Innovation Policies in the United States

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About Me

Work at IDA Science and Technology Policy Institute (STPI), a Federally Funded Research and Development Center (FFRDC) that supports the Office of Science and Technology Policy (OSTP) within the Executive Office of the President of the United States

Focus on space policy for OSTP, NASA, FAA, and other space agencies

Outline

- Context - History of Innovation Policies in the United States
- Enablers of Innovation—not all are policies—in the Space Sector
- Examples from Ongoing Efforts
- Future Directions

Broadly defined, innovation is the implementation of something new and useful.

Four Major Innovation Organization policy Moments for the US Federal Government

- **Connected, challenge model.** During WW2, the US had a innovation system driven by science connected with societal challenge, where breakthroughs in science were immediately harnessed (MIT Rad Labs, Manhattan Project)
- **Basic science-focused, disconnected, decentralized model.** Soon after that, the linear model went into effect – and the Cold War helped drive a basic research "pipeline" model for new and expanded science agencies. This system was disconnected from the later stages of innovation
- **'Right–left' translational model—**decide the technologies you require from the right side of the innovation pipeline, then nurture breakthrough science advances on the left side of the pipeline to achieve that goal**.** Sputnik aftermath with the formation of the Defense Advanced Research Projects Agency and scaled up funding for science
- **Spanning the 'Valley of Death' Model.** Competitiveness era programs of the 1980s (Bayh Dole Act, MEP, ATP, SBIRs, Sematech) that bridged basic research and use by industry
- **Back to the Connected Model (but legacy sectors).** Technology implementation in Legacy Sectors. Obama Administration's energy technology shift driven by energy and climate demands, and advanced manufacturing driven by the need to link innovation with production

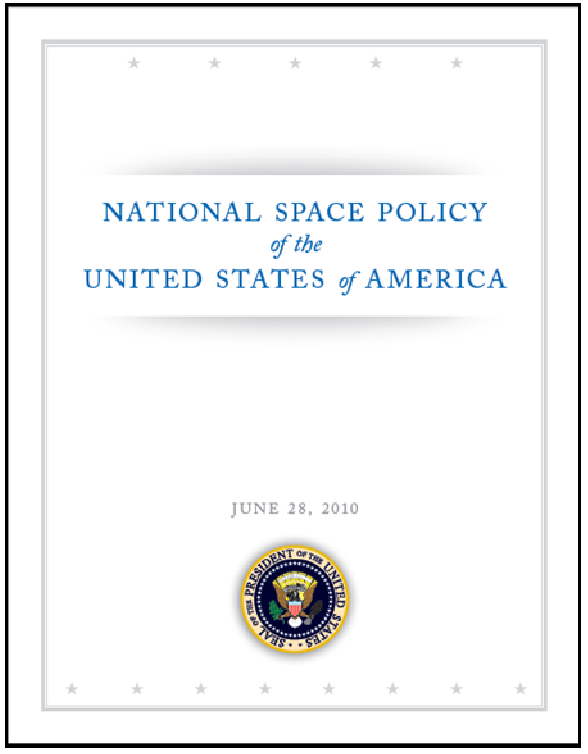
Linear Model was an anomaly in the system! Not that basic research is not important, but that it must be complemented with additional institutional elements that reach much further down the innovation pipeline to development and later innovation stages

Source: https://www.researchgate.net/publication/274502255_The_new_model_innovation_agencies_An_overview

