

Implementation of Federal Prize Authority: Fiscal Year 2015 Progress Report

*Appendix 2: A Selection of Agency Prizes and Challenges
Conducted Under Authorities Other Than the America
COMPETES Reauthorization Act of 2010*

A Report from the
Office of Science and Technology Policy

In Response to the Requirements of the
America COMPETES Reauthorization Act of 2010

August 2016



Implementation of Federal Prize Authority: Fiscal Year 2015 Progress Report – Appendix 2

ABOUT THE OFFICE OF SCIENCE AND TECHNOLOGY POLICY

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DEPARTMENT, AGENCY, OFFICE, AND DIVISION ABBREVIATIONS

ASA	Office of the HHS Assistant Secretary for Administration (part of HHS)
CDC	Centers for Disease Control and Prevention (part of HHS)
CNCS	Corporation for National and Community Service
CPSC	Consumer Product Safety Commission
CTTSO	Combating Terrorism Technical Support Office (part of DOD)
DARPA	Defense Advanced Research Projects Agency (part of DOD)
DHS	Department of Homeland Security
DOC	Department of Commerce
DOD	Department of Defense
DOE	Department of Energy
DOI	Department of the Interior
DOJ	Department of Justice
DTRA	Defense Threats Reduction Agency (part of DOD)
EDA	Economic Development Administration (part of DOC)
Education	Department of Education
EPA	Environmental Protection Agency
EERE	Office of Energy Efficiency and Renewable Energy (part of DOE)
FDA	Food and Drug Administration (part of HHS)
FMC	Federal Maritime Commission
FTC	Federal Trade Commission
GSA	General Services Administration
HHS	Department of Health and Human Services
HRSA	Health Resources and Services Administration (part of HHS)

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HUD	Department of Housing and Urban Development
IARPA	Intelligence Advanced Research Projects Activity
NASA	National Aeronautics and Space Administration
NIC	National Institute of Corrections
NIEHS	National Institute of Environmental Health Sciences (part of NIH in HHS)
NIH	National Institutes of Health (part of HHS)
NIST	National Institute of Standards and Technology (part of DOC)
NIJ	National Institute of Justice (part of DOJ)
NNCO	National Nanotechnology Coordination Office
NNI	National Nanotechnology Initiative (coordinated out of NNCO)
NOAA	National Oceanic and Atmospheric Administration (part of DOC)
NSA	National Security Agency
NSF	National Science Foundation
OMB	Office of Management and Budget (part of the Executive Office of the President)
ONC	Office of the National Coordinator for Health Information Technology (part of HHS)
OSTP	Office of Science and Technology Policy (part of the Executive Office of the President)
SAMHSA	Substance Abuse and Mental Health Services Administration (part of HHS)
SBA	Small Business Administration
TSA	Transportation Security Administration (part of DHS)
USAID	United States Agency for International Development
USBR	United States Bureau of Reclamation (part of DOI)
USDA	Department of Agriculture
USFWS	United States Fish and Wildlife Service (part of DOI)
USGS	United States Geological Survey (part of DOI)
USSOCOM	United States Special Operations Command
VA	Department of Veterans Affairs

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Appendix 2: A Selection of Agency Prizes and Challenges Conducted Under Authorities Other than the America COMPETES Reauthorization Act of 2010

This Appendix provides a summary of select prizes and challenges conducted in FY 2015 under agency prize authorities other than COMPETES. Agency reporting on prizes conducted under non-COMPETES prize authorities was optional, therefore the selection presented here is itself based on an incomplete list.

A. Department of Commerce

a. EDA Strong Cities, Strong Communities Economic Visioning Challenge: Phase 2¹

Summary: One key strategy for helping distressed communities achieve their economic goals is for the federal government to support the development of local or regional comprehensive plans that can provide communities a roadmap to economic stability and growth. The Strong Cities, Strong Communities (SC2) Economic Visioning Challenge (EVC), sponsored by the Economic Development Administration (EDA), in partnership with the cities of Greensboro, North Carolina, Hartford, Connecticut, and Las Vegas, Nevada. EDA designed the challenge to help eligible U.S. cities generate effective economic development plans. The competition was divided into two phases: Phase 1, in which any eligible team could compete, and Phase 2, in which only the finalists from Phase 1 competed. The amount of prize money offered by all three cities in both Phases of the competition totaled \$2.8 million: \$300,000 in Phase 1 and \$2.5 million in Phase 2. Each city appointed its own selection of community leaders to serve as judges of the proposals, and all proposals were evaluated according to their originality, feasibility, and how well they were tailored to the city's unique strengths and opportunities. The Common Pool supported the implementation of this prize competition.

