Things to Try: Grand Challenges

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# Overview

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 inspire significant advances for national priorities. A pioneering vision, large-scale collaborative effort, and an ambitious but defined 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 2016, p.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 have 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.

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

## Why Grand Challenges?

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, there is potential for significant progress. Along with innovative policy tools like [[prize competitions]] and [[crowdsourced citizen science]], 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.

## How to Start With Grand Challenges

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 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 seven active [Grand Challenges for Development](https://www.usaid.gov/grandchallenges) that address challenges in infant mortality, energy for agriculture, water, reading, fighting Ebola, and improving government performance and accountability. *[*[*StratInnov 2015*](about:blank)*]*

This challenge-oriented policy framework 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;
* Tackling important problems related to energy, health, education, the environment, national security, and global development; and
* Serving as a “North Star” for collaboration between the public and private sectors. [CROSSLINK PPP]

# Benefits of Grand Challenges

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

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

## Inspire 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. [[Source]](http://www.battelle.org/docs/default-document-library/economic_impact_of_the_human_genome_project.pdf)

## Architect greater multi-sector collaboration with transformative outcomes.

Companies and philanthropies could sponsor major incentive prizes designed to address a Grand Challenge. 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]

## Is potentially a "new language" for research frameworks.

It’s more than just 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." (Diana Hicks 2016, p. 12).

## Inspire 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 brought together by the National Science Foundation 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/)

# How to Create Grand Challenges

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 incite cross-sector collaboration between the private sector, universities, researchers, and other public entities. 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 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 actually 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? 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, USAID’s Global Development Lab, reflecting how Grand Challenges have been a powerful tool for USAID in their work to support electrification in Africa

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 OSTP and formerly head of operations at the X Prize Foundation -- either because they haven’t thought of it, they don’t have enough resources for it, or the goal didn’t call for it.

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 [PCAST](https://www.whitehouse.gov/administration/eop/ostp/pcast)’s [Nano Grand Challenge](http://www.nano.gov/grandchallenges), where the goal was announced via [blog post](https://www.whitehouse.gov/blog/2015/10/15/nanotechnology-inspired-grand-challenge-future-computing). Follow-on engagement work at industry-specific convenings spurred active discussion on what it would take to pursue such a goal.) At the midpoint 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. 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.

## Grand Challenge versus Prize Challenges

“Unlike prizes, where there are some very 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 operations at the X Prize Foundation. In other words, a Grand Challenge may choose to encompass a prize competition element, 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: Venn diagram graphic depicting overlap between Grand Challenges and other modalities, including prizes]]*

## History of Grand Challenges [[Sidebar embed]]

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. 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. [[“Grand Challenges” Definition](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](https://www.gpo.gov/fdsys/pkg/USCODE-2011-title15/html/USCODE-2011-title15-chap81-sec5503.htm)

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)

# Success Stories

1. [Department of Energy: SunShot Initiative](#_24c52qxqhsim)
2. [NASA: Asteroid Grand Challenge](#_tmpc1273occ8)
3. [USAID: Grand Challenges for Development](#_uwa9z9a0shjm)
4. [Grand Challenges Scholars Program](#_24d588e1kb06)

## Department of Energy SunShot Initiative

### Summary

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

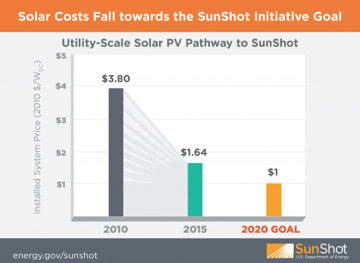
Launched in 2011, the [Department of Energy’s (DOE) SunShot Initiative](http://www1.eere.energy.gov/solar/sunshot/index.html) is a Grand Challenge effort to make solar energy cost-competitive with other forms of electricity by the end of the decade. The audacious goal -- to drive down the cost of solar 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 350 awardees, funding cooperative research, development, demonstration, and deployment projects by private companies, universities, state and local governments, nonprofit organizations, and national laboratories.

