

## NASA, “Emerging Space: The Evolving Landscape of 21st Century American Spaceflight.” A Review

By Gordon Arthur

### Abstract

This article is a review of NASA’s “Emerging Space: The Evolving Landscape of 21st Century American Spaceflight” report. It explores the history of American spaceflight, explains NASA’s current activity, and discusses how NASA sees its future. It critiques the paper for its general lack of a philosophical argument about why we should explore space, also drawing on the reports “Voyages: Charting the Course for Sustainable Human Space Exploration” and “‘Why We Explore,’ Beyond Earth: Expanding Human Presence into the Solar System” as sources for such a rationale. It concludes that while “Emerging Space” lacks a thorough philosophical grounding for exploring space, it does give an extensive briefing on the current state of the space program, and it points to many practical benefits of the program, using them to justify ongoing exploration.

**Keywords:** Emerging space, NASA, space history, private space exploration, why explore.

### Introduction

According to the authors of this report, “America stands today at the opening of a second Space Age. Innovative NASA programs and American entrepreneurs together are transforming the space industry.”<sup>1</sup> This second space age, in which governments and private sector corporations are co-operating in the exploitation of space, contrasts with the first Space Age, in which only governments had the resources to engage in space travel. The current space landscape extends beyond the geostationary orbit to a height of 36,000 km (22,369 miles) above ground, and it includes a myriad of objects, including GPS, communications, and imaging satellites, which have become essential components of Western economies.

None of the technology involved in the space economy would exist without government-sponsored research. Going forward, NASA expects to see governments pushing technological innovations, but private-sector companies developing and implementing them. To a large extent, this is already happening, with private companies having invested \$2.5 billion in space technology between 2003 and 2013.<sup>2</sup> In addition, NASA has a statutory duty to “encourage, to the maximum extent possible, the fullest commercial use of space.”<sup>3</sup> The report explores the collaboration between NASA and private companies to invest in space, an endeavour it describes as “emerging space.”<sup>4</sup>

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<sup>1</sup> NASA, “Emerging Space: The Evolving Landscape of 21st Century American Spaceflight” (Washington, DC: NASA, 2014), 1.

<sup>2</sup> Ibid. NASA obtained this figure from the Commercial Spaceflight Federation ([www.commercialspaceflight.org](http://www.commercialspaceflight.org)).

<sup>3</sup> Ibid., 2. The source of this obligation is the National Aeronautics and Space Act of 2010, Pub. L. No. 111-314, 124 Stat. 3328, § 20102 (c).

<sup>4</sup> Ibid.

## **History**

NASA outlines the history of American space flight, starting with the Mercury, Gemini, and Apollo programs, and moving on to the Space Shuttle and International Space Station (ISS) projects. Surprisingly, there is no mention of Skylab, the first American space station and, like the Russian Mir, one of the forerunners of the ISS. NASA recognises its ongoing role to offer support to commercial organisations investing and operating in space, while reiterating that the responsibility for the success or failure of these operations lies within the private sector.

## **Economic Development**

The sections on economic development focus on the ISS. The ISS is “a partnership between the United States, Russia, Europe, Japan, and Canada, with 15 nations coming together to design, assemble, occupy, and conduct research inside and out.”<sup>5</sup> Over the last decade, government and the public sector have been the primary users of the ISS. Going forward, NASA is seeking “a broader array of partners”<sup>6</sup> and is pursuing the economic development of the ISS. The paper lists a number of universities and businesses that are using the ISS for research.

In addition, NASA is now purchasing flight services from companies such as SpaceX and Orbital Services to send cargo to and from the ISS, thereby saving NASA considerable amounts of money (the report was released before the explosions of the Orbital Services Antares rocket on October 28, 2014 and Virgin Galactic’s SpaceShipTwo on October 31, 2014). To date, NASA has invested \$5.7 billion in contracts and agreements for commercial crew and cargo services.<sup>7</sup>

## **Technology**

NASA is engaging with the private sector to develop technologies such as solar electric propulsion, cryogenic propellant storage and transfer, and laser communications. It is doing so through programs such as the NASA innovative advanced concepts program, space technology research fellowships, the flight opportunities program, and a variety of small satellite programs. This section is fairly general and lacks detail, presumably to protect sensitive commercial information. The report lists all space facilities within the United States, both pre-NASA and current, both government and privately owned, and gives explanations of what each facility does. In addition, NASA reports on a number of emerging states that have recently become involved in space activities.

## **Entrepreneurship**

The report gives a history of entrepreneurs involved in space exploration, citing Andrew Carnegie, who largely funded the Mount Wilson Solar Observatory, and Daniel Guggenheim, who provided grants for Robert Goddard’s rocketry experiments, among others. It then gives profiles of some current entrepreneurs, such as Robert Bigelow and Jeff Bezos. It lists the major space companies, explaining the projects in which they are involved and the vehicles they use or plan to use. The projects range from suborbital

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<sup>5</sup> Ibid., 5.

