**FINAL DRAFT – Citations Reformatted**

**Vertical 3. Identify and pursue Grand Challenges**

|  |
| --- |
| **Outline:**   1. **An “elevator pitch,” which provides highlights of the content, such as why the approach is important, how it works, and examples of where it has worked.** 2. **A short, digestible summary of underlying premises and rationales, supported by research (i.e., not a report).** 3. **Profiles of major categories of candidate users, including specific examples of when, and under what circumstances, the approach may be employed, supported by research into the target audience and their needs.** 4. **One or more “success stories” or other learning narratives that highlight the impact of and justification for using this approach.** 5. **Documentation of challenges to deployment, and potential limitations of the approach, including barriers or obstacles encountered within agencies employing the approach.** 6. **A “How-To” document, detailing key steps for deploying the approach, including promising practices in adaptation and deployment.** 7. **An online inventory of resources.** 8. **Examples of policy (e.g. legislation, Executive Order, etc.) that have enabled or encouraged the approach.** 9. **Future directions (next practices as opposed to best practices).** |

#### Pull quotes: [[For web designer]]

“A Grand Challenge can create and disrupt powerful culture and power paradigms inside of an industry or organization, embracing new players and stimulating long-time experts to lead differently.” Dave Ferguson, Director for the Center for Development Innovation, the U.S. Global Development Lab at USAID [Ferguson D., personal communication with Policy Design Lab, November 10th, 2016]

“The secret sauce to a Grand Challenge is in the goal definition. Everything else is about creative program design.” Cristin Dorgelo, Chief of Staff at the White House Office of Science and Technology Policy (OSTP) and formerly Vice President of Prize Operations at the XPRIZE Foundation [Dorgelo C., phone interview with Policy Design Lab, August 3rd, 2016]

“By defining our goal more clearly, by making it seem more manageable and less remote, we can help all peoples to see it, to draw hope from it, and to move irresistibly towards it.” President John F. Kennedy

#### Deliverable 1: Elevator pitch summary

[[Website embed: [18 second clip of Obama introducing Grand Challenge concept](https://www.youtube.com/watch?v=i6v5EFYnPjE)]]

A “Grand Challenge” is an articulation of an ambitious yet achievable goal that captures the public’s imagination. The power and the value of the Grand Challenge framework lie in its ability to galvanize action. By using Grand Challenges to issue a call for new and audacious thinking, agencies can catalyze significant advances for national priorities. A pioneering vision, large-scale collaborative effort, and an ambitious but concrete target are the defining hallmarks of Grand Challenges that spur transformative breakthroughs:

##### **Grand vision:** Explicitly setting grand, ambitious targets – like making solar energy as cheap as coal, understanding the human brain, or destroying cancerous tumors while leaving healthy cells untouched – galvanizes public excitement and draws in new communities of solvers. The term itself suggests a sense of daring and boldness is required [Hicks, D., "[Grand Challenges in US Science Policy Attempt Policy Innovation](https://works.bepress.com/diana_hicks/38/)," International Journal of Foresight and Innovation Policy, 2016, pp. 5]. Grand Challenges must be captivating and intrinsically motivating, so much so that many people should be willing to devote a good chunk of their career to the pursuit of one of these goals.

##### **All hands on deck:** Grand Challenges can accelerate the rate of progress on sticky problems by engaging a coordinated, “all-hands-on-deck” approach with multi-sectoral collaborations. Agencies can augment their impact by involving contributions from other agencies, foundations, research universities, companies, and citizens.

##### **Ambitious yet achievable:** The key lies in a willingness to set bold, audacious goals: Historical examples include landing a man on the moon, the Human Genome Project, and Wikipedia. But Grand Challenge targets must be well defined with a “Goldilocks” level of specificity and focus. “Improving the human condition” is not a Grand Challenge, because it does not provide enough guidance for what to do next or how to measure progress. While “landing a man on the moon and returning him safely to the earth” is daring and ambitious, it is also inherently clear whether it has been achieved.

##### **Flexible framework:** Grand Challenges are galvanizing frameworks through which a variety of implementation mechanisms can be used to engage new solvers – including challenge funds, prize competitions, crowdsourced innovations, and strategic partnerships.

##### **Why**

Consider using this framework when confronting open-ended policy challenges of considerable magnitude and complexity where there is no obvious solution, but it is possible to envision a different path forward. The call for a Grand Challenge is a priority statement; when it is followed by concerted effort to source new thinking and spur new collaborations through a variety of implementation modalities, there is potential for significant progress. Grand Challenges are powerful levers for shifting the framework not only in science and research policy, but also for domains such as health, energy, sustainability, education, economic opportunity, national security, and human exploration.

Grand Challenges can address the biggest problems of our time by:

* Helping to create the industries and jobs of the future;
* Expanding the frontiers of human knowledge about ourselves and the world around us; and
* Serving as a “North Star” for collaboration between the public and private sectors. [CROSSLINK PPP]

**How**

Grand Challenges are best suited for confronting open-ended, sticky problems with no pre-defined solutions, where “what if?” ambitious thinking can generate new approaches. It’s an appropriate tool to consider for societal challenges that need to be worked at scale and with an interdisciplinary approach. Grand Challenge deployments are unique to each agency context, but three overarching themes emerge from program designs:

* An intermediate timeframe (not a year, and not 50 years)
* A quantified target
* Some commitment of resources

The quantified target – “We need to develop more effective ways of treating cancer” – functions as a declaration of priorities. But the resources marshaled to support this call to action can vary tremendously as appropriate for an agency’s needs, either with the use of challenge funds, prizes, public private partnerships, or use of administrative authority. Agencies take a lead role by explicitly articulating important and ambitious Grand Challenge targets, and then convening funding and private sector commitments to help realize those goals.

A number of agencies are already using Grand Challenges to support their missions. For example, [DOE’s SunShot Grand Challenge](http://energy.gov/eere/sunshot/sunshot-initiative) seeks to make solar energy cost competitive with coal by the end of the decade, and [NASA’s Asteroid Grand Challenge](http://www.nasa.gov/feature/what-is-the-asteroid-grand-challenge) aims to find and address all asteroid threats to human populations. USAID has eight active [Grand Challenges for Development](https://www.usaid.gov/grandchallenges) that address challenges in infant and maternal mortality, clean energy for agriculture, water for agriculture, early grade literacy, fighting Ebola, combatting Zika and future threats, accelerating access to off-grid energy, and improving government performance and accountability[[A Strategy for American Innovation](https://www.whitehouse.gov/sites/default/files/strategy_for_american_innovation_october_2015.pdf), National Economic Council and Office of Science and Technology Policy, October 2015].

#### Deliverable 2: Summary of underlying rationales / empirical research

**Benefits of Grand Challenges:**

The identification and pursuit of Grand Challenges has a number of benefits:

* Catalyzing innovations that foster economic growth and job creation;
* Marshaling greater resources with multi-sector collaborations, leading to a greater impact with an “all hands on deck” approach;
* Aligning with the modern collaborative research environment, while offering a “new language” and framework for science and research policy;
* Spurring the formation of multidisciplinary teams of solvers, bringing new expertise to bear on important problems, and encouraging multi-sector collaborations;
* Strengthening the “social contract” between science and society; and
* Inspiring the next generation of scientists, engineers, and entrepreneurs to work on hard and important problems.

Grand Challenges can catalyze innovations that foster economic growth and job creation.

The Human Genome Project demonstrates the potential impact of ambitious research undertakings. From 1988 to 2003, the Federal government invested $3.8 billion in the Human Genome Project, which has since generated an economic output of $796 billion; a return of $141 for every $1 invested [Tripp, S. and Grueber, M., “[Economic Impact of the Human Genome Project](http://www.battelle.org/docs/default-document-library/economic_impact_of_the_human_genome_project.pdf)”, Battelle Memorial Institute, May 2011].

Grand Challenges can architect multi-sector collaborations with “all hands on deck” to generate transformative outcomes

Numerous companies have undertaken their own audacious Grand Challenge goals in recent years. Google’s self-driving car [is a direct outgrowth of the DARPA Grand Challenge](http://spectrum.ieee.org/robotics/artificial-intelligence/the-unknown-startup-that-built-googles-first-selfdriving-car). IBM’s advances in AI have been driven by [Grand Challenge frameworks –](http://www-03.ibm.com/marketing/br/watson/what-is-watson/the-next-grand-challenge.html) including Big Blue that beat Gary Kasparov at chess, and Watson which defeated Ken Jennings at JEOPARDY. Companies and philanthropies can also play a role by sponsoring major incentive prize competitions to address Grand Challenges, such as [Qualcomm’s $10 million Tricorder XPrize](http://tricorder.xprize.org/about/overview). Angel, venture, and impact investors could back start-ups that are pursuing Grand Challenges. Large companies could partner with these startups by serving as early customers and providing capital, mentoring, and milestone-based payments. Universities can create and launch learning opportunities, research initiatives, and capital campaigns to focus on ambitious Grand Challenge goals. Media companies and other storytelling enterprises could help elevate the role that Grand Challenges and innovators play in our culture—and help make engineers and entrepreneurs the rock stars of the 21st century. [Crosslink here: Prizes/Challenges,collective impact element of partnerships, citizen science crowdsourcing]

Grand Challenges have potential as a "new language" for research frameworks.

It’s more than a rhetorical device. The Grand Challenge framing syncs with the “group effort” dynamic that increasingly characterizes research, leading some scholars to observe that Grand Challenges support the new emerging paradigm: “In contrast to the tired categories of basic and applied, Grand Challenges offers a research agenda more appropriate to our times, one that combines intellectual and practical motives, generating excitement to address problems so big that they exceed the capacity of specialist communities" [Hicks, D., ["Grand Challenges in US Science Policy Attempt Policy Innovation,"](https://works.bepress.com/diana_hicks/38/) International Journal of Foresight and Innovation Policy, 2016, pp. 12].

Grand Challenges inspires the next generation of scientists, engineers, and entrepreneurs to work on hard and important problems.

In the landmark 2008 [Grand Challenges for Engineering](http://www.engineeringchallenges.org/File.aspx?id=11574&v=ba24e2ed) report, a committee of world-class scientists and engineers issued a clarion call to the engineering field. The vision? For the engineering field – particularly academia – to orient itself around solving the biggest Grand Challenges facing humanity in the 21st century, including long-term energy solutions, carbon sequestration, cyber security, and advancements in personalized medicine. In embracing the Grand Challenge framework on such a fundamental level, the goal is to inspire the next generation to devote their life’s work to solving these audacious challenges. A genuine shift in the field has begun to coalesce: In 2015, deans of 122 engineering programs [announced their commitment](http://www.engineeringchallenges.org/File.aspx?id=15680&v=c29105cb) to integrate Grand Challenge programs into their undergraduate curriculums, pledging that in a decade, 20,000 engineers will be trained to tackle these complex challenges.