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 and Impact

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. 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 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. Meanwhile, the overall costs of solar have dropped by 65 percent:



### How They Did It

Describing the genesis of SunShot, Minh Le, deputy director of the Solar Energy Technologies Office within the Office of Energy Efficiency and Renewable Energy, identified the cost-effective nature of using a Grand Challenge framework: “We were challenged to think about any tech and how you bring it to scale and have broad, global impact. We needed it to be economically competitive, so cost was an important factor in thinking about how to use our funds.”

SunShot’s broad articulation enabled a systems-level perspective to emerge during implementation, which highlighted the importance of certain aspects previously under-resourced. Prior to SunShot, there had been an overall cost goal, for example, with emphasis on the cost of the module. 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 to balance systems and [soft costs](http://energy.gov/eere/sunshot/soft-costs).

### Key Insights

#### Grand Challenges 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. SunShot program staff spent a year soliciting feedback from stakeholders into program definition. After integrating feedback, Dorgelo explains, DOE “took their existing funding streams in each of these cases and reoriented them towards what they had heard would be needed to achieve that goal.”

#### Set a big target and ensure its sufficiently funded.

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 for the program.

#### Hire the right people.

The Challenge demanded highly trained technical team for active management of the grants. A concerted push was made with grantees to find new avenues, with an overarching emphasis on the ambitious quantitative goal.

#### Leadership from the top.

The Secretary of Energy was integrally involved in the effort and supported co-funding of projects across the agency and had high involvement by the National Science Foundation.

#### Good branding.

The program wasn’t originally launched as SunShot; the name came later, but effective branding and messaging has been essential to the program’s success.

#### Use a wide variety of funding mechanisms.

“In SunShot’s case, they used a wide variety of funding mechanisms,” 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 like grants and contracts but also incentive prizes where appropriate.” Prize competitions, for instance, were a good fit for software needs – by using short timeframes and smaller funding rates, it encouraged software companies to lower hurdle rates.

#### Make it timely.

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.

### Additional Resources

* [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 Vision 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)

## National Aeronautics and Space Agency: Asteroid Grand Challenge

### Summary

[[[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 is focused on finding all asteroid threats to human populations and knowing 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.

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 asking the public for help can draw in citizen solvers.

### Key Accomplishments and Impact

The AGC has accelerated NASA’s cataloging capabilities for near-earth objects, and the benefits of the Challenge are not limited to the immediate contributions. Marrying serious science and smart engagement with the public (one tagline: "Dinosaurs didn't have a space program"), the Challenge framework and its successes drew significant attention to the program. 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). The AGC is an example of how Challenges can helps to seed and sustain continued work in critical mission areas.

### How They Did It

NASA used a brainstorming technique (“Big Think”) to help the agency to select a grand challenge. Originally, the idea considered finding all asteroids. The President helped sharpen the focus to target asteroids that could harm humanity. Deconstructing the problem through a process of "problem decomposition" was essential for NASA to identify areas that they could encourage the broader population to engage with. They invested time to identify the specific dimensions of the problem non-experts could support and the areas that were more likely to allow for "distant experts" (experts in other fields) to contribute specialized knowledge. Using problem decomposition methodologies enabled NASA to define and segment the Challenge so that citizen solvers could also participate, volunteering labor to assist in pattern recognition.

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

The overriding message of the Asteroid Grand Challenge? Asteroid hunting is an activity everyone can get involved in. But 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.

### Key Insights

The Asteroid Grand Challenge demonstrates how the framework can help to shift the policy environment. Cristin Dorgelo, who previously supported agencies’ Grand Challenge work at OSTP, comments: “NASA has been probably the most creative in getting public input for both the goal itself and the pursuit of the goal.” The idea of "everyone an asteroid hunter" was also a powerful way to further involve the public in NASA's work. Asking for the public’s help was a powerful narrative for NASA; by framing the call as, “We can’t do this alone, we need you,” it drew in motivated citizen scientists and experts alike. In this instance, NASA wasn't attempting to change how its program operated. Instead, the goal was to fill in gaps and accelerate progress through adding in new ideas.. 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 the general public, international actors, and other federal agencies.