<sup>6</sup> Ibid.

<sup>7</sup> Ibid., 7. See also Table 1 on page 8.

and orbital launch services to remote sensing, LEO human spaceflight, and missions to the Moon, asteroids, and Mars.

### **From a Spacefaring Nation to a Nation of Spacefarers**

Since 2001, seven people have bought orbital flights for between \$25 and \$35 million each.<sup>8</sup> This number is bound to increase. With Virgin Galactic (despite its recent accident), Blue Origin, and XCOR all committed to offering commercial suborbital flights, the number of humans in space is likely to more than double from the current 500 or so in the coming years. Lady Gaga, Tom Hanks, Angelina Jolie, and Brad Pitt have all purchased tickets for such flights. One of the major attractions of spaceflight for most of them seems to be seeing the curvature of the Earth from space (of course, this can already be seen, to a much lesser extent, from commercial airliners).

Other companies are developing high-altitude balloons with the same intention. Felix Baumgartner broke multiple world records and gained worldwide publicity with his successful 39 km (24 mile) parachute jump from a balloon on October 14, 2013. In 2013, NASA received 6,300 applications for eight vacancies in its astronaut program. This indicates that interest in and demand for spaceflight is growing, and this may lead in due course to one or more private-sector astronaut corps in addition to NASA's government corps.

### **Private Inventors**

While most of the funding for rocketry technology came from military sources following World War II and during the Cold War, much early experimentation in spaceflight came from citizens working in their garages and supported by private investors. Robert Goddard is a prime example of this.

In recent years, private inventors have started to work on satellites, using kits developed by NASA in the 1990s to encourage university research. NASA has launched 115 such satellites since 2009. Sometimes, garage-based projects can develop into multi-million dollar businesses, as Planet Labs did. Thomas Mueller's garage-based rocketry research attracted the attention of Elon Musk, and led to the development of the Falcon 9 rocket, which has had nine successful launches. NASA wants to encourage such innovation, and offers a number of challenges and prizes as incentives.

### **Prizes and Challenges**

Since 2007, NASA has awarded more than \$6 million to 16 winning teams out of more than 5,000 individual and 117 corporate entries to competitions. NASA's Centennial Challenges program

seeks to drive progress in aerospace technology, encourage participation in aerospace research and development, and find the most innovative solutions to technical challenges through competition and cooperation. Seven challenges have been initiated during the past eight years, with

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<sup>8</sup> One participant has flown twice, bringing the total number of flights to eight.

objectives including lunar lander demonstration missions, power beaming, and improved astronaut gloves.<sup>9</sup>

Not all prizes are offered by government agencies. Virgin Galactic won the \$10-million Ansari X Prize for scaled composites in 2004 for the successful flights of SpaceShipOne, which was a major milestone in private spaceflight development. The Google Lunar X Prize offers \$40M to a private team that lands safely on the Moon, travels 500 metres above, below, or on the lunar surface, and sends back two Mooncasts to Earth. The prize expires on December 31, 2015, and, in light of recent events, it is therefore unlikely to be claimed unless it is extended.

### **Crowdsourcing and Crowdfunding**

NASA invites public participation through crowdsourcing, in which the public is invited to contribute “services, ideas, or content with an aim toward advancing the agency’s mission,”<sup>10</sup> and encourages crowdfunding of private initiatives. Crowdsourcing allows NASA to sort through large volumes of data more quickly than it otherwise could and gives interested individuals real-world experience in space science. NASA provides a large number of online tools to assist in this endeavour. To date, crowdfunding has raised more than \$2 million for a variety of private space projects.

### **Emerging Space in 2044**

Finally, NASA gives a vision of how the space landscape might appear in 2044. This includes mining near-Earth asteroids, human exploration of Mars, commercial space stations, and a base on the Moon used as a proving ground for deeper space missions.

NASA states that its goal has shifted from going somewhere (the Moon) to enabling capabilities to explore, pioneer, and develop the space economy. It realises that this will happen through a partnership of government and private industry. The report concludes:

NASA is proud to recognize that American spaceflight—after sparking, nurturing, and carrying its flame for over half a century—is not just about us anymore. This economic and cultural transition in the American space industry and in American spaceflight culture is an exciting one and it will further NASA’s mission of advancing exploration and discovery. Our continued national leadership in spaceflight relies on the ability to adapt our habits and strategies for success when needed. NASA will continue to be the world leader in space exploration. It is that role of leadership that is expected of NASA by American citizens and by the world. It is exciting to consider that as we move farther into the 21st century that leadership will be expressed as much by the American private-sector space activities that NASA supports and enables as it is by our own missions. Realizing this broader role of leadership is a significant part of the challenge—and the adventure—that lies before us.

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<sup>9</sup> *Ibid.*, 27.

<sup>10</sup> *Ibid.*, 29.