**References and further reading:**

Diana Hicks, ["Grand Challenges in US Science Policy Attempt Policy Innovation" International Journal of Foresight and Innovation Policy (2016).](http://works.bepress.com/diana_hicks/38/)

Gerald Holton and Gerhard Sonnett, ["A Vision of Jeffersonian Science." Issues in Science and Technology. Volume XVI Issue 1, Fall 1999.](http://issues.org/16-1/holton/)

#### Deliverable 3: Profiles of major categories of candidate users - examples of when to deploy

**When/How to use**:

Conditions and contexts are optimal for a Grand Challenge when officials are looking to raise the profile of a specific issue, garner multiple and diverse ideas for solving or understanding the problem, and promote cross-sector collaboration between the private sector, universities, researchers, and other public entities. “A Grand Challenge can be a powerful tool to disrupt traditional thinking in a sector and industry and introduce, expand, and evolve what is possible in that industry,” says Alexis Bonnell, Division Chief of Applied Innovation, the U.S. Global Development Lab at USAID [Bonnell, A., personal communication with Policy Design Lab, November 10th, 2016]. It’s most operative in a context where technological progress has shifted our collective understanding, making it conceivable to imagine that - with focused investment and work - we can render possible what was previously unthinkable. Grand Challenges can harness that potential and translate to real progress.

Such lofty narrative language is in fact where Grand Challenges derive their power. Agency practitioners report that the one of the most crucial ingredients for designing a Grand Challenge is articulating a grand vision to convey to the public and stakeholders. The framing helps shift the burden of proof from “Why would we do that?” to “Why *aren’t* we doing that?” The potency comes from articulating not just the grand goal but also making the compelling case for why *now* is the moment for action.

Grand Challenges are powerful but flexible frameworks that accommodate multiple types of modalities. The inherent flexibility has encouraged agencies like USAID to tailor the program design of individual challenges in order to support the greatest holistic impact in each context. USAID has used the Grand Challenge call to action and then follows-on with a variety of tools for sourcing, funding, and implementation:

“The Grand Challenge [framework] allows us to deploy multiple types of methodologies that hit on different parts of that problem; not just the supply of an innovation, but how do we catalyze more of an ecosystem approach, how do we bring more investment to the table? How do we adopt or apply that innovation into a more traditional programming approach? We have different approaches beyond prize and challenge funds to do that in this systems approach. The Grand Challenge gives us that galvanizing force to bring the partners together around the broader goal between this one innovation and the presidential priority. It allows us to play that middle ground of continuing to catalyze and connect these two dots.”

**Seema Patel, Division Chief, Innovation Design and Advisory, the U.S. Global Development Lab at USAID, reflecting how Grand Challenges have been a powerful tool for USAID in their work to tackle critical international development challenges [Patel, S., in-person interview with Policy Design Lab, July 7, 2016].**

There are common implementation ingredients – like imaginative framing, public-private collaborations, and competitive funding approaches that encourage novel solutions and remain agnostic about who the best performers will be. There may be regular convenings within the communities to encourage progress towards the goal, to find what next steps might be, or what needs or platform technologies might be best-suited. But not all Grand Challenge program managers use all of those ingredients in pursuing their Grand Challenge goal, notes Cristin Dorgelo, Chief of Staff at the White House Office of Science and Technology Policy (OSTP) and formerly Vice President of Prize Operations at the XPRIZE Foundation -- either because the goal being pursued didn’t call for it, they haven’t thought of it, or they don’t have enough resources for those activities. [Dorgelo, C., phone interview with Policy Design Lab, August 3, 2016]

Instead, an emerging taxonomy of Grand Challenge activities is best understood as a spectrum. At one end, a minimal deployment of the approach entails internal problem definition and goal framing work, with the agency then issuing a compelling goal challenge to the public and allowing further action to develop organically. (One example is [The](http:///h) National Nanotechnology Initiative’s [Nano Grand Challenge](http://www.nano.gov/grandchallenges) for Future Computing, where the goal for nanotechnology grand challenges first was announced via [blog](https://www.whitehouse.gov/blog/2015/06/17/call-nanotechnology-inspired-grand-challenges) [posts](https://www.whitehouse.gov/blog/2015/10/15/nanotechnology-inspired-grand-challenge-future-computing). A public request for information and follow-on engagement work at industry-specific convenings spurred active discussion on what it would take to pursue such a goal, leading to the development of a [white paper](https://www.nano.gov/futurecomputing) and statements of support from various agencies and organizations.) At the mid-point of the spectrum, Dorgelo points to efforts like the [DARPA Grand Challenges](http://archive.darpa.mil/grandchallenge/) -- including its most recent [Cyber Grand Challenge](https://www.cybergrandchallenge.com/) -- which have a grand challenge goal but primarily rely on an incentive prize model, with additional elements of push funding and community convening [Dorgelo, C., phone interview with Policy Design Lab, August 3, 2016]. At the far and most developed end of the spectrum, rigorous goal definition and announcement can be a lengthy process. For the Department of Energy’s [SunShot](http://www1.eere.energy.gov/solar/sunshot/index.html) and [EV Everywhere Grand Challenges](http://energy.gov/eere/vehicles/downloads/ev-everywhere-grand-challenge-blueprint), the process of internal problem definition was followed by an additional year of soliciting input from stakeholders around the country regarding additions or revisions to the stated goal definition [Dorgelo, C., phone interview with Policy Design Lab, August 3, 2016].

**Q: What distinguishes a Grand Challenge from prize challenges?**

A: “Unlike prizes, where there are well-defined types of incentive prizes for particular types of problems, Grand Challenge programs so far have been designed in a very custom way, based on the goal itself, as well available resources,” explains Cristin Dorgelo, Chief of Staff at OSTP and formerly head of prize operations at the XPRIZE Foundation [Dorgelo, C., phone interview with Policy Design Lab, August 3, 2016]. In other words, a Grand Challenge program manager may choose to encompass a prize competition element as one aspect of their Grand Challenge program, but not necessarily.

Successful challenges demonstrate the array of possible approaches, from all-in funding commitments that fund and scale solutions, offerings to match funding from private and philanthropic sectors, commitments to source a prize without funding the resulting solutions, or even simply high-level commitments that create the space for other stakeholders to develop and fund implementation.

*[[Website suggestion: Venn diagram graphic depicting overlap between Grand Challenges and other modalities, including prizes]]*

**SIDEBAR: History of Grand Challenges:** [[embed separately on website]]

The understanding of a “Grand Challenge” framework has evolved considerably over the past 25 years from a narrow technical discipline to a broad call that extends beyond the scientific and research community. Kenneth Wilson first introduced the concept to the research lexicon in 1980 as part of the advocacy for high-performance computing. [The High Performance Computing Act of 1991](https://www.gpo.gov/fdsys/pkg/USCODE-2011-title15/html/USCODE-2011-title15-chap81-sec5503.htm) defined Grand Challenges narrowly as “a fundamental problem in science or engineering, with broad economic and scientific impact, whose solution will require the application of high-performance computing resources and multidisciplinary teams of researchers.” A dozen years later, the Bill & Melinda Gates Foundation recognized power and potential of the Grand Challenge framework, setting the stage for their [Grand Challenges in Global Health](http://gcgh.grandchallenges.org/). The elevation of the term by Gates was a milestone in the broader application of the concept. The Gates Foundation saw the agenda-setting power of the Grand Challenge framework as a way to articulate specific scientific or technological innovations that could break through critical research barriers to solving important global health challenges.

A second, concurrent milestone was the first instance of a Grand Challenge undertaken by a Federal agency (DARPA) in 2002. DARPA deployed the approach with the DARPA Grand Challenge for long distance trials of driverless vehicles. The National Academy of Engineering’s *Grand Challenges in Engineering* followed in 2008.

In the past decade, with encouragement from the Office of Science and Technology Policy, the Grand Challenges framework has broadened further to encompass a wide range of disciplines. For more on how the common understanding of “Grand Challenge” has evolved in the past 25 years, see Dr. Diana Hicks’ summary of the term’s evolution [Hicks, D., “[Grand Challenges: tracking a topos   
wandering through US science policy](http://dhgc.weebly.com/definitions.html)”].

References

Diana Hicks, ["Grand Challenges in US Science Policy Attempt Policy Innovation" International Journal of Foresight and Innovation Policy (2016).](http://works.bepress.com/diana_hicks/38/)

[The High Performance Computing Act of 1991](http://works.bepress.com/diana_hicks/38/)

Gates Foundation, “Grand Challenges in Global Health” (2003).

[2008 National Academy of Engineering Grand Challenges for Engineering](http://www.engineeringchallenges.org/File.aspx?id=11574&v=ba24e2ed)

#### Deliverable 4: One or more “success stories” or learning narratives to underscore impact

Case studies

1. **DOE: SunShot**
2. **NASA: Asteroid Grand Challenge**
3. **USAID: Grand Challenges for Development**
4. **Grand Challenges Scholars Program**

**Case Study 1:** [**DOE: SunShot**](http://www1.eere.energy.gov/solar/sunshot/index.html)

[Ulrich, E., and DOE staff, personal communications and interviews with Policy Design Lab, December 2, 2016]

[[[Embed 3 min intro video for SunShot](https://youtu.be/RzM2bvcHKHM)]]

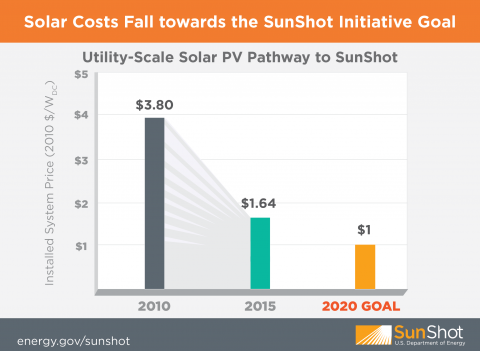
Launched in 2011, the Department of Energy’s (DOE) SunShot Initiative is a Grand Challenge effort to make solar energy cost-competitive with conventional forms of electricity generation by the end of the decade (2020). The audacious goal -- to drive down the cost of solar electricity to $0.06 per kilowatt-hour or ~$1 per watt – arose from one question: What would it take for solar to become a large portion of nation’s energy supply mix? Through SunShot, DOE has leapfrogged progress on an answer to this call, partnering with more than 450 awardees, funding cooperative research, development, demonstration, and deployment projects by private companies, universities, state and local governments, nonprofit organizations, and national laboratories. [Ulrich, E., and DOE staff, personal communications and interviews with Policy Design Lab, December 2, 2016]

Five years into the Energy Department’s decade-long SunShot Initiative, the solar industry is already more than 70% of the way to achieving SunShot’s cost target. Longer-term goals are now being set, and one important learning from SunShot is how successful Challenges can sometimes wildly exceed their goals and evolve to push the bar even further.

