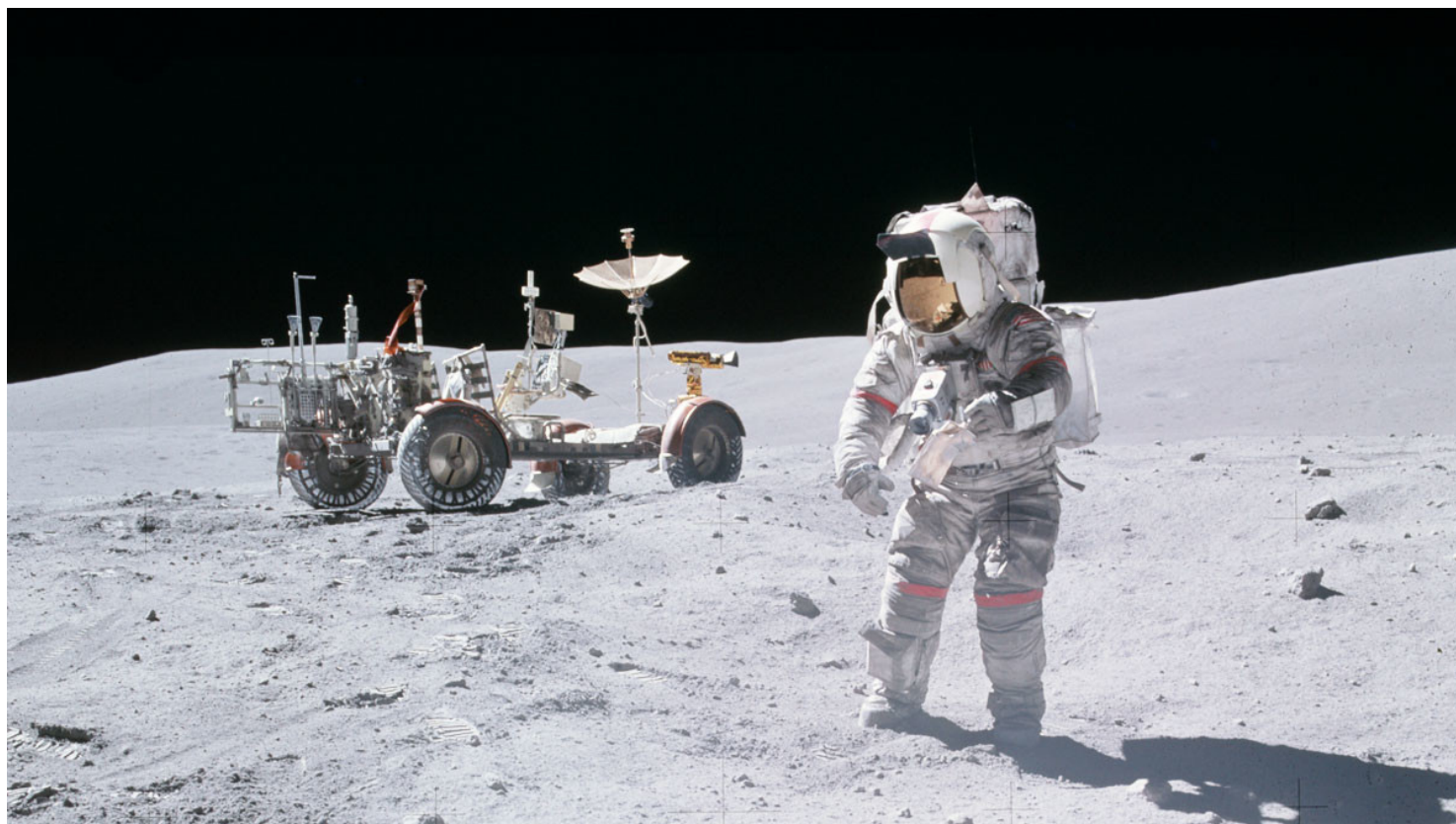


The Reinvention of NASA

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NASA today is a very different beast from the NASA of the 1960s. Though many would call that decade NASA's golden age, we'd argue that NASA's innovation and influence is even greater today.