### Additional Resources

* [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%2520Activity/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)

## U.S. Agency for International Development (USAID) Grand Challenges for Development

### Summary

[USAID’s Grand Challenges for Development (GCDs)](https://www.usaid.gov/news-information/frontlines/grand-challenges/introduction-grand-challenge-next-generation-solutions) are effective programmatic frameworks that focus global attention and resources on specific, narrowly defined international development problems and promote the innovative approaches, processes and solutions to solving them. The Grand Challenges emphasize the engagement of non-traditional solvers around critical development problems while prioritizing systems-level thinking. “Under these Grand Challenges, we realize that it’s not enough to source innovation,” explains Ann Mei Chang, Chief Innovation Officer of the Global Development Lab at USAID: “There are all these other barriers to scaling up -- whether that’s capacity of skills in country, or bringing the right ecosystem of players and financiers coming together, or other industry relationships -- we can actually do different methodologies within the Grand Challenge framework.” USAID’s use of the Grand Challenge framework in particular shows 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. [crosslink to Partnerships, Prizes/Challenges]

To date, USAID has launched seven Grand Challenges with public and private sector partners to address critical challenges in global health, water, energy, agriculture, literacy, and improving government performance and accountability, including:

* [Saving Lives at Birth](about:blank), which was designed to improve maternal and newborn health during the critical 48 hour period after birth by increasing access to primary health care for pregnant women and newborns by at least 50%.
* All Children Reading, which seeks to dramatically increase the number of children in low-income countries who leave primary school with basic reading skills.
* [Ebola Grand Challenge](http://www.ebolagrandchallenge.net/), where 14 innovative solutions were ultimately funded, each addressing key gaps in the Ebola response.

### Key Accomplishments and Impact

Beyond the direct return on investment in terms of solutions in its innovation pipeline, USAID’s experience demonstrates the substantial benefit of highly visible market signaling. “Grand Challenges drive value, with outcomes that often aren’t being measured directly. We tend to [only] measure innovator impact,” 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. The articulation of a Grand Challenge also mobilizes citizen engagement and increases the community of potential solvers, further contributing to systems-level impact.

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.

### How They Did It

Each Grand Challenge for Development is its own unique prototype, adapted for the domain and particular challenges. 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 Insights

#### Define the problem with stakeholder input

Each GCDs 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 that catalyze global action and create an opportunity for problem-solving,” argues Seema Patel. 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. First, frame the problem by assessing the issue landscape and conducting barrier analysis. 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 framework, invest resources in bringing new partners 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: “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, she advises – time is needed to build momentum, and catalyze enough activity that a self-sustaining marketplace emerges.

#### Leverage the framework’s flexibility

Each Grand Challenge for Development has been uniquely structured to most appropriately address the specific problem identified. The variations in the GCDs 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 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. “All of the teams have experimented under the Grand Challenge blueprint to address different parts of the systemic barriers to getting innovations to integrate and scale.”

In all cases, the value of the framework emerged from the convening power, notes Seema Patel. 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 ASP/GDA case study]

#### Continuously learn and refine

USAID’s experience in deploying Grand Challenges reflects a process of continuous learning and refinement. “Underneath the covers,” comments Cristin Dorgelo, there’s been an evolution in how AID”S Grand Challenges are designed. Building on learnings from the early GCDs, later deployments became more complex in the use of implementation tools, moving from one standard funding mechanism to later complementing competitive grant programs with prize competitions and other innovative funding approaches. [Cristin Dorgelo interview] Similarly, early efforts were very driven through partnerships, while more recent challenges with highly technical focus areas have been more appropriately driven through research development. [Seema Patel interview]

Reflecting on Power Africa, one of AID’s most recent Grand Challenge efforts, 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. It’s about how to come up with ideas to solve the problem. This Grand Challenge is really about scaling this sector.” Using the Grand Challenge model, USAID is bringing together different partners to concentrate on scaling cluster solutions.