**Key accomplishments:**

As a result of DOE’s SunShot Initiative, investments and the industry’s accelerated pace to meet the SunShot goal, solar-generated electricity is now price competitive with traditional energy sources in 14 states across the United States. [Ulrich, E., and DOE staff, personal communications and interviews with Policy Design Lab, December 2, 2016] Increased deployment of affordable and accessible solar energy continues to grow quickly across the country. Two key points deserve emphasis:

* *Outstanding ROI*: DOE has spent roughly $2.3 billion on R&D, but net economic benefits total more than $15 billion to date. SunShot has been a catalytic focusing lens, generating significant economic and job growth in the solar industry.
* *Leapfrog Technical Advancement*: The country has more than 10 times more solar installed today than in 2011 when the SunShot Initiative was first launched [Delapez, J., “[SunShot Reports: Solar Energy Progress and Challenges](http://www.agri-pulse.com/SunShot-reports-Solar-energy-progress-and-challenges-05262016.asp)”, Agri-Pulse, 2016]. Meanwhile, the overall costs of solar have dropped by over 65 percent:



**How they did it:**

The appeal of using a Grand Challenge framework for DOE was its cost-effective ability to promote scale and impact under a broad umbrella. For SunShot, DOE has held an annual summit; released research papers regarding technical milestones needed to achieve the goal; funded nearly 300 cooperative research, development, demonstration, and deployment projects; and also offered open prize competitions to fuel entrepreneurship and drive innovation in solar technology [Dorgelo, C., personal communication with Policy Design Lab, December 5th, 2016]. SunShot’s broad articulation and interagency coordination also enabled a systems-level perspective to emerge during implementation, which highlighted the importance of certain aspects that needed increased attention. Prior to SunShot, there had been an overall cost goal, for example, with emphasis on the cost of cells and modules. But the learning gained through the initiative proved that even if the module were free, the cost goal couldn’t be met without addressing other important areas particularly the work in grid integration and [soft costs](http://energy.gov/eere/sunshot/soft-costs).

Effective messaging has also been essential to the program’s success. The program wasn’t originally launched as SunShot; the name came later. Building a brand identity was a central part of establishing the program’s narrative.

**Key learning insights:**

* **Use Grand Challenges to spur holistic impact**
* **Set a big (and timely) goal that can be sufficiently funded**
* **Use a wide variety of funding mechanisms**
* **Hire the right people – and have senior leadership support**
* **Continually iterate and refine processes**

Use Grand Challenges to spur holistic impact

SunShot exemplifies how systems-level perspectives can emerge from Grand Challenge frameworks, and how investing in holistically understanding the problem can lead to more effective problem-solving to advance technology *and* integrate it into the marketplace. SunShot program staff spent a year soliciting feedback from stakeholders into program definition, identifying five areas where innovation was needed: photovoltaics, concentrating solar power, systems integration, soft costs, and technology-to-market. After integrating stakeholder feedback and developing technology white papers, Dorgelo explains, DOE “took their existing solar-technology funding streams and oriented them towards what they had heard would be needed to achieve the overall goal through advances in those five technology areas” [Dorgelo, C., personal communication with Policy Design Lab, December 5th, 2016]. The integrated portfolio approach across multiple technology paths and stages, coupled with collaboration across Federal agencies helped the program to make impacts across the U.S. solar value chain. Iterative assessment of the state of the industry, market and existing programs helped the program to maintain agility.

Set a big (and timely) goal that can be sufficiently funded

Big ideas evolve from issues of our time. A Challenge needs to inspire people to want to propose solutions and be incentivized enough to make it worth their time. Considerable research and industry consultation went into the $1 goal, which fell just outside of what industry felt at the time was feasible. $1 billion was allocated in pursuit of the goal. [Ulrich, E.,personal communication with Policy Design Lab, December 2nd, 2016]

Use a wide variety of funding mechanisms

“In SunShot’s case, they used a wide variety of funding mechanisms, including prize competitions as well as funding awards for cooperative research, development, demonstration, and deployment projects,” notes Cristin Dorgelo. “They looked holistically about what type of funding would make most sense for certain aspects of pursuing the goal, and deployed standard funding mechanisms such as grants and contracts, but also incentive prizes where appropriate” [Dorgelo, C., phone interview with Policy Design Lab, August 3, 2016]. Prize competitions, for instance, were a good fit for driving entrepreneurship and meeting software needs that could reduce solar soft costs – by using short timeframes and smaller funding rates, it encouraged software companies to lower hurdle rates. The variety of funding approaches also recognized the other kinds of value the program could bring to the table through data and information assets, analyses, training, convenings and by working with stakeholders to identify the right questions to answer together to keep the industry moving forward.

Hire the right people – and have senior leadership support

The Challenge required a highly trained technical team for active management of the grants. A concerted push was made with grantees to assess whether projects would yield results competitive with forward looking estimates for current technologies and approaches, with an overarching emphasis on the ambitious quantitative goal. (This meant that if it would take 10 years for a solution to mature and gain market acceptance, it would have to be competitive with cost reduction curves on current technologies in that same 10 year horizon.) Leadership from the top was also key for ensuring continued, unwavering support for these goals. The Secretary of Energy was integrally involved in the effort.

Continually iterate and refine processes

Internal process improvements piloted within the SunShot program led to updates to how all grants and cooperative agreements were selected and managed within EERE. The time from announcement to award was reduced from about 18 months, to 6 months to keep up with the rapidly changing technology and market environment.

**To Learn More:**

[**DOE SunShot factsheet**](http://energy.gov/sites/prod/files/2016/06/f32/SunShot-factsheet-2016.pdf)

[**On the Path to SunShot: A series of 8 reports**](http://energy.gov/eere/sunshot/path-sunshot)

[**SunShot Vison Study: 5-Year Assessment**](http://energy.gov/eere/sunshot/sunshot-vision-study)

[**SunShot Catalyst: “Next Generation of Prize Challenges”**](http://energy.gov/eere/sunshot/sunshot-catalyst-energy-innovation-prize)

[**SunShot 2030**](http://energy.gov/eere/sunshot/sunshot-2030)

**Case Study 2: NASA - Asteroid Grand Challenge**

Case study derived from interviews with Jenn Gustetic [phone interview with Policy Design Lab, July 25, 2016] and Jason Kessler [phone interview with Policy Design Lab, November 11, 2016].

[[[Embed NASA’s 2 minute introduction video](https://youtu.be/xki5Q_LRfeg)]]

NASA’s Asteroid Grand Challenge (AGC) aims to find and address all asteroid threats to human populations and figure out what to do about them. The Challenge statement is “find all asteroid threats to human populations and know what to do about them.” With estimates suggesting less than 10% of objects smaller than 300 meters in diameter and less than 1% of objects smaller than 100 meters in diameter have been discovered, a global effort with innovative solutions is necessary to accelerate the completion of the survey of potentially hazardous asteroids [[“Grand Challenge”](https://www.nasa.gov/mission_pages/asteroids/initiative/grand_challenge.html), NASA, June 2013].

Launched in June 2013, the Challenge is a large-scale effort reliant on multi-disciplinary collaborations and a variety of partnerships with other government agencies, international partners, industry, academia, and citizen scientists to detect, track, characterize, and create mitigation strategies for potentially hazardous asteroids. The AGC demonstrates how the Grand Challenge framework can help to shift the policy environment, while also showing the power of engaging citizen solvers through public appeals for help.

**Key accomplishments:**

The AGC is an example of how Challenges can seed and sustain continued work in critical mission areas. Marrying serious science and smart engagement with the public (one tag line: "Dinosaurs didn't have a space program"), the Challenge framework and its successes drew significant attention to the program and helped to accelerate NASA’s cataloging capabilities for near-earth objects. As a result, the budget for the Near-Earth Object Observations Program more than doubled from $20.4 million in FY2012 to $50 million in FY2016. (Previously, the program had received $4 million per year since the 1990s) [Gustetic, J., phone interview with Policy Design Lab, July 25, 2016].

NASA’s Asteroid Grand Challenge Components:

1. Detect: Find the asteroid objects
2. Track: Figure out how to quickly and accurately measure the object's orbit
3. Characterize: Once the orbit is known, learn more about the asteroid's composition
4. Mitigate: Study mitigation solutions, so we'll know what to do if a threat is identified

**How they did it:**

NASA invested heavily in problem definition at the outset in order to broaden engagement with potential solvers. NASA first used a brainstorming technique (“[Big Think”)](http://www.launch.org/process) to select a Grand Challenge focus. From there, deconstructing the chosen problem area through a process of problem decomposition was essential: “We wanted to see if there was a way to engage a broader audience and bring a new community to think about this problem in a different way," explains Jason Kessler, formerly NASA's Asteroid Grand Challenge Program Executive [Kessler, J., phone interview with Policy Design Lab, November 11, 2016]. With the help of researchers at [George Washington University's systems engineering program](https://www.seas.gwu.edu/department-engineering-management-systems-engineering), NASA was also able to leverage insights from third-party academic participants. Their observations were useful for decomposing the problem so that "non-expert" groups could meaningfully participate -- for instance, citizen solvers could volunteer labor for pattern recognition, and "distant experts" (experts in other fields) could contribute specialized knowledge [Gustetic, J., phone interview with Policy Design Lab, July 25, 2016].

**Key learning insights:**

* Problem definition enables meaningfully engagement by citizen solvers, even in technical problems
* Powerful narratives can drive engagement, but decomposed problems also require segmented messaging
* Co-creation and collaborative partnerships are essential
* Follow-on engagement should be integrated into program implementation

Problem definition enables meaningfully engagement by citizen solvers, even in technical problems

The overriding message of the Asteroid Grand Challenge was that asteroid hunting is an activity everyone can get involved in. “With projects like Asteroid Data Hunter, NASA proved that it could think through ‘NASA-hard’ programs and find places where the crowd can meaningfully contribute,” observes Jenn Gustetic, program executive for NASA’s Small Business Innovation Research (SBIR/STTR) division [Gustetic, J., phone interview with Policy Design Lab, July 25, 2016]. Defining the problem into four parts made it possible to ask for engagement from every level, from deep technical experts to leveraging motivated citizens willing to write computer code, build hardware, observe through a telescope, tell stories, and publicize the issue.

At the same time, observes Kessler, program managers should recognize the cultural challenges as well as the time and energy required to engage with technical experts in the problem definition process [Kessler, J., phone interview with Policy Design Lab, November 11, 2016]. It’s essential to find technical experts that can describe the problems without explaining *how* they would solve the problems. It requires additional initial work, but collaboration with experts can enable challenge owners to better understand how a problem could be examined by others in a new light.

Powerful narratives can drive engagement – but decomposed problems also require segmented messaging

Developing a solid narrative to enable a meaningful conversation with the public was a critical first step, observes Kessler [Kessler, J., phone interview with Policy Design Lab, November 11, 2016]. The idea of "everyone as an asteroid hunter" was a powerful way to further involve the public in NASA's work. Asking for the public’s help was a powerful narrative; by framing the call as, “We can’t do this alone, we need you,” it drew in motivated citizen scientists and experts alike.

At the same time, segmented messaging that is appropriate and sensitive to each group is required. An existing small community of scientists had been doing “amazing work on a shoestring,” recounts Kessler, but some of the initial public messaging seemed to discount the technical challenges they had overcome managed on a daily basis [Kessler, J., phone interview with Policy Design Lab, November 11, 2016]. A segmented, targeted communications plan should be embedded in program implementation, with the goal of ensuring that all relevant constituencies are engaged and motivated. It’s especially important to engage expert communities early, to build relationships and ensure that public engagement outcomes can be more easily integrated into existing systems and processes.

Co-creation and collaborative partnerships are essential

NASA’s AGC is also an example of agency-driven co-creation, where the agency played a key role in coordinating discussions among global partners. Concerted efforts were made by the agency to think through which aspects of the Grand Challenge could involve not just the general public, but also international actors and other federal agencies. The program enabled NASA to partner with industry and academia in new ways, and gave the Near-Earth Object office the ability to quickly form partnerships with entities they had not worked with before [Gustetic, J., phone interview with Policy Design Lab, July 25th, 2016].