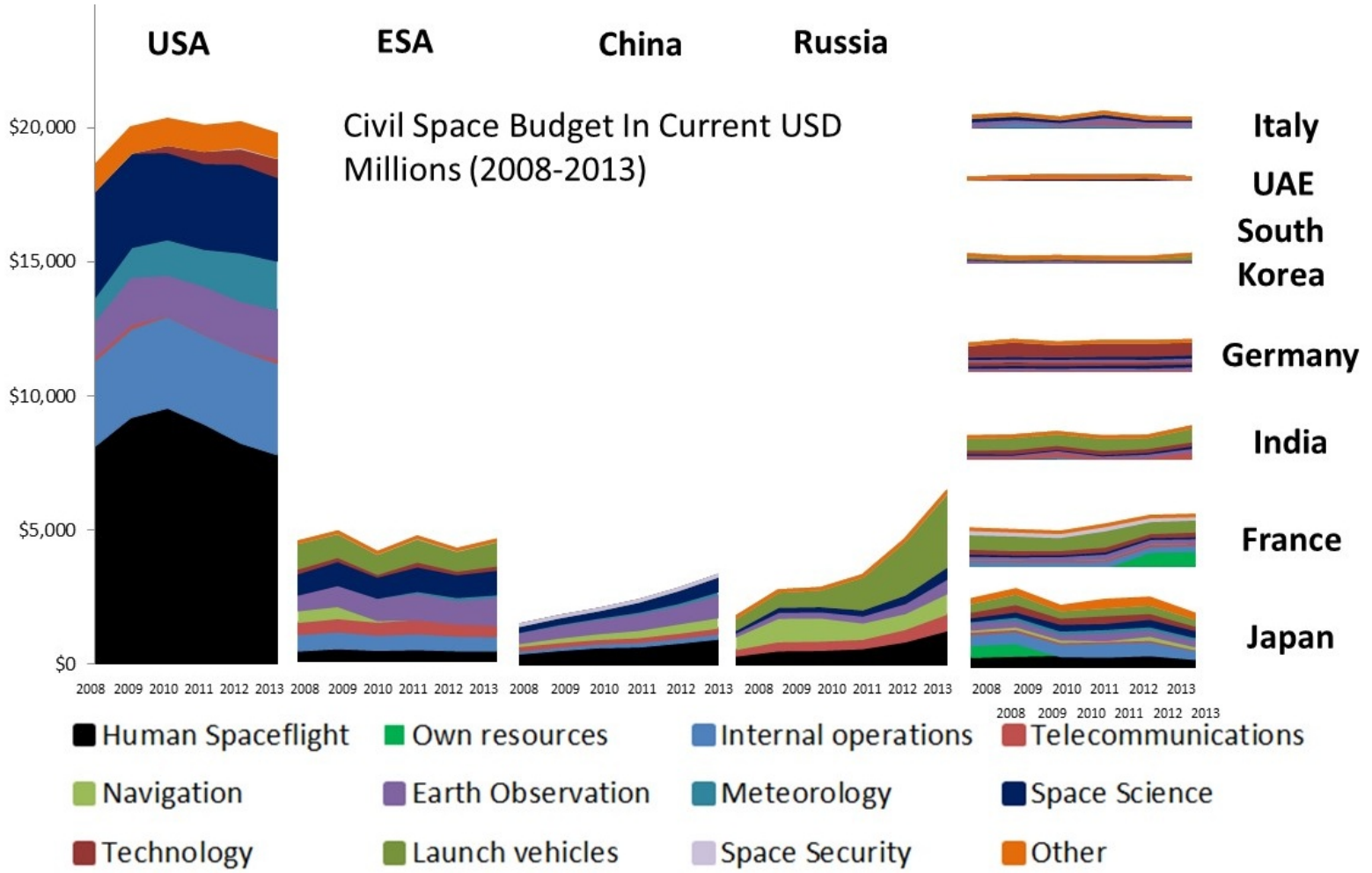
Innovation Policies in Space in the United States

Government Guidance

- Executive Branch
  - National Space Policy
  - National Security Space Policy
  - National Space Transportation Policy
  - (Agency Level) Strategies
- Legislature
  - Commercial Space Launch Act
  - Agency Authorizations



Federal [and State] Funding



- US total space expenditures may exceed that of the entire world combined
- Civilian expenditures may be higher than the next 19 countries combined