### Additional Resources

[Grand Challenges for Development](https://www.usaid.gov/grandchallenges)

## National Academy of Engineering (NAE) Grand Challenges Scholars Program

### Summary

In 2008, the National Academy of Engineering’s (NAE’s) issued Grand Challenges for Engineering report, which identified 14 Grand Challenges for Engineering in the 21st century. Cristin Dorgelo explains, the report was intended “to inspire the engineering community to encourage students to pursue engineering fields, to give students opportunities to pursue those fields, and to give other groups beyond NAE a reference point for what **audacity** means for engineering and where the interesting problems are.”

The [Grand Challenge Scholars Program](http://www.engineeringchallenges.org/) developed out of the engineering academic community’s efforts to answer the call. The Program enables engineering students to organize their coursework, research, service, international studies, and experiential learning around a Grand Challenge. The effort aims to pilot new innovative approaches in education that will eventually shift the mainstream training paradigm for all engineering students.

### Key Accomplishments and Impact

Originally envisioned to involve a selective cohort of 20 to 30 students at each school, the goal now is to mainstream the model in engineering programs throughout the country. The ultimate objective: A pool of thousands of graduates per year who are uniquely prepared and highly motivated to address the most challenging problems facing the country and the world. 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 programs into their undergraduate curriculums. They pledged that in a decade, 20,000 engineers will be trained to tackle these complex challenges.

There are several stand-out “early adopter” academic institutions:

* The University of California Los Angeles (UCLA) Grand Challenges initiative connects faculty and students in a multi-disciplinary and holistic engagement to tackle critical problems. The new paradigm emphasizes multi-sector partnerships and collaboration, with an emphasis on new perspectives and transformative outputs. UCLA has launched two Grand Challenges, to date, on Los Angeles' sustainability concerns and depression.
* Indiana University (IU) has committed to invest $300 million over the next five years to tackle up to five Grand Challenge initiatives; the significant investment will be allocated to seed funding and over 175 new faculty lines. The largest research infrastructure investment in the university's 200-year history, the Grand Challenges framework was an important focal point for the university's Bicentennial Strategic Plan. The first research initiative, announced in June 2016, will target precision health. The lofty goals include: 1) curing at least one cancer through the development of new cell, gene, and immune therapies; 2) developing novel methods for identifying or preventing adult neurodegenerative diseases like Alzheimer's; and 3) curing at least one genetic pediatric disease through the use of gene and other therapies.

### How They Did It

Each university is encouraged to embed key principles of the program in their specific context. The program has five integral components:

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 in a global economy;
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 Insights

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

The 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.

#### Effective collaboration gives latitude for each implementing partner

It also emphasizes the flexibility for modalities that fit within the framework; each participating institution is encouraged to define their own unique realization of the goal.

#### Influence, not funds, is necessary for shifting the collective conversation

The original call to action by the NAE, it was not accompanied by substantial funding, notes Cristin Dorgelo. 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.

### Additional Resources

* [**Engineering dean's commitment announcement**](http://www.engineeringchallenges.org/File.aspx?id=15680&v=c29105cb) **in 2015**
* [**Grand Challenges for Engineering**](http://www.engineeringchallenges.org/File.aspx?id=11574&v=ba24e2ed) **– 2008 report**

## Additional Grand Challenges

* BRAIN Initiative [crosslink case study – or embed final version]
* [DOE’s EV-Everywhere Grand Challenge Blueprint](http://energy.gov/sites/prod/files/2016/05/f31/eveverywhere_blueprint.pdf%2520%2520-%2520EV-Everywhere)
* [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](https://nei.nih.gov/audacious)

**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]

# Challenges to Launching Grand Challenges

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. 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.”