Integrate follow-on engagement into program implementation

While resource constraints can be a limiting factor, sustaining follow-on engagement can continue to accrue value for agencies. The Grand Challenge motivated great deal of interest and potential for continued engagement from the newly formed community. “There were connections made by people who had never talked together, but could really benefit from collaboration,” notes Kessler[Kessler, J., phone interview with Policy Design Lab, November 11, 2016]. He recommends that where possible, program planners invest in infrastructure than can enable communities of solvers to flourish.

**To Learn More:**

[What is the Asteroid Grand Challenge?](https://www.nasa.gov/feature/what-is-the-asteroid-grand-challenge)

[What Makes the AGC a Grand Challenge?](https://ac.arc.nasa.gov/p29695ty4fm/)

[3 minute video: “Find them Now”](https://youtu.be/98UoNqvZGUg)

[More recordings and transcripts from the 2014 First Anniversary Event of AGC](http://sservi.nasa.gov/event/nasas-asteroid-grand-challenge-anniversary-event/)

**Artifacts/Key Historical Documentation:**

* [Near-Earth Object Survey and Deflection Analysis of Alternatives Report to Congress March 2007](http://neo.jpl.nasa.gov/neo/report2007.html)
* [White paper on the 2013 Planetary Defense Conference](http://iaaweb.org/iaa/Scientific%20Activity/pdc2013report.pdf)
* [National Research Council report, Defending Planet Earth: Near-Earth Object Surveys and Hazard Mitigation Strategies, January 2010](http://www.nap.edu/openbook.php?record_id=12842)
* [Report of the NASA Advisory Council Ad Hoc Task Force on Planetary Defense, October 6, 2010](http://www.nasa.gov/pdf/490945main_10-10_TFPD.pdf)
* [NASA Near Earth Object Survey and Deflection – Analysis of Alternatives Report to Congress, March 2007](http://www.nasa.gov/pdf/171331main_NEO_report_march07.pdf)

**Case Study 3:** [**USAID - Grand Challenges for Development**](https://www.usaid.gov/news-information/frontlines/grand-challenges/introduction-grand-challenge-next-generation-solutions)

[Case study and all figures herein derived from interviews with Seema Patel, Ann Mei Chang, a](https://www.usaid.gov/news-information/frontlines/grand-challenges/introduction-grand-challenge-next-generation-solutions)nd Tony Bloome, Alexis Bonnell, Karen Clune, Grace Hoerner, Chris Jurgens, Bruce Kay, Marissa Leffler, Ku McMahan, and Ryan Shelby

USAID’s Grand Challenges for Development (GCDs) are effective programmatic frameworks that focus global attention and resources on specific, well-defined international development problems and promote the innovative approaches, processes, and solutions to solving them.

Conceived, launched, and implemented in coordination with public and private sector partners, Grand Challenges for Development (see list) emphasize the engagement of non-traditional solvers around critical development problems. The Grand Challenges for Development approach is a complement to USAID’s current programming methods, with each GCD is led by experts at the bureau level. These experts work directly with partners to implement the day-to-day activities of the program.

Despite this decentralized approach, there is collective movement that prioritizes systems-level thinking. "It’s not enough to simply source innovation,” explains Ann Mei Chang, Chief Innovation Officer of the Global Development Lab at USAID: “We must overcome the barriers to adoption and scale, whether that’s an organizational limitation like talent, or bringing the right ecosystem of partners including government, investors, and industry together." [Chang, A., In-person interview with Policy Design Lab, July [AMC]

Furthermore, the Grand Challenges for Development programs show how the power of the framework can be leveraged through a variety of modalities, including partnerships, prizes, challenge grant funding, crowdsourcing, [hack-a-thons](http://open.nasa.gov/blog/2012/06/29/the-power-of-hackathons-in-government/), ideation, commit fairs, and [massive online open courses](https://poweringag.org/mooc). [crosslink to Partnerships, Prizes/Challenges] To date, USAID has launched eight Grand Challenges with 18 public and private sector partners to address critical challenges in development, including:

* [Saving Lives at Birth](http://www.savinglivesatbirth.org) a partnership of USAID, Grand Challenges Canada, The Bill and Melinda Gates Foundation, the Government of Norway, UKAid, and the Korean International Cooperation Agency, was designed to increase access to groundbreaking prevention and treatment approaches for pregnant women and newborns in poor, low-resource communities around the 48 hours of delivery.
* [All Children Reading](http://www.allchildrenreading.org) brings together USAID, World Vision, and the Australian government to dramatically increase the number of children in low-income countries who leave primary school with basic reading skills.
* [Powering Agriculture: An Energy Grand Challenge for Development (2012)](http://www.poweringagriculture.org) is a partnership between USAID, the Swedish International Development Cooperation Agency (SIDA), the German Ministry for Economic Cooperation and Development (BMZ), Duke Energy, and OPIC, that supports clean energy innovations that (1) enhance agricultural yields and productivity; (2) decrease post-harvest losses; (3) improve farmer and agribusiness income; and (4) increase energy efficiency within the operations of farms and agribusinesses to help end extreme poverty and extreme hunger.
* [Making All Voices Count](http://www.makingallvoicescount.org) supports citizens and governments use of innovation, web, and mobile technologies to improve government performance and accountability.
* [Securing Water for Food](http://www.securingwaterforfood.org) helps farmers around the world grow more food using less water, enhance water storage, and improve the use of saline water and soil to produce food by ensuring that the entrepreneurs and scientists behind groundbreaking new approaches are getting the support they need to apply and expand their solutions around the world.
* [Fighting Ebola](http://www.ebolagrandchallenge.net) sought to address key gaps in the response to the largest Ebola epidemic in history.
* [Combating Zika and Future Threats](https://www.usaid.gov/grandchallenges/zika), aims to generate cutting-edge approaches to fight the current Zika outbreak and help strengthen the world’s ability to prevent, detect, and respond to future infectious disease outbreaks.
* [Scaling Off-Grid Energy](http://www.scalingoffgrid.org), a partnership between Power Africa, USAID, the U.K. Department for International Development, and the Shell Foundation, which aims to accelerate growth in the off-grid energy market with a goal to provide 20 million households in sub-Saharan Africa with access to modern, clean and affordable electricity by 2030.

**Key Accomplishments (Impact): []**

[All figures herein sourced directly from USAID program managers, personal communication with Policy Design Lab, November 10th, 2016.]

As a result of USAID’s investment in Grand Challenges for Development (as of 10/2016), Saving Lives at Birth has funded 94 innovations through 111 awards and reached 1.5 million women and newborns and saved nearly 10,000 lives. Securing Water for Food has funded 30 innovations that has saved more than 2 billion liters of water for agriculture and produced 300,000 tons of food for more than 1,000,000 farmers and other customers. Powering Agriculture has supported 24 innovators that have helped keep 2,244 metric tons of carbon dioxide out of the atmosphere and reached more than 200,000 customers with clean energy agricultural solutions.

Grand Challenges allow USAID and its partners to be a driver of innovation in markets that are underserved or perceived to be high risk. They signal demand and also allow for risk-sharing of investments across a number of donors. This has resulted in:

* **Leveraging of Resources**: GCDs leverage the expertise, resources, and assets of partners. Across the GCD portfolio, $312 million has been jointly committed (of which $170 million has been provided by USAID). In addition, some innovators supported by GCDs are then recognized and supported by others. To date, GCD innovators have raised at least $61.4 million in additional capital.
* **Democratizing Innovation:** The GCD approach makes it easier for those who have not worked with USAID previously to engage. Since 2011, USAID has received more than 8,500 applications and awarded more than 270 seed, validation, and transition grants (staged funding) to innovators in more than 60 countries. These results suggest improved outreach in sourcing new solutions from those closest to the problems, new ideas from non-traditional actors, and providing new opportunities for small and local businesses. For example, Powering Agriculture released two Global Calls for Innovations in December 2012 and November 2014. The first call received 473 applications (55% from developing countries) and the second call received 871 applications (62% from developing countries.) Recently, Securing Water for Food’s fourth round call for applications yielded 555 applications. Of those applications, 89 percent were from organizations that had not previously applied for funding from USAID, and 76 percent were from developing countries.

In addition, USAID’s experience demonstrates the substantial benefit of highly visible market signaling. “Grand Challenges drive value, with outcomes that often are difficult to measure. We tend to measure innovator impact as that helps us determine our immediate progress,” notes Seema Patel, “but there’s impact through formulating new partnerships and creating a market signal that motivates additional R&D” and other kinds of spillover ROI. [Patel, S., phone interview with Policy Design Lab, July 29, 2016. ]

The media attention of the Grand Challenge also helps to drive mission progress forward; it not only reflects positively on the “brand” of the Federal government for the general public, but crucially, it focuses attention around problems worth solving and worth thinking about. For example, Grand Challenges for Development generate significant press coverage for its innovators that helps socialize and promote the adoption of solutions. Some key wins include the significant coverage Fighting Ebola received around its innovations, which has helped reduce timelines to market. Saving Lives at Birth’s Odon Device, which provides a simplified way to deliver babies during prolonged labor, has received widespread press attention. Securing Water for Food’s Adaptive Symbiotic Technologies was able to raise $3.4 million of Series A funding based on coverage in press of its microbial seed treatment innovation [USAID program managers, personal communication with Policy Design Lab, November 10, 2016].

**How they did it:**

Each Grand Challenge for Development is its own unique prototype, conceived, tailored for the domain and particular challenges associated with a specific development problem, and led Iterative refinements also reflect AID’s continuous learning and evaluation. The overriding theme is one of heavy engagement with stakeholders and a reliance on partnership – from sponsors, to partnerships at the activity level, carrying out implementation, and partnering for media communications and scaling. The emphasis on partnership carries into how USAID engaged issues of problem definition, where a first principle is: Find someone else who agrees this is a problem to solve.

Because Grand Challenges take considerable talent and resources for effective execution, USAID has found it most effective to complement agency resources with sourcing external partners in a range of areas, from management of the process, partners for communications and outreach, and partners to help run acceleration and pitch training for innovators.

**Key Learning Insights:**

* **Define the problem with stakeholder input**
* **Commit resources to multi-year engagement strategies**
* **Leverage the framework’s flexibility Put innovation on the fast-track to scale**
* **Continuously learn and refine**
* **Build a community**

**Define the problem with stakeholder input**

Each Grand Challenge for Development required a significant investment in problem identification to frame the challenge call. This step is essential: It takes the right problem, right partners, and right activities to catalyze global action and create an opportunity for problem-solving. Problem definition work begins broadly, with additional criteria added as the challenge framing is refined. The development phase focuses not just on understanding the problem, but also the market of potential solvers. Partnership is critical, even in this early stage of iterative problem definition. Barrier analysis and state of innovation assessments are key parts to the problem definition process; first identifying what the barriers are to solving, and next taking stock of the existing landscape to understand what sort of call to action is most needed. For instance, is it a technology gap? Or are there already broad solutions out there that need support in order to be viable and scale? Early conversation with partners can enhance understanding of the technical obstacles.