Since the Apollo program, NASA has faced funding cuts, competition from other nations for space leadership, and a radical restructuring of its operating environment due to the emergence of commercial space - all of which have forced the organization to change its ways of thinking and operating.

Over the past few decades, not only has NASA delivered crucial technologies for society, such as water filtration systems, satellite-based search-and-rescue, and UV coating on eyeglasses, it has also evolved its dominant logic and business model. NASA has moved from being a hierarchical, closed system that develops its technologies internally, to an open network organization that embraces open innovation, agility, and collaboration.

This reinvention demonstrates that substantial organizational change is possible, even amid barriers such as regulations and politics. It offers an example of what we call “strategic agility,” or the ability to effectively (and continually) adapt how a firm operates and competes. This is not driven by a single leader, but by a multitude of champions scattered around the organization who push forward initiatives that slowly create change.

The challenges facing NASA

During the Apollo program NASA’s funding peaked at 4.5% of the federal budget (US\$5,250 million) in 1966. But shortly after the first moon landing in 1969, their budget plummeted. It is currently at less than 0.5% of the federal budget.

Meanwhile, the organization’s mission aspirations grew bolder. The Commercial Space Launch Act of 1984 (and amendments in 1988 and 2004) called for government agencies such as NASA to support the development and growth of commercial space. This not only necessitated a more collaborative way of operating, but it also called for the agency to differentiate its missions. As commercial space organizations began to drive more low-earth orbit (up to 2,000 km from earth) activities, NASA has had to shift its efforts toward exploring deep space, accomplishing further manned missions, and setting up permanent facilities on the moon as a gateway for missions to Mars and beyond.

The emergence of commercial space has also gone hand in hand with an accelerating pace of technology development. This means that the technologies necessary for successful space-faring, particularly human space travel beyond low earth orbit, cannot all be developed by a single organization. NASA has had to become more outward-looking and network-oriented to develop and acquire the technologies it needs.

Competing nations have also been expanding their space exploration efforts. The space industry is now a global, multi-faceted, multi-stakeholder endeavor, where commercial activity accounts for the lion’s share of value. (Over three quarters of the \$350 billion global space industry

revenues are driven by commercial products, services, infrastructure, and support industries.) Sustaining NASA's and the USA's space leadership has called for a new way of organizing and competing.

Adapting to change

The reinvention of NASA has been an evolution spanning three phases, each focused on achieving different goals and characterized by particular technology strategies, cultural values, and ways of working with external parties.

The traditional model (from 1960s to 1990s): In its early days NASA served as both the prime contractor and the exclusive customer of space technologies. This model made sense for a few reasons. First, the frontier technologies that NASA needed were not already available on the market; they had to be developed from scratch by specialized contractors. Second, the Cold War and the space race meant that NASA needed to have control of the resulting technology rather than the technology being made available on the market by contractors after development. Third, NASA's military heritage, and more broadly the procurement processes of government agencies at the time, meant it operated by issuing cost-plus contracts and owning the resulting technology.

Think of the Apollo program in the 1960s. NASA gave detailed specifications to contractors (such as North American Aviation, which built the command/service module of the Apollo spacecraft, and Ford Aerospace, which built the mission control), defining what should be done and how. NASA, purely funded by government, incurred the total costs and became the owner of the resulting technology.

In this model, the relational approach was one of positional authority and hierarchy. NASA focused on developing and monitoring precise engineering specifications. NASA engineers had large amounts of control over what the contractors were doing. The technology strategy focused on agency-driven investments and strict control over the internally developed technologies. there was a sense of technological superiority and exceptionalism that developed from the government's efforts to attract the brightest scientists.

The transitional model (from 1993 - 2006): This phase kicked off with the International Space Station project. In 1993 NASA was directed by the White House to collaborate with other nations on the design and construction of the International Space Station. The agencies involved were

the European Space Agency (ESA), the Japan Aerospace Exploration Agency (JAXA), the Canadian Space Agency (CSA), and Roscosmos.

The ISS was a necessary step in the grand goal of launching human missions in deep space, such as to Mars, a key NASA aspiration for decades. A round-trip human journey to Mars would take around 21 months, depending on a variety of factors. NASA needed to understand what would happen to the human body during extended missions in space, and the ISS would provide a way to gather this knowledge by stationing astronauts on the space station for long periods. But ISS would be too expensive for any one country to build alone.