## **Discussion**

This report offers a great deal of encouragement for the private space industry. Having a body with NASA's worldwide reputation committed to supporting privateers and encouraging crowdfunding, albeit with limited resources, can only aid progress in this field. NASA's acknowledgement of the need to move from public-only projects to public-private partnerships is also welcome. The report gives a thorough briefing on NASA's facilities and their capabilities. These facilities are present in every region of the United States, which should aid accessibility to entrepreneurs. It emphasises the impact space technology, and in particular satellite technology, is having on ordinary life.

There are, however, a few omissions. Given NASA's desire to engage more countries in the ISS and other projects, it would have been nice if NASA had said at least something about the joint ventures in which it is involved, such as the NASA/ESA Hubble Space Telescope, and other joint ventures it might wish to pursue in the future, rather than concentrating exclusively on its work in the United States. NASA's duty is, after all, to encourage "the fullest commercial use of space,"<sup>11</sup> not just the fullest American commercial use of space, although work within the United States will obviously receive the majority of its attention and is the principal subject of the paper.<sup>12</sup> More detail and depth on the non-sensitive aspects of technological development, perhaps also with a more international perspective, would have been useful, as would a brief account of some the useful, if more mundane, inventions that have already resulted from the space program, such as Velcro.

More fundamentally, the report concentrates on the what and how of space exploration, but says little about why it should be encouraged, although it does cite the 2012 NASA report "Voyages: Charting the Course for Sustainable Human Space Exploration"<sup>13</sup> as a source for its philosophy of space travel. This document states that curiosity is a driving force behind space travel and that pushing the boundaries of knowledge has provided tangible benefits to society. It states that technological developments in space have applications on Earth, and can be ways to engage the next generations to pursue careers in science. It states that the reasons for exploring cis-lunar space are to increase scientific knowledge, to promote technical and economic growth, and to pave the way for future exploration. It states that visiting asteroids may teach us about Earth's heritage and the origins of life, may help us to protect the Earth, may allow us to assess the resources available in space, and may act as a stepping stone for journeys to Mars. It states that visiting the moon may help us to understand the origins of the solar system, to sustain life off Earth using local resources, and to encourage international collaboration. It states that Mars provides the opportunity to test whether humans can live for long periods away from Earth, which will be essential if missions into deeper space are to be considered.

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<sup>11</sup> *Ibid.*, 2.

<sup>12</sup> However, Virgin Galactic is owned by British tycoon Richard Branson, so the international scene is not entirely excluded.

<sup>13</sup> This can be found at [www.nasa.gov/sites/default/files/files/ExplorationReport\\_508\\_6-4-12.pdf](http://www.nasa.gov/sites/default/files/files/ExplorationReport_508_6-4-12.pdf). NASA gives a different URL. See also "Why We Explore," *Beyond Earth: Expanding Human Presence into the Solar System*, [www.nasa.gov/exploration/whyweexplore/why\\_we\\_explore\\_main.html](http://www.nasa.gov/exploration/whyweexplore/why_we_explore_main.html).

In short, it emphasises the practical over the theoretical by majoring on the large-scale tangible benefits that have resulted from space exploration. While this is, perhaps, not surprising from a government agency, it would also be nice to have a statement of the theoretical reasons for space exploration as well. These might include the human drive to explore and to overcome challenges and obstacles, pushing back the boundaries of the achievable, in addition to natural human curiosity. Nevertheless, both “Emerging Space” and “Voyages” make compelling cases for ongoing space exploration.

### Conclusion

The overall impression of the report is a celebration of the first 50 or so years of NASA and a look forward to what it might do in the next 50 years. While it lacks a thorough philosophical grounding for why we should explore space, it does give an extensive briefing on the current state of the space program, and it points to many practical benefits of the program, using them as justification for ongoing exploration. It presents a credible account of the past and a plausible vision of the future. It is therefore well worth reading.

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**About the Author:** Gordon Arthur is the author of *Law, Liberty and Church: Authority and Justice in the Major Churches in England* (Aldershot, Ashgate, 2006); “The Development of Canonical Jurisprudence in the Roman Catholic Church and the Church of England”, *Ecclesiology* 4 (2008): 308-25, *On Frustrated Vocation* (Ilford: FeedARead, 2012), and “Religion and Values: Cosmic or Universal Ethics?” *Journal of Space Philosophy* 3, no. 2 (Fall 2014): 23-31. He gained a BSc in Physics from Birmingham University in 1984, an MA in Philosophy of Religion from King’s College, London in 1998, and a PhD in theology, also from King’s College, London in 2004. Gordon is Associate Editor of the *Journal of Space Philosophy*.



**Editor’s Notes:** Thanks to Dr. Gordon Arthur for this review of NASA’s 2014 Report *Reviewing Spaceflight*, citing the transformation of the Space commercial industry and predicting a second Space Age. His notes on what was omitted from the report are relevant to the mission of Kepler Space Institute’s *Journal of Space Philosophy*. Readers will find in the press releases for past issues, Article 5 of this Spring issue, the systems approach to subjects from philosophy to physics and from Earth’s nation-states to the Universe. **Bob Krone.**