**Commit resources to multi-year engagement strategies**

To capture the full value of the Grand Challenge for Development framework, invest resources in bringing new solvers to the table. “You don’t just put the call out there and expect people will come; you don’t motivate new solvers that way,” explains Seema Patel [Patel, S., phone interview with Policy Design Lab, July 29, 2016. If you want to broaden the community base of problem-solvers, you must have a constant drumbeat through activities and communications. Planning an engagement and communications strategy on a multi-year trajectory, time is needed to build momentum, and catalyze enough activity that a self-sustaining marketplace emerges [Patel, S., phone interview with Policy Design Lab, July 29, 2016].

**Leverage the framework’s flexibility**

Each Grand Challenge for Development has been uniquely structured by technical staff throughout the Agency to most appropriately address the specific problem identified. The variations in the Grand Challenges for Development exemplify how agencies can mix and match modalities for solving within the Grand Challenges framework; in some cases, it was most appropriate to leverage private sector partnerships, while others used an Request for Applications (RFA) to call for grant intake. “There’s been a lot of range of experimentation of methodology under the Grand Challenge framework,” explains Seema Patel [Patel, S., phone interview with Policy Design Lab, July 29, 2016]. “All of the teams have experimented under the Grand Challenge blueprint to address different parts of the systemic barriers to source innovations to integrate and scale.”

In all cases, the value of the framework emerged from the convening power. The call to action – the creation of a sense of urgency and feasibility – draws in the many stakeholders necessary in order to execute meaningful innovation and progress. [Crosslink V5/GDA case study]

**Put innovation on the fast-track to scale**

“Uncovering an innovation is inconsequential if it is not going to be used or adopted, or if that innovative organization cannot overcome their barriers to success,” notes Alexis Bonnell [Bonnell, A., personal communication with Policy Design Lab, November 10, 2016]. Grand Challenges for Development have evolved to include acceleration services (support to innovators other than grant funding) to help innovators and their solutions to reach customers and end-users and overcome organizational barriers. This is achieved through customized technical assistance that helps solvers to establish and meet aggressive targets. “When we fund innovation, it isn’t just writing a check. We agree very specifically on the targets and performance growth path of that innovation, and we stage our funding to align with those targets. Innovation must ultimately be accountable for impact. But we don’t leave innovators hanging. We provide assistance and support beyond just the money,” said Dave Ferguson [Ferguson, D., personal communication with Policy Design Lab, November 10, 2016].

Further, Grand Challenges for Development leverage the power of USAID’s networks to support innovators’ long-term growth goals by helping them connect with commercial investment and financing, companies and organizations interested in innovation, and public sector and non-governmental organizations seeking solutions. “Innovation must be tied back to the traditional business of the Agency. If we source an incredible innovation but no one uses it, then it doesn’t matter. We complement our innovation sourcing work through approaches like Grand Challenges for Development with thoughtful matchmaking to integrate and incorporate the innovations that are discovered into USAID’s programs both with players inside the organization and outside. If you stop at discovery, the vision goes unrealized,” said Alexis Bonnell [Bonnell, A., personal communication with Policy Design Lab, November 10, 2016].

**Continuously learn and refine**

USAID’s experience in deploying Grand Challenges reflects a process of continuous learning and refinement. “Saving Lives at Birth, USAID’s first Grand Challenge for Development, helped set the stage and build a framework for Grand Challenges for Development across the Agency. The programs that followed have incorporated new elements such as crowdfunding, incentive prizes, and diverse acceleration service offerings. Further, even within a GCD, each subsequent call for innovations incorporates lessons learned from previous calls. Powering Agriculture and Securing Water for Food, for example, revised requirements for later calls based on learnings from earlier rounds to bring in higher-quality, later-stage innovations. Scaling Off-Grid Energy, a Grand Challenge for Development founded by USAID, Power Africa, the UK Department for International Development and Shell Foundation is the culmination of lessons learned. Seema Patel noted, “This Grand Challenge is not like any of our other Grand Challenges. If you look at our previous Grand Challenges, they have mostly been about sourcing innovations and then scaling them. It’s about how to come up with ideas to solve the problem. This Grand Challenge is really about scaling the solar household energy sector in sub-Saharan Africa”[Patel, S., phone interview with Policy Design Lab, July 29, 2016]. Using the Grand Challenge model, USAID is bringing together different partners to concentrate on scaling cluster solutions.

“This focus on adoption and application of the innovations into USAID’s larger programming and commercial sustainability is an evolution of what a Grand Challenge can truly be,” said Dave Ferguson [Ferguson, D., personal communication with Policy Design Lab, November 10,2016].

**Build a community**

Grand Challenges for Development has spurred on the development of cross-industry partnerships of major players to ensure that the business intelligence and learning emerging from these programs is being shared and help to consistently inform investment decisions that could be made by innovators, funders, and customers.

This has been accomplished through a variety of mechanisms such as the Saving Lives at Birth DevelopmentXchange which is an annual convening of investors, partners and innovators that convene each year to meet and evaluate Saving Lives at Birth award finalists. The event is interactive and action-oriented and serves as one of the leading maternal and newborn health innovation summits with over 500 attendees each year. Securing Water for Food and Powering Agriculture has also partnered to host the Agricultural Innovation Investment Summit which will bring together leading investors and agriculture innovators.

The [Global Innovation Exchange](http://www.globalinnovationexchange.org) was created to serve as a marketplace of development relevant innovations, funding, partners, and resources. USAID, Gates Foundation, Australia, and South Korea, along with 80 other partners committed to share innovations in a central place so the larger ecosystem of innovation in development could be represented. The Global Innovation Exchange has helped strengthen understanding of what innovations already exist, where they were being used, and which organizations and partners support them. As of October 2016, the Exchange has over 4,500 innovations, nearly $100 million in active innovation funding, and more than 15,000 collaborators.

**To Learn More:**

Grand Challenges for Development:

[Saving Lives at Birth](http://www.savinglivesatbirth.org)

[All Children Reading](http://www.allchildrenreading.org)

[Making All Voices Count](http://www.makingallvoicescount.org)

[Powering Agriculture: An Energy Grand Challenge for Development](http://www.poweringagriculture.org)

[Securing Water for Food](http://www.securingwaterforfood.org)

[Fighting Ebola](http://www.ebolagrandchallenge.net/)

[Combating Zika and Future Threats](https://www.usaid.gov/grandchallenges/zika)

[Scaling Off-Grid Energy](http://www.scalingoffgrid.org)

[Grand Challenges for Development Toolkit](https://www.globalinnovationexchange.org/resources/usaid-full-innovation-programming-and-design-toolkit)

**Case Study 4:** [**Grand Challenges Scholars Program**](http://www.engineeringchallenges.org/)

The National Academy of Engineering (NAE) [Grand Challenge Scholars Program](http://www.engineeringchallenges.org/) (GCSP) aims to create the next generation of engineers who are specially equipped to address the most challenging problems facing the country and the world. Originally involving a cohort of 20 to 30 undergraduate students at a handful of schools, the goal now is to mainstream the model in engineering programs throughout the country. Currently, over 30 US schools and 4 international schools participate [Atkins, R., personal communication with Policy Design Lab, December 1, 2016].

The Program enables students to organize their coursework, research, service, international studies, and experiential learning around one of the [NAE Grand Challenges for Engineering](http://www.engineeringchallenges.org/challenges.aspx), which cover four thematic areas: sustainability, security, health, and joy of living. (The latter theme, notes NAE communications director Randy Atkins, emphasizes that the Challenges aren’t all about solving problems – they’re also about innovations that simply make life better) [Atkins, R., phone interview with Policy Design Lab, November 3, 2016]. The program aims to pilot new innovative approaches in education that will eventually shift the mainstream training paradigm for all engineering students. The effort also stresses cross-disciplinary collaboration.

Each university embeds five central components into their program:

**1. A Hands-on Project *or* Research Experience** related to a Grand Challenge;  
**2. Interdisciplinary Curriculum:** Complementing engineering fundamentals with courses in other fields, preparing students to work at the intersections of public policy, business, law, ethics, human behavior, risk, and the arts, as well as medicine and the sciences;  
**3. Entrepreneurship:** Learning to translate invention to innovation, and preparing students to develop public-interest oriented market ventures that can scale to global solutions;  
**4. Global Dimension:** Developing the necessary global perspective for tackling worldwide challenges as well as preparing students to lead innovation outside their comfort zones;  
**5. Service Learning:**Using mentored experiential learning (with real clients) to encourage and deepen students’ social consciousness and their motivations to apply their technical expertise to societal problems. [[Source](http://www.grandchallengescholars.org/)]

**Key Accomplishments:**

In 2015, more than 120 US engineering schools [announced their commitment](http://www.engineeringchallenges.org/File.aspx?id=15680&v=c29105cb) to integrate Grand Challenge Scholars Programs into their undergraduate curriculums. They pledged that in a decade, 20,000 engineers will be trained to tackle these complex challenges.

One of the early accomplishments of the program has been to bring more diversity into the engineering field. There are a wide range of participating universities, from school size to disciplinary focus. The demographics of the program are also notably diverse, with more than 50% female enrollment as well as sizeable participation from historically underrepresented minorities. Bringing more diversity into the engineering profession is essential for developing a range of approaches and meeting a large variety of societal needs [Atkins, R., phone interview with Policy Design Lab,November 3, 2016].

The Grand Challenge framework has also begun to filter down to K-12 education, with high schools in [Virginia](https://www.washingtonpost.com/opinions/a-nontraditional-approach-to-stem-in-fairfax/2016/09/30/6c4ca5f6-79bc-11e6-bd86-b7bbd53d2b5d_story.html?utm_term=.55192f85bdde), [North Carolina](http://www.shell.com/inside-energy/grand-feats-for-young-scientists.html), and other states piloting approaches that are breaking down the silos of class subjects – including STEM, English, art, history, etc. – and connecting them through the frame of the biggest issues of our time.

**How they did it:**

The program emerged as a response to a [2008 landmark NAE report](http://www8.nationalacademies.org/onpinews/newsitem.aspx?RecordID=02152008), [Grand Challenges for Engineering,](http://www.engineeringchallenges.org/File.aspx?id=11574&v=ba24e2ed) which identified [fourteen Grand Challenges for engineering](http://www.nbcnews.com/id/23175788/#.VzJE_00VFBp) in the 21st century. [[Footnote: The report was written by a select group of some of this generation’s leading technological thinkers and doers, and one of the most extensively reviewed reports in the Academy’s history, notes Randy Atkins, NAE director of communications. Read more: http://www.engineeringchallenges.org/14365/committee.aspx]] The Academy’s goal was to look to the future and “inspire the engineering community to encourage students to pursue engineering fields, to give students opportunities to pursue those fields, and to give the general public and others a reference point for what **audacity** means for engineering and where the interesting problems are,” explains Cristin Dorgelo, Chief of Staff at OSTP and former head of prize operations at the XPRIZE Foundation [Dorgelo, C., phone interview with Policy Design Lab, August 3, 2016].

Initially spearheaded by [Olin College](http://www.olin.edu/), [University of Southern California](http://www.usc.edu/), and [Duke University](http://www.duke.edu), the GC Scholars Program has since taken root at dozens of colleges and universities across the country. "The findings took on a life of their own," notes Randy Atkins, NAE director of communications, "because of the sheer power of the message" [Atkins, R., phone interview with Policy Design Lab, November 3, 2016].