Solution Type: Ideas; Business plan

Primary Goals: Engage new people and communities; Find and highlight innovative ideas

Results: All three cities completed Phase 2 in FY15. In total, the challenge received submissions from 143 teams from across the country, and twenty-six of these teams competed in Phase 2. As a result of the competition, the cities now have 18 actionable economic development plans from the award winners (six in each city), and the cities are moving forward with implementation of the best plans. In Hartford, the first place winner, the Hartford Health Works, put forward a plan for a healthcare and medical technology cluster. In Las Vegas, the winning plan was submitted by Build a Better Las Vegas with a plan for an unmanned aerial and robotics resource center at the Cashman Center. In Greensboro, the winning Global Opportunities Center submitted a proposal to create a center for universities, firms, and communities to coordinate educational and business goals.

¹ <http://www.eda.gov/challenges/sc2challenge/>; this challenge was described in the FY 2014 COMPETES report, starting on page 202.

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The competition brought together diverse, multi-disciplinary teams to design tailored economic development plans at a lower cost to the cities. As part of researching their plans, the teams also interacted with local public and private interests to discuss regulations and policies related to their plans, as well as possible investment plans. Overall, the competition has helped strengthen the economic development networks in these cities.

These plans ought to spur innovative public and private economic development, by offering detailed planning blueprints for well-researched proposals customized to local conditions. The competition also helped increase public and private confidence behind local economic development plans. Long term, investment in these plans are expected to lead to increased jobs, but the focus of this competition was on the efficient generation of innovative and customized economic development plans.

In all three cities, the award recipients represented the diversity of idea submissions. This prize allowed for ideas from a vast range of topics to be presented, ranging from solutions that would support entrepreneurs in the food sector; to ideas for repurposing shipping containers as inexpensive commercial outlets; to proposals for testing centers to support technology firms. Going forward, the cities will continue to work with the winning teams to implement the best economic development plans, and will be able to draw upon set-aside city funds and the plans as the basis for highly competitive grant applications.

B. Department of Defense

a. Error! Reference source not found.²

Summary: The Chikungunya viral infection (CHIKV) is an emerging and untreatable mosquito-borne viral infection of humans. Its emergence in the Caribbean has caused substantial morbidity in the population and concern about the subsequent spread in the Americas. The Department of Defense's (DOD) role in global health includes conducting timely, relevant and comprehensive health surveillance to promote, maintain and enhance the health of military and associated populations. To date, existing mathematical and statistical models have not successfully predicted infectious disease events with sufficient accuracy.

The CHIKV Challenge attempted to address this shortcoming by promoting innovation in data collection techniques, exploring the suitability of current approaches to forecasting emerging diseases, and testing the performance of new predictive models. Solvers were encouraged to utilize any publicly available data as the basis for their forecasts, including known or potential CHIKV mutations and effects on vector transmissibility, historic and current chikungunya case data, vector distribution, climate models, transportation information, social media and other environmental data. Proprietary data was allowed if it was obtained by participants and used for research, modeling or other related efforts. Solvers were not required to disclose the content of proprietary data, but were required to include a detailed description of how it was obtained or generated in the Challenge methodology deliverables. CHIKV Challenge solvers were offered a

² This challenge was conducted under DoD Prize Authority 10 U.S.C. § 2374a, Prizes for Advanced Technology Achievements and described in the FY 2014 COMPETES report, starting on page 207.

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total prize purse of \$500,000 to provide predictions of CHIKV epidemics in countries in the Americas for a six-month period (September 1, 2014 to February 16, 2015).

DARPA assembled a team of subject matter experts from other Federal agencies in chikungunya and infectious disease modeling to evaluate solver submissions against data released by the Pan American Health Organization PAHO and on criteria such as numerical accuracy, choice of data sources, methodology and computational requirements. In addition, DARPA invited scientists from the Los Alamos National Laboratory (LANL) to independently examine the attributes of both successful and unsuccessful solver submissions, and explore alternative metrics to evaluate the usefulness and accuracy of proposed models. InnoCentive supported the implementation of this prize competition.