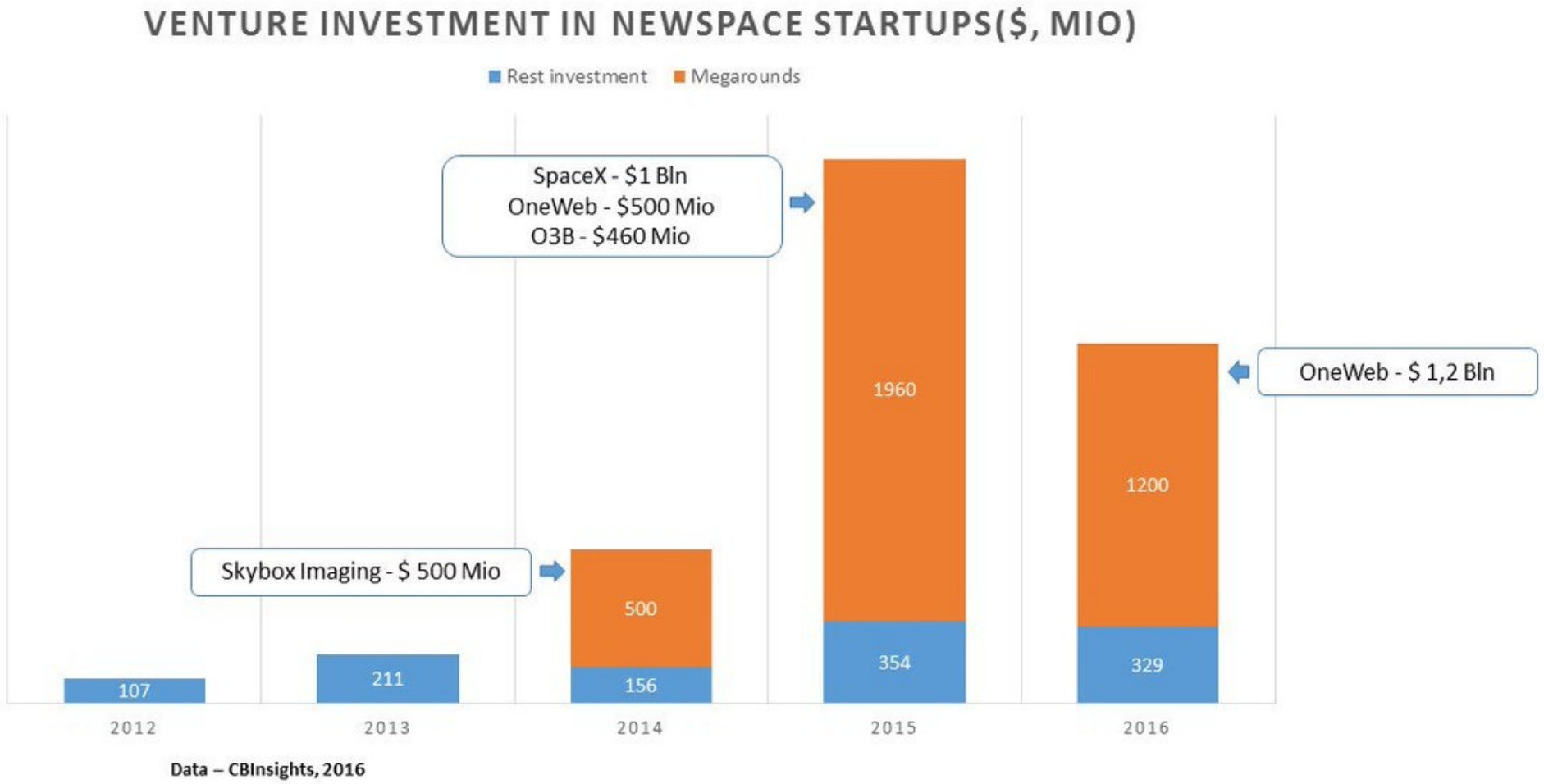
Source: Global Trends in Space, https://www.ida.org/idamedia/Corporate/Files/Publications/STPIPubs/2015/d5682final.ashx

Experimentation with Funding Mechanisms

- Grants, contracts, and other custom instruments (e.g., OTA, Space Act Agreements)
  - NASA use of SAA for Commercial Cargo
- Crowdfunding
  - IARPA: Functional Map of the World Challenge (to use data analytics to identify building functions and land use) in 2017
- Prizes
  - Google Lunar X Prize (landing a commercial rover on the moon by the end of 2017) attracting entrepreneurs and media attention, but also motivating the established industry