Volunteer efforts by educators across the country have helped to launch the program, but as it continues to scale, the NAE is creating a central coordination office to network participating schools and share best practices. In addition, two Global Grand Challenges Summits (a collaboration between the NAE, the Chinese Academy of Engineering, and the Royal Academy of Engineering), aimed at brainstorming ways that global cooperation can solve these challenges, have already taken place – [one in London](http://www.engineeringchallenges.org/14365/committee.aspx) and one in Beijing – and a third is planned for Washington, DC in 2017. The third summit will be held in conjunction with the FIRST Global Robotics Competition on Grand Challenges.

[Read more](http://www.businessweek.com/stories/2009-03-09/the-grand-challenge-for-science-and-mathbusinessweek-business-news-stock-market-and-financial-advice) about the inaugural 2009 summit at Duke University that galvanized the movement.

**Key learning insights:**

* **Non-Federal partners can use the Grand Challenge framework**
* **Collaboration gives latitude for each implementing partner and promotes diversity**
* **A powerful narrative, not funds, is necessary for shifting the collective conversation**

**Influential non-Federal partners can use the Grand Challenge framework**

The NAE Grand Challenges Scholars Program highlights the central role that entities outside of the Federal government can play in the identification and pursuit of Grand Challenges. The Grand Challenge call for engineering was first issued by the National Academy of Engineering.

**Collaboration gives latitude for each implementing partner and promotes diversity**

Similar to Federally implemented Grand Challenges, the GCSP structure also emphasizes flexibility in its framework; each participating institution incorporates the program’s five central pillars, but schools are encouraged to tailor curricula to fit their unique school environments.

**A powerful narrative, not funds, is necessary for shifting the collective conversation**

The original call to action by the NAE was not accompanied by substantial funding, notes Cristin Dorgelo. [Dorgelo, C., phone interview with Policy Design Lab, August 3, 2016]. Instead, the organization developed a framing document that galvanized the community to rethink its priorities and reorient its approaches. This worked because of NAE’s prestige and influential role within the community.

**To learn more:**

[**Engineering deans commitment announcement in 2015**](https://www.nae.edu/Projects/MediaRoom/20095/130169/134046.aspx)

[**Grand Challenges for Engineering**](http://www.engineeringchallenges.org/File.aspx?id=11574&v=ba24e2ed) **– 2008 report**

[**Grand Challenge Scholars and the BRAIN Initiative**](http://www.whitehouse.gov/blog/2014/10/09/brain-initiative-and-grand-challenge-scholars)

[UPLOAD-article attached]

**Contact:** For more information, contact Randy Atkins, ratkins@nae.edu.

**Additional examples of Grand Challenge deployments:**

* BRAIN Initiative [crosslink case study from V5]
* DOE’s EV-Everywhere Grand Challenge Blueprint
* [A Nanotechnology-Inspired Grand Challenge for Future Computing](https://www.whitehouse.gov/blog/2015/10/15/nanotechnology-inspired-grand-challenge-future-computing)
* [DARPA Cyber Grand Challenge](http://www.cybergrandchallenge.com/)
* [National Eye Institute’s Audacious Goal Initiative](http://www.cybergrandchallenge.com/)

**Read more about the Audacious Goal Initiative:**

* + <https://nei.nih.gov/sites/default/files/nei-pdfs/AGI_brochure.pdf>
  + <https://www.nei.nih.gov/agmeeting/>
  + <https://www.whitehouse.gov/blog/2013/05/15/audacious-goals-eye-research>
  + <https://youtu.be/TbSEmzCHfKM> [4 min video – what audacious goals do for scientific research]

#### Deliverable 5: Challenges to deployment / approach limitations (inc. lessons learned from agencies where implemented)

Like any policy tool, Grand Challenges are not appropriate for every context. They work best when the problem is well-defined but the scope of possible solutions is not. Successful execution requires both smart design and smart implementation.

**Key ingredients for successful Grand Challenge deployment include:**

* Thoughtful program design to appropriately adapt the framework
* Open-minded approach to goal definition and redefinition
* High-level support and receptivity for new problem-solving approaches
* Right team in place to break down silos
* Advanced planning and alignment within budget cycles

**Thoughtful program design to adapt the framework appropriately for sectoral contexts**

Digging underneath the covers of individual Grand Challenges reveals a wide variation in program structures, including a significant degree of difference in terms of funding levels, formality, and division of roles and responsibilities. “That level of variation has been a real challenge -- no pun intended! -- for Federal agencies and other organizations that say, ‘Hey, I think I want to launch a Grand Challenge goal or Grand Challenge program for X. … What do I do next?’ That wide variation has rightfully been a roadblock because it means that the onus is on the program manager to figure out what structure makes the most sense,” comments Cristin Dorgelo [Dorgelo, C., phone interview with Policy Design Lab, August 3, 2016] She adds, “While that’s a challenge, I actually think it’s the right thing: When you’re thinking about a Grand Challenge -- an ambitious, yet achievable goal -- […] it makes sense that in each given sector or industry that […] the means to reach that goal are going to be different, based on the state of the market and based on who the actors are. It requires very savvy and thoughtful program design” [Dorgelo, C., phone interview with Policy Design Lab,August 3, 2016].

**Open-minded approach to goal definition and redefinition**

Appropriately defining the scope and boundaries of the challenge goal is foundational for success. It’s important not only to invest adequate time and resources in the problem definition process, but to remain receptive to further refining the target based on feedback. It’s essential, says Dorgelo, that agency staff retain “the flexibility and willingness to adjust the goal if needed -- if you’re learning that what you put forth to the public either is isn’t achievable, or it’s too hard, or the facts on the ground may mean you need to change it” [Dorgelo, C., phone interview with Policy Design Lab, August 3, 2016]. She observes that in some Grand Challenge instances, the initial problem definition turned out to need further adjustment – and savvy Grand Challenge managers can respond by tweaking program language in order to orient towards success [Dorgelo, C., phone interview with Policy Design Lab, August 3, 2016].

**High-level support and receptivity for new problem-solving approaches**

A Grand Challenge requires the support of high-level authority, as it requires access to a coalition of diverse stakeholders and the ability to convene them together. Leadership is also key to establishing a culture where a team is brought into the process. Beginning at the top, leadership needs to create a space for people to feel comfortable imagining how they might do their job differently, and how to engage with innovative approaches like challenges to deliver on those objectives. While this holds true for nearly any innovation approach, Grand Challenges in particular require permission to reimagine how we frame, engage with, and solve problems. Identifying clear objectives and how the problem can be best solved using a Grand Challenge helps gain traction within a department.

**Breaking down silos requires having the right team**

Grand Challenges inherently require multi-sectoral collaboration, which also brings natural organizational challenges. But overcoming barriers to collaboration is essential for Grand Challenges to succeed; this can require challenging conventional arrangements and breaking down silos to bring different stakeholders together. [Crosslink V5 content]

One program director also stressed that “Grand Challenges will not be successful unless you have the right people” assigned to the project internally. Successful implementation requires assembling a team of creative, non-linear thinkers with the ambition to see beyond what will happen next year, and who can instead target longer time horizons.

**Advance planning and alignment within budget cycles**

A necessary ingredient is a Grand Challenge champion with budget authority. But the reality of the budget and solicitation cycles can be a tough obstacle for Grand Challenge deployment. Program managers and agency leadership may both want to first consider how to structure Grand Challenges for their budgeting within a 1-2 year timeframe. For instance, with solicitation planning cycles beginning 8 months before going public, it's difficult to adjust content two months before launching [Gustetic, J., phone interview with Policy Design Lab, July 25th, 2016].Additionally, budget planning needs to consider long-term plans for integration and follow-on from the outcomes produced by the challenge. There needs to be both a plan and budget for implementation. Although program planning needs to align with budget planning, Grand Challenges must remain unapologetically ambitious.

**Deploying in an appropriate context, or, what a Grand Challenge is not:**

Too much deviation from the common understanding of a “Grand Challenge” dilutes the power and efficacy of the approach. While there’s great flexibility in how Grand Challenge goals can be pursued, there are bright lines around what it is, and isn’t. The quality of the goal matters; it must be audacious, achievable, and innately relatable. It must bring people together and inspire engagement. “There are goals that simply are not Grand Challenge goals. […] They are not compelling, they are not ambitious, or they’re a pipedream and you’re highly unlikely to achieve them based on current capabilities and trends in science, technology, and society. Or, they’re not understandable to the person on the street who would want to know why an engineer is devoting his life to that goal, or why a scientist is devoting her research to that goal,” comments Cristin Dorgelo [Dorgelo, C., phone interview with Policy Design Lab, August 3, 2016].

TheGrand Challenge framework is also not credible if used as ex-post rationalizations of existing policy, or as a communications framework that merely repackages existing agency initiatives. A misguided application of the Grand Challenge label would be to apply it to in-house strategic planning efforts.

#### Deliverable 6: How-To: Steps for deploying, practices for adapting

* **What is a moonshot?**
* **Grand Challenge 3 stage process**
* **Recommended checklist**
* **Problem definition textbox**

Grand Challenges are often referred to as “moonshot” goals because of their scale and audacity. Chris Gerdes, former Chief Technology Officer at the Department of Transportation, comments that the term has “become shorthand notation for everything innovative: ‘I’m doing a moonshot.’” [Gerdes, C., phone interview with Policy Design Lab, July 1, 2016]. But “a moonshot is not just a moonshot,” he argues Gerdes, C., phone interview with Policy Design Lab, July 1, 2016. Transformative breakthroughs are achieved through a series of incremental and additive steps. [Crosslink Moonshot textbox here –from V8]

The broad and inspiring call of a Grand Challenge breaks down into a series of constituent parts and processes for implementation:

**Grand Challenge Three-Stage Process**

|  |  |  |
| --- | --- | --- |
| **Phase One** | **Phase Two** | **Phase 3** |
| Problem Definition | Program Development | Program Implementation |

Cristin Dorgelo emphasizes that problem definition is such a key component of instituting a Grand Challenge that agencies need to consider as its own process – with its own timeline, budget, and project management plan [Dorgelo, C., phone interview with Policy Design Lab, August 3, 2016] “Just to get to the place where you have the goal you want to pursue is, in itself, its own project,” she notes [Dorgelo, C., phone interview with Policy Design Lab, August 3, 2016] Then what? “What happens next is essentially a program development effort where, based on that goal, the program managers need to work backwards to figure out ‘What resources do we already have or could we develop that would help us pursue the goal? What partners and stakeholders do we need to bring around our planning table?’” [Dorgelo, C., phone interview with Policy Design Lab, August 3, 2016]

Three key steps:

* Figure out how appropriated funds can be designated for particular purposes
* Develop an engagement strategy and timeline. Assess your communications resources -- event planning, communications roll-out strategy, with the goal of convening the community
* Look at who your partners are or could be, and evaluate authorities, requirements, and responsibilities for partnerships.

Program staff should consider a range of questions about how they can, in a Federal context, engage with other organizations – formally or informally – and which approach is most appropriate for the goal. Questions might include:

* “How much control do I want to maintain?
* “Do I want to just issue this into the world, and let a 501c3 or other entities out there in the public take it forward?”
* “Do I want to formally partner with other organizations to help me run this?”
* “Am I contracting with them, or am I partnering?”

