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Viewpoint

Two modest proposals for propelling NASA forward

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ABSTRACT

The external and internal environments of NASA have been shifting, necessitating new approaches to problem solving and innovation. Based on a strategic alignment analysis, and an understanding of NASA's internal and external contexts, we have two modest proposals: First, give NASA flexibility to manage its human resources and infrastructure based on market-based, competitive, performance-oriented principles. Second, it is time for NASA to become a real network organization. One that is properly integrated both internally (across NASA centers) as well as externally with whatever organizations have superior space-related knowledge and technology, wherever they are.

NASA's technological and scientific accomplishments have inspired generations of scientists and captured the imagination of people across the globe. Its use of planning and integrative processes from large systems management, transferred from the military, as well as the applied, hands-on, problem-solving culture of the research laboratories and technology centers that made up NASA, enabled the successful completion of ambitious missions of high complexity and risk. NASA's culture in its early years embraced a can-do attitude and a sense of technological excellence where everything was possible and technical challenges could be solved through the application of scientific knowledge and experimentation.[1] The cold war and the space race of the 1960s meant that the government made available progressively higher funds to NASA, culminating to 4.5% of the federal budget in 1969.[2]

Over the last few decades, technologies developed or advanced by NASA have contributed to several areas including healthcare, sustainability, and lifestyle. Such technologies include laser angioplasty, cardiac and body imaging, gait analysis, ocular screening, food preservation and safety, UV-blocking lenses, scratch-resistant lens coatings, X-ray imaging, meteorological information processing, air and water purification, solar energy, virtual reality, digital imaging, laser technology, and robotics.[3] Aspects of these technologies, initially developed to address spaceflight-related challenges, have been subsequently taken up and commercialized by the private sector. As a publicly-funded body, NASA has restrictions on commercializing its own innovations.

The external and internal environments of NASA have been shifting however, necessitating new approaches to problem solving and innovation. Externally, space technology is no longer a monopoly. US and global stakeholders expect more than blue-sky scientific advancements from NASA, given its $18bn budget; such as technologies that can improve life for humanity and to help address fundamental world challenges such as global warming. Private space companies have emerged within the United States, such as Space X, that often license NASA technology, compete for NASA contracts and employ NASA scientists. . Further, hyper-ambitious and well-funded national space agencies such as China National Space Administration mean that NASA has real competition on space-faring competence. According to the Space Foundation,[4] global expenditure on space activities amounted to US$290bn in 2012, where NASA accounted for only around 6% of that figure. NASA has moved from a position of near monopoly on space activities in the early 1960s, to being just one of many credible actors in the global space industry.

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[1] McCurdy, H. E., 1993, *Inside NASA: High technology and organizational change in the U.S. Space Program*, Baltimore: Johns Hopkins.

[2] Office of Management and Budget, 2013. Historical Tables, www.whitehouse.gov/omb/budget/Historicals, accessed on 11 May 2014; and NASA Budget, http://www.nasa.gov/news/budget, accessed on 11 May 2014.

[3] The best of NASA's spinoffs, http://er.jsc.nasa.gov/seh/spinoff.html, accessed on 11 May 2014.

[4] Space Foundation, 2012, *Pioneering: Sustaining US leadership in space*, www.spacefoundation.org/research/pioneering, accessed on 11 May 2014.

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Internally, with continuous budget pressure and uncertainty (NASA budget is currently less than 0.5% of the federal budget, even though in real dollars it is around 2%),[5] tasks have to be accomplished much more efficiently. NASA's workforce is not as young as it was in earlier days. In 1993 38% of NASA's scientists were in the 45–59 age range, a percentage which has gradually risen to 58% by 2013. Scientists between 20 and 34 years old comprised 34% of NASA's total employees in 1993, a figure that fell to 14% by 2013 (both sets of figures closely reflect the age composition of NASA's overall workforce). Employee turnover is currently 5.2% (of which 3.5% is retirees), from a high of 15% in its early years,[6] when scientists could easily go to work in the private sector and return to NASA with new ideas.

Budget pressures also served to expand the use of contractors. This serves to improve efficiency and access technology within NASA's network of partners and to promote exchange of technological competencies across the community. Over time the number of NASA employees serving as administrators and project managers overseeing and integrating contractor work has increased.[7] This was exacerbated by the substantial growth of state administrative regulations and oversight of NASA, in line with a general trend of accountability in government.

Independent reports have been critical of NASA. For example a recent National Research Council report found that NASA's field centers do not seem to be managed in an integrated way but operate as silos; that regulatory and legislative conditions, part of being a public sector entity, constrain NASA's effective management of its human resources and infrastructure and that NASA's funding is not sufficient to meet the portfolio of diverse missions that are included in its strategic plan.[8]

We have two modest proposals that may contribute to returning NASA to greatness. These derive from an understanding of organizational dynamics as well as NASA's context and history. The overall logic of the recommendations derives from considerations of strategic alignment; specifically, how NASA's competencies and organizational configurations can develop to effectively support a robust strategy, in the context of environmental shifts. The Figure below outlines this logic through the ESCO model (Environment, Strategy, Core Competencies and Organization)[9] (Fig. 1).