Private Funding (in maturing early stage research) including Venture Funds

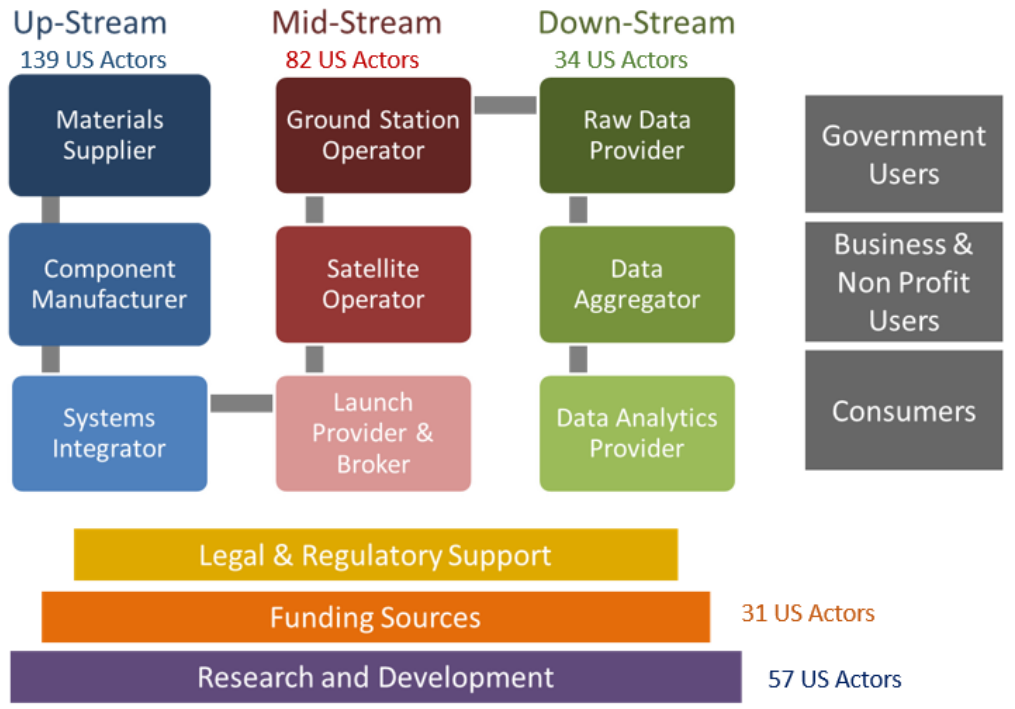
Note size difference from government R&D funding of space: ~$40-50 billion annually



Source: https://twitter.com/germanorbital

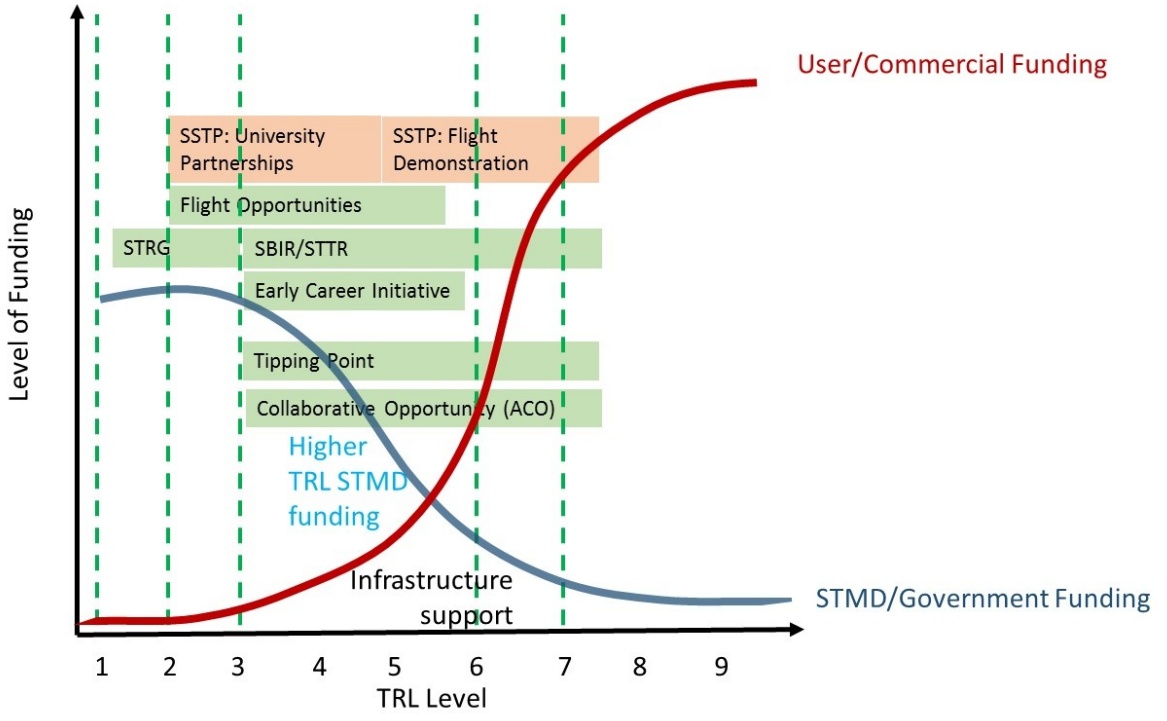
A Thriving Ecosystem of Actors – Critical Mass