Dorgelo advises: “Figure out what funding and other resources you have. Figure out your plan for getting the word out and attracting people to help you and to work towards your identified goal. Figure out what relevant authorities your agency has at its disposal for partnering or for funding projects flexibly, and what you can and can’t do based on those authorities. And figure out what the schedule and timeline is going to be for getting people around the table to execute the Grand Challenge Program. Who is going to be around that planning table, what are you going to ask them to do, and what are you allowed to ask them to do?” [Dorgelo, C., phone interview with Policy Design Lab, August 3, 2016]

This stage of program development is very similar to similar planning processes for prize competitions; program managers may find prize competition resources valuable in their planning work. [CROSSLINK Prizes toolkit]

**Recommended Checklist for Grand Challenges**

**Problem Definition**

* Identify the ultimate goal; achieve a “Goldilocks” balance between ambition and feasibility.
* Use problem decomposition methodologies or segmenting processes. Invest significant time in breaking the goal down into component parts that can be addressed by different segments of the public so that field experts, distant experts, and citizen solvers can all contribute in different ways. This is particularly true for Grand Challenges focused around technical research questions, where segmenting can help identify the contributions non-experts can still make.
* Conduct barrier analysis to assess the environment surrounding the problem, sourcing input from stakeholders and incorporating feedback into the goal definition.

**Designing a Challenge**

* Clearly define measurable targets for success and timing of completion.
  + A Grand Challenge that is too narrowly defined or that presumes some particular technical approach may reduce the opportunity for new and truly effective solutions; to combat this, invest significant planning time in problem definition.
* Set a timeframe: Typically a 5 to 10 years natural timeframe, but at most 20 years.
  + The timeframe often falls outside the customary administrative time frame (four-year term).
  + Multi-year engagement is fundamental; time is necessary to build momentum and catalyze self-sustaining “marketplaces” where stakeholders have truly invested.
* Assess incentive levels if designing prize or grant element:
  + Set a prize level large enough to get people interested and engaged.
  + Balance the level of talent resources (internal and external) needed to service different levels of funding.
* Launch a comprehensive engagement strategy to draw in stakeholders, particularly new voices.

**Challenge Implementation**

* Pair with a variety of back-end modalities, appropriate for different contexts:
  + An all-in commitment from government (like NASA’s space program);
  + Engaging matching funds from private sector’
  + Agency announces commitment framework, creating space for others to support it’
  + Agency makes a commitment and sources a prize with external partnerships, but the agency does not fund resulting solutions.
* Leverage the stakeholder community.
  + Encourage partners and networks to plan follow-on activities around the Challenge, in order to fully capture benefit from the activity generated.
* Set clear benchmarks for progress.
  + The challenge has to be something that's easy to assess progress against, but does not necessarily require a lot of new measurement apparatus.

**Deeper insight on the problem definition process**

|  |
| --- |
| Q: **Is there a particular diagnostic process that you encourage people to go through to help identify the big audacious goal?**  A: There are some proven approaches that I think Grand Challenge program designers should use when it comes to problem definition, and they all focus on the concepts of ever increasing circles of input. It is unlikely that a single individual in a room could conceive of a Grand Challenge goal that could check all those boxes I described as being compelling, of being audacious, of being achievable et cetera.  There are probably some very talented, very bright scientists and engineers who could and have defined that goal by themselves alone in a room. But most program managers who are wrestling with a thorny problem such as how to get solar adoption across the United States or how to make electric vehicles as cost-effective as gas powered vehicles, struggle -- like all of us do -- with problem definition. And so, the ways that program managers have approached this that has worked is to engage in a brainstorming process with a diverse set of participants. Often this happens, as I said, in an ever expanding way, where first, they’re doing this problem definition within their organization.  NASA for example hosted what they called Big Think sessions where they brought people within the agency, from different aspects of the agency, together to start brainstorming about what those audacious goals might be, where their leadership team then down-selected that list of audacious goals to the most compelling, where some feasibility assessment was done (meaning, how much does this goal match with what Congress is telling us to, what do we have money for already, what is already going to happen without our help). And then they take that more limited set of goals and start expanding their circle to external advisory bodies, to the general public, to get input and reactions. And they are flexible and willing to adjust course, and willing to tweak their concept for their Grand Challenge goal based on feedback received.  Also, you can look to what the Department of Energy did with EV-Everywhere Grand Challenge. They used that internal process that I was describing -- of coming up with the idea, vetting the ideas to figure out how feasible they are, and getting input from key internal stakeholders. And when they went public with their goal, they issued essentially what I think of as their top bullet—we want to make electric vehicle as affordable and cost-effective and convenient to own as gas-powered vehicles. But at the start, they didn’t publish any what I think of as the sub-bullets to that overarching goal, because they wanted more input. So even though they had a theory of the case about how you would get an electric vehicle that was as affordable and cost-effective and convenient to own as gas powered vehicle, they didn’t publish that immediately. They went out and they talked to tons of stakeholders and said ‘What would we need to do this?’ And they learned things, and they changed the definition of how they were going to pursue that goal as a result of that input.  If I think back to XPRIZE and to how DARPA also has tried to define the goals that they were going to use for their Grand Challenge prize competitions to pursue their Grand Challenge goals, they did similar things. They talked to a lot of experts. They narrowed down the range of how you might measure success, because like any smart goal, you need it to be measurable, you need it to be time bound, and you need to be realistic. And so they asked, “what are the criteria we’re going to use to measure success?” They came up with a few potential framings for how to go after that envisioned future of success.  They usually included in that a few different types of criteria that could be used to measure whether the goal had been reached. So, for example, if you’re looking at radically improving the cleanup of oil from water, you could be looking at efficiency of cleanup oil from water. You could be looking at effectiveness of cleanup oil from water, or the total volume of oil collected. You could be looking at the diversity of environments in which that new technology can operate, et cetera. They then took all those potential criteria; they aired them in front of a large number of experts. The experts told them, “Right criteria, wrong criteria. A bar too high. A bar too low.” They listened to that and *then* they set the goal.  And so, **if there’s one secret sauce, it’s that increasing feedback loop until you heard that feedback so frequently that you think you got it right**. And then there’s the willingness to put that goal out there publicly and get input on how to define the next level, the next sub bullets down, in terms of how you get there, how you achieve that Grand Challenge goal.  [Dorgelo, C., phone interview with Policy Design Lab, August 3, 2016] |

#### Deliverable 7: Online inventory of resources

**Contact**

Agencies interested in learning more about Grand Challenges can contact Lorin Kavanaugh-Ulku at lkavanaughulku@usaid.gov

**How-to resources:**

* [“Moving from a Culture of "Problem Solving" to a Culture of "Problem Definition,"](https://www.youtube.com/watch?v=5AFGV9oPOR0&index=6&list=PLd9b-GuOJ3nHmi8ezudkvqyEtZ3r7WB5Q) Dr. Zoe Szajnfarber, George Washington University researcher [1:15 minutes; 25 minute presentation]
* [“Identify and Define the Problem.”](https://static.globalinnovationexchange.org/s3fs-public/asset/document/Innovation%20Toolkit%20Step1%20Identify%20and%20Define%20Problem.pdf?fTX9Pboak5vTfNrxM2VbaF_wXPo0DugY)  Problem Definition Toolkit from Tools for Innovative Programming, U.S. Global Development Lab at USAID.

**Resources for problem definition**

* Spradlin, D., [“Are you solving the right problem?”](https://hbr.org/2012/09/are-you-solving-the-right-problem)  Harvard Business Review, September 2012. A discussion a process for defining the problem.

**Further Reading:**

[[Upload OSTP Slide deck]]

[“Grand Challenges.”](https://www.whitehouse.gov/administration/eop/ostp/grand-challenges) Office of Science and Technology Policy. Web page that explains the genesis and goals of Grand Challenges

[“The Grand Challenges of the 21st Century”](https://www.whitehouse.gov/sites/default/files/microsites/ostp/grandchallenges-speech-04122012.pdf) Tom Kalil, 2012 speech. Transcription of speech explaining Grand Challenges - their benefits and roles.

["Grand Challenges in US Science Policy Attempt Policy Innovation" *International Journal of Foresight and Innovation Policy* (2016).](http://works.bepress.com/diana_hicks/38/) This paper by Dr. Diana Hicks provides a comprehensive history of the evolution of Grand Challenges outside and within the Federal government.

[“From Science Fiction to Science Fact”](https://www.whitehouse.gov/blog/2015/10/21/science-fiction-science-fact) (OSTP, October 2015). Blog post by OSTP on the imaginative power of science fiction to frame how we dream big.

News Articles:

[Lamb, G.M., "Grand challenges spur grand results," Christian Science Monitor, 12 January, 2006](http://aaswsw.org/wp-content/uploads/2014/07/Grand-Challenges-and-Great-Opportunities-Omenn-SCIENCE-2006.pdf).Ad[e](http://aaswsw.org/wp-content/uploads/2014/07/Grand-Challenges-and-Great-Opportunities-Omenn-SCIENCE-2006.pdf)e[p](http://aaswsw.org/wp-content/uploads/2014/07/Grand-Challenges-and-Great-Opportunities-Omenn-SCIENCE-2006.pdf)e[r](http://aaswsw.org/wp-content/uploads/2014/07/Grand-Challenges-and-Great-Opportunities-Omenn-SCIENCE-2006.pdf) [l](http://aaswsw.org/wp-content/uploads/2014/07/Grand-Challenges-and-Great-Opportunities-Omenn-SCIENCE-2006.pdf)o[o](http://aaswsw.org/wp-content/uploads/2014/07/Grand-Challenges-and-Great-Opportunities-Omenn-SCIENCE-2006.pdf)ki[n](http://aaswsw.org/wp-content/uploads/2014/07/Grand-Challenges-and-Great-Opportunities-Omenn-SCIENCE-2006.pdf)t[o](http://aaswsw.org/wp-content/uploads/2014/07/Grand-Challenges-and-Great-Opportunities-Omenn-SCIENCE-2006.pdf) [G](http://aaswsw.org/wp-content/uploads/2014/07/Grand-Challenges-and-Great-Opportunities-Omenn-SCIENCE-2006.pdf)r[a](http://aaswsw.org/wp-content/uploads/2014/07/Grand-Challenges-and-Great-Opportunities-Omenn-SCIENCE-2006.pdf)n[d](http://aaswsw.org/wp-content/uploads/2014/07/Grand-Challenges-and-Great-Opportunities-Omenn-SCIENCE-2006.pdf) [C](http://aaswsw.org/wp-content/uploads/2014/07/Grand-Challenges-and-Great-Opportunities-Omenn-SCIENCE-2006.pdf)h[a](http://aaswsw.org/wp-content/uploads/2014/07/Grand-Challenges-and-Great-Opportunities-Omenn-SCIENCE-2006.pdf)l[l](http://aaswsw.org/wp-content/uploads/2014/07/Grand-Challenges-and-Great-Opportunities-Omenn-SCIENCE-2006.pdf)e[n](http://aaswsw.org/wp-content/uploads/2014/07/Grand-Challenges-and-Great-Opportunities-Omenn-SCIENCE-2006.pdf)g[e](http://aaswsw.org/wp-content/uploads/2014/07/Grand-Challenges-and-Great-Opportunities-Omenn-SCIENCE-2006.pdf)s[,](http://aaswsw.org/wp-content/uploads/2014/07/Grand-Challenges-and-Great-Opportunities-Omenn-SCIENCE-2006.pdf) [e](http://aaswsw.org/wp-content/uploads/2014/07/Grand-Challenges-and-Great-Opportunities-Omenn-SCIENCE-2006.pdf)s[p](http://aaswsw.org/wp-content/uploads/2014/07/Grand-Challenges-and-Great-Opportunities-Omenn-SCIENCE-2006.pdf)e[c](http://aaswsw.org/wp-content/uploads/2014/07/Grand-Challenges-and-Great-Opportunities-Omenn-SCIENCE-2006.pdf)i[a](http://aaswsw.org/wp-content/uploads/2014/07/Grand-Challenges-and-Great-Opportunities-Omenn-SCIENCE-2006.pdf)l[l](http://aaswsw.org/wp-content/uploads/2014/07/Grand-Challenges-and-Great-Opportunities-Omenn-SCIENCE-2006.pdf)yi[n](http://aaswsw.org/wp-content/uploads/2014/07/Grand-Challenges-and-Great-Opportunities-Omenn-SCIENCE-2006.pdf) [s](http://aaswsw.org/wp-content/uploads/2014/07/Grand-Challenges-and-Great-Opportunities-Omenn-SCIENCE-2006.pdf)p[e](http://aaswsw.org/wp-content/uploads/2014/07/Grand-Challenges-and-Great-Opportunities-Omenn-SCIENCE-2006.pdf)c[i](http://aaswsw.org/wp-content/uploads/2014/07/Grand-Challenges-and-Great-Opportunities-Omenn-SCIENCE-2006.pdf)f[i](http://aaswsw.org/wp-content/uploads/2014/07/Grand-Challenges-and-Great-Opportunities-Omenn-SCIENCE-2006.pdf)cf[i](http://aaswsw.org/wp-content/uploads/2014/07/Grand-Challenges-and-Great-Opportunities-Omenn-SCIENCE-2006.pdf)e[l](http://aaswsw.org/wp-content/uploads/2014/07/Grand-Challenges-and-Great-Opportunities-Omenn-SCIENCE-2006.pdf)d[s](http://aaswsw.org/wp-content/uploads/2014/07/Grand-Challenges-and-Great-Opportunities-Omenn-SCIENCE-2006.pdf).