During this transitional phase, NASA learned how to function within a cluster of partners, as opposed to being the dominant party in a supplier/buyer relationship. This demanded shifts in cultural values, relational approaches, and technology strategy.

Culturally, the sense of technological superiority developed during the Apollo program was still present, but now there were more players with their own cultures, technology, and operating models. NASA had to learn how to collaborate. Further, greater cost consciousness developed, as the American public and politicians began questioning the amount of resources needed by the agency. Unlike the Apollo era, when funds were no barrier in the effort to win the space race, NASA now had to accomplish its missions as efficiently as possible and be more explicit about its added value to society. It invested more in external communication.

Relationally, the hierarchical pecking order of the traditional model had to accommodate a cluster of international governmental organizations. NASA negotiated with, coordinated, and led the network of international space agencies to accomplish one of the most complex undertakings of humanity, designing and building the ISS. The work was distributed: NASA ISS program managers led the effort at the operational level and worked with international counterparts to implement the program. There were 15 centers around the world focused on ISS; in the U.S., much of ISS training and program management took place at the Johnson Space Center in Houston.

NASA's technology strategy also evolved to leverage the investments of state partners and share technical responsibility. The agency worked with its partners on developing shared technical interfaces, standards, and protocols, learning how to operate within public-public partnerships.

The network model (from 2006 to present): The network model began with the Commercial Resupply Services program that launched in 2006 to carry cargo to the International Space Station after the space shuttle was retired. The space shuttle's retirement meant that NASA had to find other ways to resupply the ISS that would not only be reliable but also require fewer resources than the space shuttle. This and a number of different factors – budget pressures, government interest in promoting commercial space, and rapidly growing commercial expertise in space – led NASA to seek suitable commercial partners.

NASA wanted to use part of its budget not only to buy services it needed, such as to resupply the ISS with cargo, but also to spur the growth of commercial space. NASA looked for outside partners because it recognized that the expertise was now available in the open market to deliver frontier capabilities, at lower cost compared to what NASA could develop them for. In 2008 NASA awarded contracts to Space X and Orbital Sciences to transport cargo to the ISS. Space X carried out its first resupply mission in 2012 and Orbital Sciences in 2013.

This model has changed NASA's technology strategy. It now involves fixed-price contracts within public-private partnerships, where NASA does not exclusively own the resulting technology. Commercial partners can sell their services and technology to other customers. Costs are shared, and NASA pays for milestones reached. Rather than providing detailed specifications for the what and the how, NASA specifies high level goals (the what), leaving the how to the commercial partners. The innovators can then exploit these technologies commercially as they see fit, further fuelling the development of space technology and enhancing the value of the industry overall.

The commercial resupply program has taught NASA how to work effectively with the commercial sector and to manage ongoing public-private partnerships. Culturally this has led to a more outward-looking agency that recognizes the innovative capacity of the market. Dealing with commercial actors has also taught NASA greater commercial awareness, that is, a focus on accomplishing things as efficiently as possible and being conscious about the costs of any given activity – a far cry from what was seen as unlimited resources of the Apollo program.

New offices such as the Commercial Crew and Cargo Program were set up within NASA to manage and promote commercial partnerships. Leaders managing these partnerships adopted the mindset that NASA is one of several parties involved in space technology development, and favor an open engineering architecture that can facilitate commercial collaborations.

In this networked model, NASA has also embraced open innovation. The agency now poses innovation challenges online in open competitions, crowdsourcing solutions and ideas as a complement to internal innovation efforts. Successful open innovation challenges have included competitions on the design of pressurized yet flexible astronaut gloves, ways to accurately measure the strain on materials used in space such as Kevlar straps, and better forecasting of potentially destructive solar flares.

Given the recent directive the U.S. government requiring NASA to return to manned missions to the moon and beyond, the organization’s new capabilities and structure are becoming even more important. NASA is now able to use innovations wherever they emerge within its networks, so that it can accomplish goals such as deep space exploration, the search for extra-terrestrial life, and a manned journey to Mars.



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