- Large “primes” play a significant role – both with respect to building systems, but also spending internal R&D funds
  - Lockheed Martin’s IRAD is $750 million
- Emerging NewSpace ecosystem (see STPI reports)
- Public research institutions and universities emphasize high risk high payoff research, and train students
  - Start-ups associated with universities
    - Accion emerged from MIT
    - Skybox emerged from Stanford University
    - Planet emerged from NASA Ames Lab
- Government corrects for market and systemic failures, funding research and being a steadfast customer



Mechanisms to Take Innovations up Value Chain

- Ensuring a robust pipeline - connecting low TRL programs with higher TRL ones within and across agencies
- Ensuring passage through the valley of death - specific programs that support research too far down the continuum to be of interest to academics and too preliminary to be of interest to commercial actors

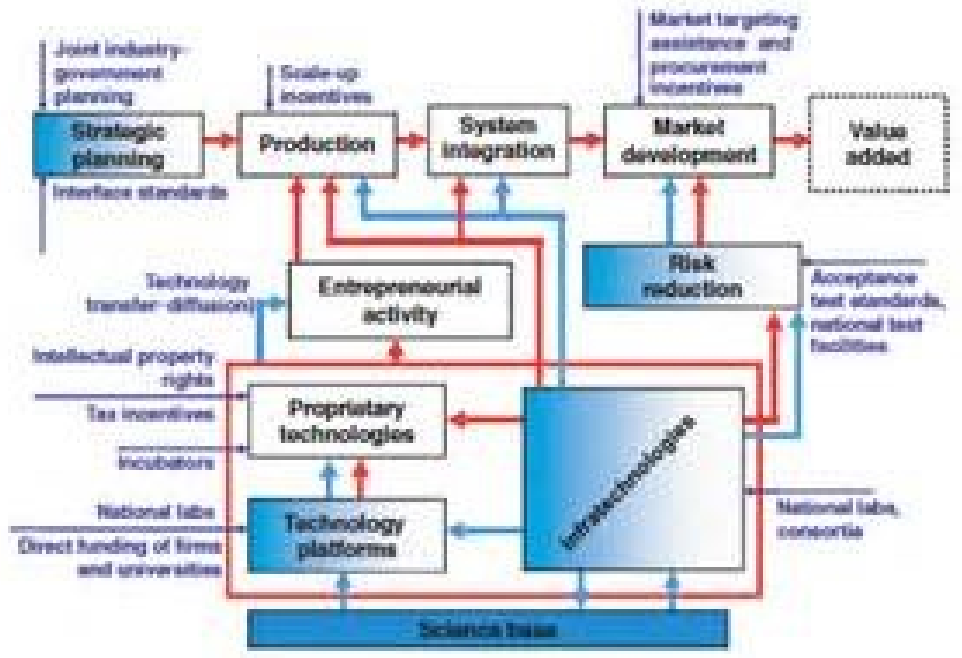


Light Touch Regulation

- (Congress) US Commercial Space Launch Competitiveness Act
  - Provides long-term extensions of the “learning period” that limits the Federal Aviation Administration’s ability to enact regulations regarding the safety of spaceflight participants, as well as for government indemnification of third-party damages for commercial launches beyond a level that the launching company must insure against
- (Administration, under review) Mission Authorization
  - Addresses Outer Space Treaty and other issues for in-space activity

Support of Industrial Commons

- Availability of public testing services and facilities to speed up the development of technology prototypes and flight-qualified hardware and software
- Clusters, incubators and platforms of cooperation to foster interactions between diverse actors, and accelerate the growth and success of entrepreneurial companies
- Examples
  - NASA Flight Opportunities Program - suborbital research flight
  - CubeSat Launch Initiative - free launch opportunities for research cubesat missions
  - Support of Silicon Valley like approaches



Source: Tassey, 2016

Intangible Factors

- United States can attract the best talent from around the world
  - Makes it easier to develop world class educational institutions (when combined with government and private financial support)
- Institutional support of innovation/entrepreneurial activity
  - Less red tape/bureaucracy
    - NASA, ARPA agency use of “other transaction authority”
  - Tax policies that support R&D
  - Bankruptcy laws that allow for recovery from failure
- Positive attitude and trust of the US society towards science and scientific institutions.
- A “cowboy” culture that lionizes – and doesn’t punish -- risk-taking