## 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.” 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.

## 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 almost 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]

“Grand Challenges will not be successful unless you have the right people,” says Minh Le, deputy director of the Solar Energy Technologies Office within DOE’s Office of Energy Efficiency and Renewable Energy. Successful implementation depends on 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. 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, 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 audacious, or they’re a pipedream, and you’re never going to achieve them. 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.

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.

# How to Launch a Grand Challenge

In this section you will find a series of tools that will help launch a Grand Challenge:

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

## What is a Moonshot?

Grand Challenges are often referred to as “moonshot” goals because of their scale and audacity. Chris Gerdes, Chief Technology Officer at the Department of Transportation, comments that the term has “become shorthand notation for everything innovative: ‘I’m doing a moonshot.’” But “a moonshot is not just a moonshot,” he argues. Transformative breakthroughs are achieved through a series of incremental and additive steps. [Crosslink Moonshot textbox here – See more] [Source: Interview with Chris Gerdes, 7/1/16] 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. “Just to get to the place where you have the goal you want to pursue is, in itself, its own project,” she notes. 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?’”

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, and evaluate rules and responsibilities for partnership authority.

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 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 the money you have. Figure out your plan for getting the word out and attracting people to help you. Figure out what your authorities are, and what you can and can’t do. And figure out what the schedule and timeline is going to be for getting people around the table. Who is going to be around that table, what are you going to ask them to do, or what are you allowed to ask them to do?”

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.

### Design 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 and
* Set a timeframe: Typically a 5 to 10 years natural timeframe, but at most 20 years.
  + The timeframe 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 big 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 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

# Future States

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?"*

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’s Big Blue or Watson? 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 R-1 universities were involved in at least one Grand Challenge?

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.

# Related Policies

[National Economic Council (NEC) and Office of Science and Technology Policy (OSTP) (2015) *A Strategy for American Innovation*, October, White House, Washington D.C.](https://www.whitehouse.gov/sites/default/files/strategy_for_american_innovation_oct)

[Zients, J.D. (2010) *Guidance on the Use of Challenges and Prizes to Promote Open Government*, M-10-11, March 8, Office of Management and Budget, Executive Office of the President.](https://www.whitehouse.gov/sites/default/files/omb/assets/memoranda_2010/m10-11.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%252FCHAPTER+81&granuleId=USCODE-2011-title15-chap81&packageId=USCODE-2011-title15&collapse=true&fromBrowse=true)

# Additional Resources

## 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]
* [Prize Design Interactive session - Developing Ambitious Prizes](https://www.youtube.com/watch?v=r9OGKa_pud8&index=5&list=PLd9b-GuOJ3nHmi8ezudkvqyEtZ3r7WB5Q), Sandeep Patel - Open Innovation Mgr at HHS [1:13 minutes]
* [“Are you solving the right problem?”](https://hbr.org/2012/09/are-you-solving-the-right-problem)  Harvard Business Review, September 2012.

## Further Reading

* [“Grand Challenges.”](https://www.whitehouse.gov/administration/eop/ostp/grand-challenges)  Office of Science and Technology Policy
* [“The Grand Challenges of the 21st Century”](https://www.whitehouse.gov/sites/default/files/microsites/ostp/grandchallenges-speech-04122012.pdf) Tom Kalil, 2012 speech.
* ["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) October 2015 blog post by OSTP on the imaginative power of science fiction to frame how we dream big.

## News Articles

* [G. M. Lamb, "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)
* [“To Win Funds, Scientists Pursue Sweeping Solutions to Social Ills.”](http://chronicle.com/article/To-Win-Funds-Scientists/151717/)  Paul Voosen, February 2015, The Chronicle of Higher Education.

## 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, May 2011, "Economic Impact of the Human Genome Project": 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

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* Mowery, D. C. (2012). ‘Defense-related R&D as a model for “Grand Challenges” technology policies’. *Research Policy*, 41(10), 1703-1715