administrator in a political environment. Given the rocky start commercial crew had, and dysfunctional Washington funding context of the Obama era, it has been critical to have a steady hand navigating NASA. Bolden's "apolitical image" ironically helped his credibility as an advocate.

## Lesson Nine: Leadership must evolve to meet the demands of a transformation change

Circumstances affecting large-scale technical projects change over time. The ultimate goal may be a constant, an overall destiny. Getting there entails shifting strategies that are scientific, organizational, and political. Leadership is utterly critical—probably the single most critical factor in success. Different styles of leadership may be required at different stages of a transformational change, depending on the scope and nature of the change. It may take a certain leadership to launch a transformation and another kind to make the changes that bring it to a successful conclusion.

With a low profile, commercial cargo did not require a "true believer" or combative style of advocacy. Griffin was forceful but pragmatic in his approach to COTS. He sold commercial cargo as an experiment in public-private partnership. Its failure was acceptable because it was a backup to the mainline program, Constellation. Also, he wanted to see if the experiment worked with cargo, and he resisted going to commercial crew. Griffin's approach was incrementalism. In contrast, it took true believers to shift from Constellation to CCDev and mount a major commercial crew program. This was discontinuous change and needed leaders who saw themselves as "change agents" to play their roles. A hard-driving entrepreneurial approach, as exemplified by Deputy Administrator Lori Garver, was needed to get commercial crew on Obama's and then NASA's agenda in 2009. But once the president and Congress reached a compromise policy in October 2010, Bolden's more facilitative advocacy style helped lower the political heat surrounding commercial crew and move its implementation forward. Both a true believer and a facilitative style can be needed for transformative change, depending on the stage of an innovation's evolution. Also, it is noteworthy that Bolden's style became more aggressive late in his term as he sought to give a final push to commercial crew before he departed. It also should be noted that in government, as in business, entrepreneurship carries risk.

Leaders must adapt strategies as political environments change. Griffin used the rhetoric of industrial policy to help sell COTS. Bolden found that approach did not go well with the Republican Congress he faced. He used "the Russian card," a foreign policy rhetoric, to frame the argument to support U.S.-based commercial crew.

## Conclusion

This report has provided a case study of NASA's shuttle successor efforts. It explored how the agency uses innovative public-private partnerships to make its new mission a reality. It examined the transformational leadership and partnership dynamics, as well as the larger political forces, involved in retiring the space shuttle and beginning commercial space.

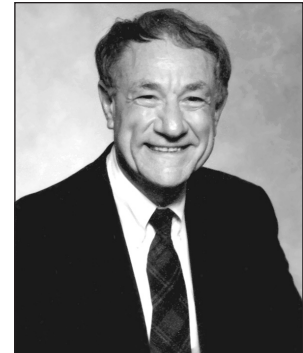
In the recent decade, NASA has seen the shuttle retirement, completion of the International Space Station (ISS), the start of a commercial cargo and crew service to the ISS, the end of one major rocket development program, and the decision to develop a different, giant rocket capable of taking astronauts and cargo to deep space—the Moon, an asteroid, and eventually Mars. Indeed, viewed historically, NASA and its political masters have initiated and sustained a transformative decision process for human spaceflight exploration, with Mars as a destination.

O'Keefe got a public-private process started; Griffin turned it into a successful program for cargo; and Charles Bolden, the current NASA administrator, is adapting the partnership concept for crew. Human spaceflight is much riskier and more complex than cargo, and it is also much more expensive and controversial. Safety is an overriding value. Hence, there has to be adaptation, which has been Bolden's most significant challenge. That adaptation is itself important to understand. NASA's goals have included: 1) shuttle replacement; 2) reshaping the aerospace industry to get new entrants, greater competition, and lower costs to government; 3) creating a division of labor in which the private sector takes a greater role in low Earth orbit while NASA concentrates on deep space; and 4) ending U.S. dependence on Russia. NASA has been successful with cargo and is progressing on crew.

This strategy merges space policy with industrial and foreign policy, and it is being achieved.

## About the Author

**W. Henry Lambright** is Professor, Departments of Public Administration and International Affairs, as well as Political Science at the Maxwell School of Citizenship and Public Affairs at Syracuse University. He teaches courses at the Maxwell School on technology and politics; energy, environment, and resources policy; and bureaucracy and politics.



Dr. Lambright has served as a guest scholar at The Brookings Institution; the director of the Science and Technology Policy Center at the Syracuse Research Corporation; and director of the Center for Environmental Policy and Administration at the Maxwell School at Syracuse University. He has served as an adjunct professor in the Graduate Program of Environmental Science in the College of Environmental Science and Forestry at the State University of New York. He has testified before Congress and been interviewed by the media on many topics, including the environment, science and technology, and government management.

A long-standing student of large-scale technical projects, he has worked for NASA as a special assistant in its Office of University Affairs and has been a member of its History Advisory Committee. Dr. Lambright has performed research for organizations including the National Science Foundation, NASA, the Department of Energy, the Department of Defense, and the State Department. He edited the book *NASA in the 21st Century*, published by the Johns Hopkins University Press in 2003. He is also the author of five previously published IBM Center reports: *Transforming Government: Dan Goldin and the Remaking of NASA* (2001); *Managing 'Big Science': A Case Study of the Human Genome Project* (2002); *The Challenge of Coordinating 'Big Science'* (2003); *Executive Response to Changing Fortune: Sean O'Keefe as NASA Administrator* (2005); and *Launching a New Mission: Michael Griffin and NASA's Return to the Moon* (2009).

Dr. Lambright is the author or editor of seven additional books, including *Powering Apollo: James E. Webb of NASA*; *Technology and U.S. Competitiveness: An Institutional Focus*; *Presidential Management of Science and Technology: The Johnson Presidency*, and *Why Mars: NASA and the Politics of Space Exploration*. In addition, he has written approximately 300 articles, papers, and reports.

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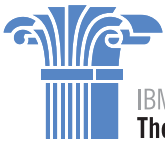
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