Example – NASA's Use of Public Private Partnerships to Develop New Technology

- Commercial Orbital Transportation Services (COTS) program awarded $788 million to develop new solutions for cargo delivery to the International Space Station
  - This constituted less than half of the total development costs
  - Rest covered by the first contracted companies, SpaceX and Orbital
- Similar efforts underway for commercial crew, on-orbit assembly and manufacturing, and others

Example – NASA's Use of Fixed Price Contracts with "Milestone Payments" to Control Costs

- Throughout these contracts, NASA signed *fixed price contracts*--as distinct from cost plus fee contracts which have no incentives to control costs
- In addition, payments were made as pre-negotiated *milestones* were achieved to ensure government received value for its investment

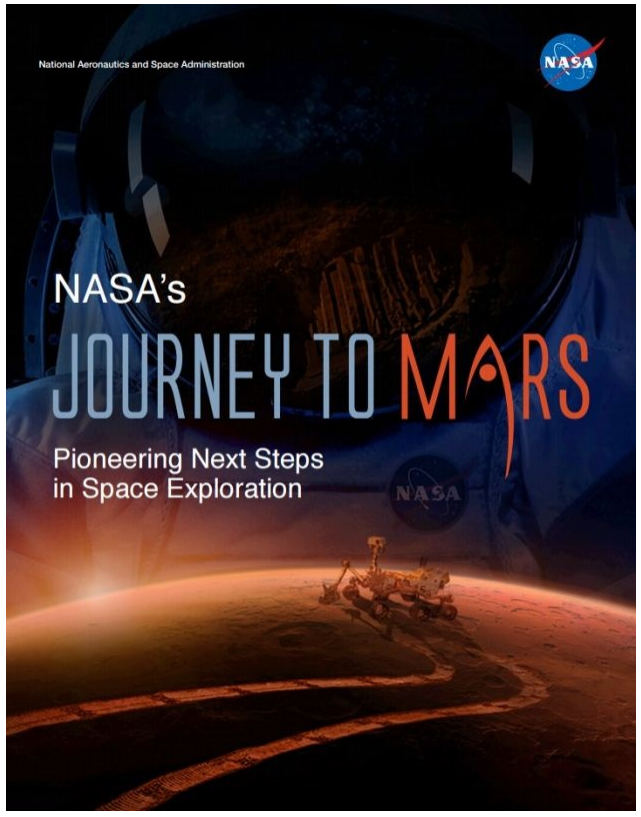
Example – NASA's Use of Prizes to Spur Innovation

- Centennial Challenges Program ($4 million annually)
  - Sample return robot challenge - demonstrating autonomous robotic capabilities to locate, retrieve and return specific sample types to a designated zone
  - Vascular tissue challenge - targeting ways to create human vascularized organ tissue in a controlled laboratory environment
  - Mars ascent vehicle prize - technologies to return samples from Mars)
  - CubeQuest challenge (i.e. developing small satellites capable of advanced operations near and beyond the Moon

- Policy support - In 2010, the US National Space Policy encouraged use of prizes and challenges to spur innovation

Example – NASA's Use of Commercial Data Buys to Make Science More Affordable

- Science Mission Directorate experimenting with new business models for collecting scientific data
- It has recently announced plans to spend $30 million to purchase Earth science data, specifically Global Positioning System radio occultations, which provide information on atmospheric conditions, and medium-resolution multi-spectral images
- The data purchase would help evaluate the research utility of the data