Voosen, P.,[“To Win Funds, Scientists Pursue Sweeping Solutions to Social Ills.”](http://chronicle.com/article/To-Win-Funds-Scientists/151717/)  The Chronicle of Higher Education, February 2015. Grand Challenges, and their politics and funding, explained.

Domain-specific reading:

[National Science Foundation Advisory Committee for Cyberinfrastructure Task Force on Grand Challenges, 2011 Report:](https://www.nsf.gov/cise/aci/taskforces/TaskForceReport_GrandChallenges.pdf) A domain-specific look at how the grand challenge framework is being used to advance discoveries in six specific computer science and engineering domains.

[Battelle Memorial Institute,"Economic Impact of the Human Genome Project", May 2011, : This](http://www.battelle.org/docs/default-document-library/economic_impact_of_the_human_genome_project.pdf) report quantifies the tremendous return on investment generated by the Human Genome Project (a return of $141 for every $1 invested), showing what’s achievable with a Grand Challenge framework.

Academic Literature:

Kallerud, E., Amanatidou, E., Upham, P., Nieminen, M., Klitkou, A., Olsen, D.S., Toivanen, M.L.,

Oksanen, J., Scordato, L. (2013) *Dimensions of Research and Innovation Policies to Address Grand and Global Challenges*. NIFU Working Paper. Working paper on issues brought up by the international development of R&I policies.

Kuhlmann, B.S., Rip, A., [*The challenge of addressing Grand Challenges*.](http://doc.utwente.nl/92463/1/The_challenge_of_addressing_Grand_Challenges.pdf) University of Twente. January 2014. A think piece on how R&D and innovation definitions and processes themselves need to change to be able to address Grand Challenges.

Leijten, J., Butter, M., Kohl, J., Leis, M., Gehrt, D., January 2012. I*nvesting in Research and Innovation for Grand Challenges.* Joint Institute for Innovation Policy (JIIP). Research into shift and evidence into “grand challenges” style thinking in Europe.

Mowery, D. C. (2012). ‘Defense-related R&D as a model for “Grand Challenges” technology

policies’. *Research Policy*, 41(10), 1703-1715. How the lesson of defense research can be applied to other challenges.

**For more on the modern origins of Grand Challenges:**

Wilson, K. G. (1983) *Views on Science Policy of the Nobel Laureates for 1982*, Hearing before the Committee on Science and Technology, U.S. House of Representatives, 98th Congress, 1st

Session, February 23, 1983, USGPO, Washington D.C., pp. 10-25.

Wilson, K. G. (1984) ‘Science, Industry, and the New Japanese Challenge’, *Proceedings of the*

*IEEE*, Vol. 72, No. 1, pp. 6-18. How the US government should support computerization of science and build a network for those working in it.

Wilson, K. G. (1988) ‘Grand challenges to computational science’, *AIP Conf. Proc.* Vol. 169, pp.

158-169. The supercomputer and its relation to science

Wilson, K. G. (1989) ‘Grand Challenges to Computational Science’, *Future Generation*

*Computer Systems*, Vol. 5, No. 2, pp. 171-189. Explores opportunities and the “tougher” challenges to the realm of computer science.

"A Research and Development Strategy for High Performance Computing", Executive Office of the President, Office of Science and Technology Policy, November 20, 1987. Research paper on how high performance computers can be used in relation to federal government research and development.

#### Deliverable 8: Examples of policy that have enabled or encouraged approach (legislation, exec order)

Legislation

[American Innovation and Competitiveness Act 2016](https://www.congress.gov/bill/114th-congress/senate-bill/3084)

[America COMPETES Reauthorization Act of 2010](https://www.nsf.gov/statistics/about/BILLS-111hr5116enr.pdf)

[15 U.S. Code Chapter 81 - High-Performance Computing § 5503](https://www.gpo.gov/fdsys/search/pagedetails.action;jsessionid=J3GRS16V8pXMyXytqXjBxBJycBGx2P8ybcxH7VzjT0nTvPJmMTlL!352320610!-18081458?browsePath=Title+15%2FCHAPTER+81&granuleId=USCODE-2011-title15-chap81&packageId=USCODE-2011-title15&collapse=true&fromBrowse=true)

Policy Guidance

“[A Strategy for American Innovation](https://www.whitehouse.gov/sites/default/files/strategy_for_american_innovation_october_2015.pdf)”, National Economic Council and Office of Science and Technology Policy, October 2015.

[Zients, J.D. “Guidance on the Use of Challenges and Prizes to Promote Open Government.” OMB M-10-11. March 8 2010](https://www.whitehouse.gov/sites/default/files/omb/assets/memoranda_2010/m10-11.pdf)

[“Memorandum for the Heads of Executive Departments and Agencies.” OMB M-10-30. July 21 2010](https://www.whitehouse.gov/sites/default/files/omb/assets/memoranda_2010/m10-30.pdf)

[“Memorandum for the Heads of Executive Departments and Agencies.” OMB and OSTP M-12-15. June 6 2012](https://www.whitehouse.gov/sites/default/files/omb/memoranda/2012/m-12-15.pdf)

[“Memorandum for the Heads of Executive Departments and Agencies.” OMB and OSTP M-13-16. July 26 2013](https://www.whitehouse.gov/sites/default/files/omb/memoranda/2013/m-13-16.pdf)

[Holdren, J.and Smith, M., “Exit Memo: Office of Science and Technology Policy” Jan 5, 2017](https://www.whitehouse.gov/administration/cabinet/exit-memos/office-science-and-technology-policy)

#### Deliverable 9: Future directions (“next practices as opposed to best practices”)

The next frontier for Grand Challenge deployment is the realm of social policy. Agencies concerned about the bottom half of the income distribution have had less connection, historically, to the entrepreneurial and STEM communities where Grand Challenges have arisen. But the framework could be used to accelerate progress on domestic and societal challenges that relate to poverty alleviation and social mobility, as demonstrated by USAID’s track record of success with internationally-focused challenges.

Harnessing the visionary power of the Grand Challenge framework for social policy could lead to big questions like:

*“Can we shift the unemployment rate by ½ percent? What would that look like?”*

*“Our current workforce development investment programs, on average, increase wages of beneficiaries by $1,800; how do we increase that by a factor of 10?" [Kalil, T., in-person interview with Policy Design Lab, July 21, 2016]*

More could be done by external stakeholders to further maximize the power of Grand Challenges. What if in 5 years a quarter of Fortune 500 companies had a goal that was ambitious as IBM advancing AI by beating Gary Kasparov at chess or Ken Jennings at Jeopardy? For instance, what if companies focused not just on developing self-driving cars, but using that approach to reduce traffic fatalities by 80%? What if half of leading research universities were involved in at least one Grand Challenge? [Tom Kalil, T., in-person interview with Policy Design Lab, July 21, 2016]

More reflection is needed to assess lessons learned as agencies continue to iterate and refine their Grand Challenge operations. “We must share information insight and resources so that we can make informed decisions around what challenges are needed, what solutions already exist and how they are performing. It doesn’t make sense to keep doing Challenges without being transparent and efficient about what it coming out of them, not just the winners, but all of the ideas, funded or not,” shares Grace Kim, Global Innovation Exchange Project Manager, U.S. Global Development Lab at USAID [Kim, G., personal communications with Policy Design Lab, November 10, 2016].

In the present, it’s also important that current and near-future Grand Challenges continue to push big questions. Once talent is assembled by the call of a challenge, what else can we be doing to fully maximize their contributions? Grand Challenges are opportunities to source catalytic breakthroughs, but they also offer an opening to mobilize the *full* distribution of stakeholders affected by the problem.

**Annex of interviews:**

Randy Atkins, NAE

Ann Mei Chang, USAID

Dan Correa, OSTP

Cristin Dorgelo, OSTP

Jenn Gustetic, NASA

Tom Kalil, OSTP

Lorin Kavanaugh-Ulku, USAID

Jason Kessler, NASA

Minh Le, DOE

Seema Patel, USAID

Sonal Shah, formerly WHOSI

Grand Challenges for Development program managers: [All: 11/10/16, personal communication]

Tony Bloome, USAID

Alexis Bonnell, USAID

Karen Clune, USAID

Grace Hoerner, USAID

Chris Jurgens, USAID

Bruce Kay, USAID

Marissa Leffler, USAID

Ku McMahan, USAID

Ryan Shelby, USAID

STPI interviews:

Jesse Goldhammer

Jenn Gustetic

George Hernandez

Points of Contact:

1) Cristin Dorgelo, Chief of Stadff, OSTP, [Cristin\_A\_Dorgelo@ostp.eop.gov](mailto:Cristin_A_Dorgelo@ostp.eop.gov)

1. Jenn Gustetic, SBIR/STTR, Program Executive, NASA, [jennifer.l.gustetic@nasa.gov](mailto:jennifer.l.gustetic@nasa.gov)
2. Seema Patel, USAID, Division Chief, Innovation and Design Advisory, Global Development Lab, [seepatel@usaid.gov](mailto:seepatel@usaid.gov)