We have discussed above how NASA's environment has shifted (element 1 of the model), becoming more competitive and placing NASA from a position of near monopoly in space-faring competence and resources, to just one from a number of actors nationally and internationally with relevant competencies and resources. The external political environment has also shifted, leading to internal resource constraints at the organizational level (element 4). This led to a drive to operate more efficiently and engage external contractors as long term partners in project delivery, to support NASA's core competencies (element 3) of innovation and technological excellence. These changes sought to realign NASA's organization with a changed environment.

A historical, strategic perspective however, shows that further changes may be warranted at the organizational level. A key reason NASA was so successful in its first decade, responding to President Kennedy's challenge of putting a man on the moon and returning him safely to earth before the decade was out, was not only the clear, compelling goal and the competition with Russia for space leadership. It was the flexibility that NASA had to accomplish this goal. In terms of element 4 of the model, it was due to the people and process aspects, supported by a highly innovative, hands-on culture. NASA could hire the brightest people, who saw NASA as an energizing, exciting, high technology place to accomplish outstanding things and then perhaps follow up with roles in industry (and often return to NASA with new ideas that could cross-pollinate with existing NASA technologies and processes). With an employee turnover of 10–15% in the 1960s, NASA's employee base could be fully revitalized within around 8 years. Currently the attrition rate of non-retirees is 1.7% (for retirees it is 3.5%), which makes such revitalization challenging. So, our first proposal is: Give NASA flexibility to manage its human resources and infrastructure based on market-based, competitive, performance-oriented principles. Innovative programs that allow the workforce to easily transition out of and back into NASA should be considered. An example of a successful government program is Sandia's Entrepreneurial Separation to Transfer Technology (ESTT). It allows Sandia employees to leave the Labs in order to start up new technology companies or help expand existing companies. Entrepreneurs are guaranteed reinstatement by Sandia if they choose to return to the Labs. This will allow brilliant scientists to not only accomplish great things in NASA but can facilitate technology transfer and exchange with industry and universities. It will give the scientists and inventors a chance to gain a different perspective on their technology and inventions prior to returning to NASA.

Secondly, with NASA accounting for 6% of the total global expenditure on space activities, and ambitious space goals announced by other nations, NASA's (and American) leadership and superiority in space are not guaranteed. What is needed is an organizational design that fosters continued development and revitalization of NASA's core competencies (element 3). Our second modest proposal is: It is time for NASA to become a real network organization. One that is properly integrated both internally (across NASA centers) as well as externally with whatever organizations have superior space-related knowledge and technology, wherever

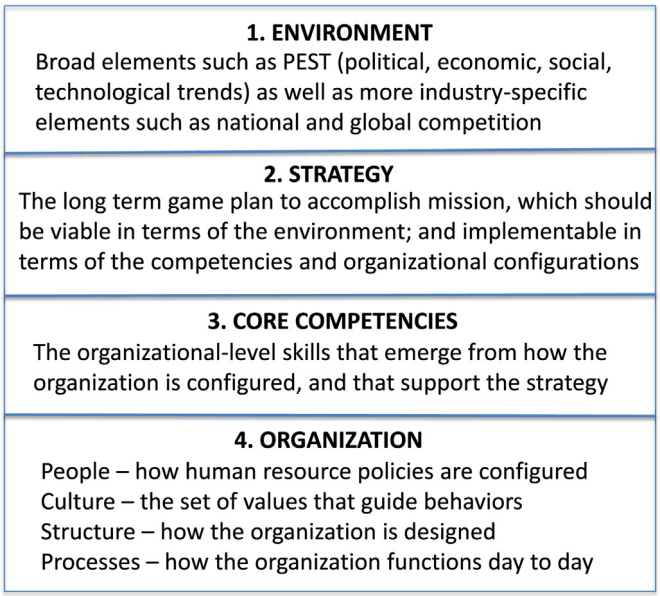

Fig. 1. Strategic alignment through the ESCO model.

[5] NASA Budget, http://www.nasa.gov/news/budget, accessed on 11 May 2014.

[6] NASA, 2013, *Workforce Information Cubes for NASA*, https://wicn.nssc.nasa.gov/wicn_cubes.html, accessed 11 May 2014.

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they are. NASA has already started moving in a network-oriented direction, experimenting with open innovation and collaboration with the private sector. Challenges in working effectively with the private sector remain however, in that many commercial companies have significant cultural differences with NASA. Further, alliances have to be subject of course to proper national safeguards for the protection of sensitive information and national security. Building a real network organization has both strategic dimensions (element 2) and dimensions of organizational structure and processes (element 4). It is a tricky balancing act, but one that must take place.

The above goals cannot be accomplished overnight, and neither can the kind of ambitious, frontier-pushing space missions that would lead NASA to greatness. Clear, long-term objectives, confident leadership, market discipline in human resource and infrastructure decisions, plus effective access to broader networks of leading edge knowledge and technology can act together to propel NASA forward.

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