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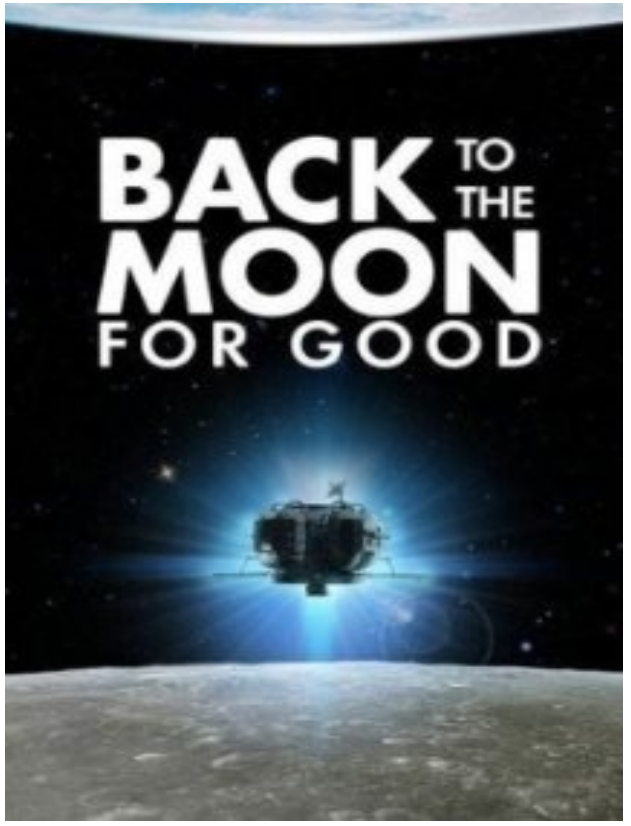


Future

Prediction is very difficult, especially about the future. Neils Bohr

Current Administration – What we *know*

- No mention of space in the President's 100-day agenda
- Mick Mulvaney, nominated to serve as White House budget director, has a track record for trying to reduce discretionary spending
- Cabinet member represent the business sector and display preference to scale back regulation
- Relevant budget proposals from advisors have sought major cuts to discretionary spending overall and targeted certain areas of science and technology for cuts, particularly energy, climate, and applied technology programs
- There is continued recognition, even among ardent spending hawks, that discovery science is something government should do, within certain bounds
- Presidents are not that powerful - Congress will have the final say on spending

A pivot to deep space, with the private sector, driven by goals of national pride and economic growth

"I will free NASA from the restriction of serving primarily as a logistics agency for low-Earth orbit activity—big deal … Instead, we will refocus its mission on space exploration. Under a Trump Administration, Florida and America will lead the way into the stars.

A cornerstone of my policy is we will substantially expand public private partnerships to maximize the amount of investment and funding that is available for space exploration and development …This means launching and operating major space assets, right here, that employ thousands and spur innovation and fuel economic growth."

Candidate Trump, October 20, 2016

"We stand at the birth of a new millennium, ready to unlock the mysteries of space, to free the earth from the miseries of disease, and to harness the energies, industries and technologies of tomorrow … A new national pride will stir ourselves, lift our sights and heal our divisions."

President Trump, January 20, 2017

- National Pride
- Focus on Deep Space
- Economic Growth
- National Security
- Private Sector

An Executive Branch Change Proposed -- Creation of a National Space Council

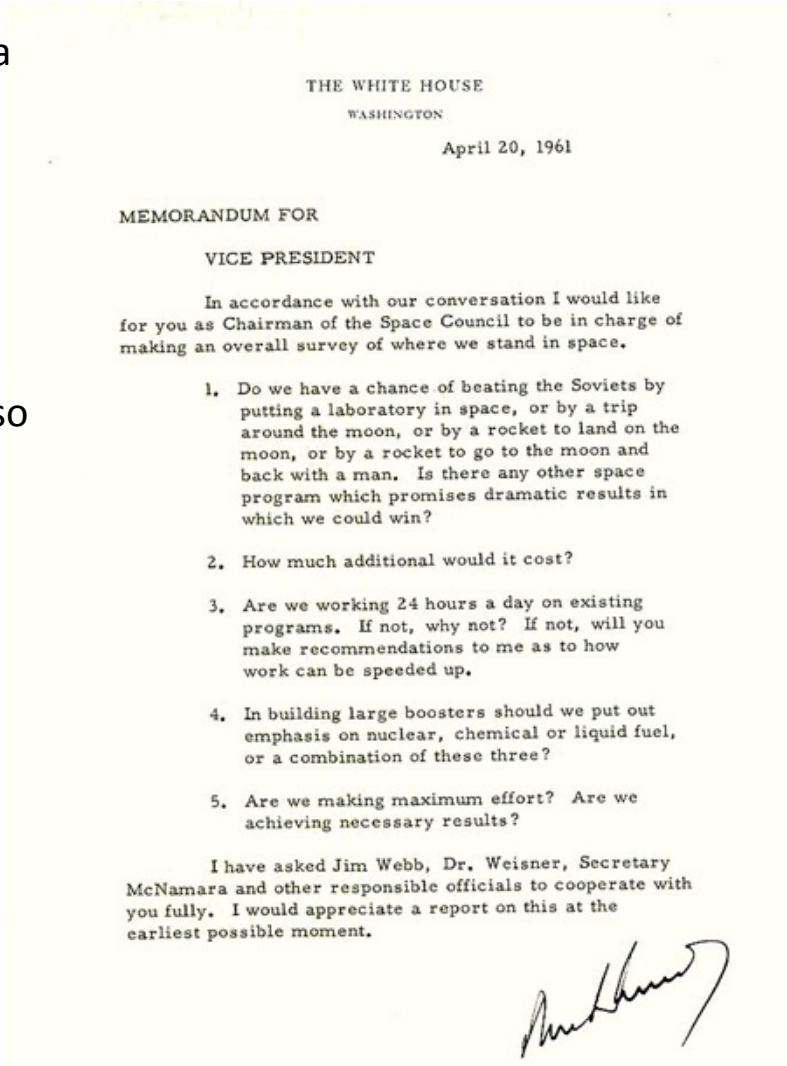
- National Space Council was a body within the Executive Office of the President of the United States during 1989-1993; modified version of the earlier National Aeronautics and Space Council (1958-1973); disbanded in 1993 and its functions absorbed by the National Science and Technology Council
- Proposals that a National Space Council be recreated and headed by the Vice President have been made
- Goal TBD but could be to
  - Evaluate how national priorities should be set across the whole of the space community
  - Decide what role government should play in achieving those priorities in civil, commercial, and military space, and how the private sector should participate

Current Congress

- Strong interest in keeping heavy launch (SLS) and capsule (Orion) programs running
- Some would like to see NASA earth science funding scaled back and redistributed to other NASA programs; and climate change/science shifted to NOAA or eliminated
- Interest in a return to the moon
- Greater interest in maintaining defense spending – focus on military readiness and modernization; research and advanced technology would likely benefit

If politics trumps science, it would not be the first time

- After Gagarin achieved spaceflight in 1961, President Kennedy wanted to beat the Soviets in a decisive way
- **Even though establishing presence in low earth orbit would have been the right start for a national space program, the moon was chosen because of the potential for this decisive victory (see memo)**
- Even after picking the moon as a destination (not ideal), Kennedy put NASA in the position of finding a technical approach to Apollo that gave the best chance of meeting an unrealistic (also driven by politics) deadline
  - development of the very powerful Saturn V launcher
  - the choice of the lunar orbit rendezvous approach
  - design of the lunar module spacecraft optimized for landing on the Moon.
- None of these capabilities were relevant to any politically feasible post-Apollo space effort
- As a result, NASA entered a four-decade identity crisis from which it has yet to emerge – we keep looking for the “next moon shot”
- No other post Apollo activities have been satisfying substitutes for another Apollo-like undertaking.
- NASA has never totally adjusted to a lower priority in the overall scheme of national affairs



THE WHITE HOUSE

WASHINGTON

April 20, 1961

MEMORANDUM FOR

VICE PRESIDENT

In accordance with our conversation I would like for you as Chairman of the Space Council to be in charge of making an overall survey of where we stand in space.

1. Do we have a chance of beating the Soviets by putting a laboratory in space, or by a trip around the moon, or by a rocket to land on the moon, or by a rocket to go to the moon and back with a man. Is there any other space program which promises dramatic results in which we could win?

2. How much additional would it cost?

3. Are we working 24 hours a day on existing programs. If not, why not? If not, will you make recommendations to me as to how work can be speeded up.

4. In building large boosters should we put out emphasis on nuclear, chemical or liquid fuel, or a combination of these three?

5. Are we making maximum effort? Are we achieving necessary results?

I have asked Jim Webb, Dr. Weisner, Secretary McNamara and other responsible officials to cooperate with you fully. I would appreciate a report on this at the earliest possible moment.

Summary

- Innovation policies in the United States have changed over time: from those supporting the “connected” model (WW2), to supporting a “linear” model, to supporting “valley of death” model, to all models at once
- Today there are a variety of policy instruments supporting different performers at different stages of the innovation continuum
  - Ensures a plurality of innovation activities
  - No evidence what works better than others – lots of experimentation underway
- There is no innovation policy that can compete with attracting the brightest people in the world and giving them a lot of money *and* autonomy to change the world!
- Future of innovation policy in space in the US is unclear but five factors will play a role – national pride, security, beyond LEO, economic growth, and private sector leadership