Solution Type: ideas; analytics, visualizations, and algorithms

Primary Goals: Solve a specific problem; Engage new people and communities; Find and highlight innovative ideas; Advance scientific research

Results: The DARPA Forecasting CHIKV Challenge evaluated 38 complete submissions from 444 registered solvers, and awarded 1st and 2nd place prizes, 4 Honorable Mentions (places 3-6), and 5 Methodology Winners (MW) for a total of \$500,000 in prizes. Winners came from small and large universities and in one case, a hospital network. None of the winners were previously known to DARPA through other funding opportunities or open BAAs. All are affiliated with academic institutions and from a wide range of disciplines including mathematics, statistics, genetics, molecular biology, epidemiology, and ecology.

The Challenge provided a better understanding of when model complexity is needed; identified metrics for measuring accuracy; evaluated the value of better ground truth data (e.g., uniformity across countries and more detailed data); and identified types of data needed to improve forecasts. This challenge demonstrated that more complex models will not necessarily translate into better forecasts. For example, increasing the number of data sources used in challenge models proved to be less beneficial than choosing the most relevant few sources of data and weighing those prime predictors appropriately. Participants typically used several data sources to complement the information provided by the PAHO. These sources included government websites, climate information (e.g., temperature and humidity), vector-specific information (e.g., reporting of other mosquito-borne illnesses such as dengue in the same population, mosquito dynamics, ecology), Wikipedia, Google searches, and others. However, there was no significant correlation between the number of data sources used and the accuracy of the forecasts, regardless of the type of model being used. In short, more data does not necessarily translate into better forecasts.

Since the program finale held at DARPA in May 2015, DARPA, LANL, Biomedical Advanced Research and Development Authority (BARDA), and the six top Challenge solvers have drafted report on the design, execution and evaluation of solver predictions in the Challenge and an independent analysis of solver submissions to determine advantages of existing methods, technological shortcomings and critical factors that govern successful predictions.

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b. USSOCOM and CTTSO Novel Ballistic Coverage³

Summary: The Joint Acquisition Task Force - Tactical Assault Light Operator Suit (JATFTALOS) project office within the United States Special Operations Command (USSOCOM) co-sponsored the Novel Ballistic Coverage challenge with the Combating Terrorism Technical Support Office (CTTSO) to identify new body armor designs that maximize ballistic protection without restricting the wearer's mobility and range of motion. The challenge sought to address the increasing availability and lethality of small arms weapons through improved operator ballistic protection and to supplement Federal research and development efforts in this domain. InnoCentive supported the implementation of this prize competition.

Solution Type: Ideas

Primary Goals: Solve a specific problem; Develop technology

Results: The competition drew 269 registered solvers with 30 total submissions in the 30-day challenge period. Challenge submissions consisted of narratives, images and drawings describing the solver's approach to optimizing ballistic protection. Three winning proposals were awarded a total of \$10,000 in cash prizes. This competition did not meet the stated objectives and submissions failed to generate usable new ideas. Challenge organizers conducted an after-action survey with registered solvers and respondents indicated that the solicitation contained clear guidelines and objectives; the required level of effort exceeded the available prize award; the 0.5 inch armor thickness restricted solutions; and lack of CAD or simulation software limited development of more mature ideas. USSOCOM and CTTSO suspect that better results may be achieved in the future by utilizing a theoretical challenge (one in which the ideas are substantiated with data); extending the allotted submission time; and offering a larger prize award incentive without a guaranteed payout.

Thus, if no submissions satisfy the stated objectives, the agency would not be obligated to award prizes. The longer submission time and larger award may draw more novel solutions. In sum, the after-action survey and discussion that followed provided valuable insight for future challenge planning.

C. Department of Energy

a. Collegiate Wind Competition 2015 – 2016⁴

Summary: Conducted every other year, the Collegiate Wind Competition challenges teams of undergraduate students to design a wind turbine based on market research; develop a business plan to market the product; build and test the turbine against set requirements; and demonstrate knowledge of current and emerging issues facing the wind industry. The Collegiate Wind Competition contests are designed to engage students from a variety of engineering, business, communications, and social science programs in complex tasks with no single solution, providing real-world experience as they prepare to enter the wind energy workforce. The

³ Challenge website is located at <https://www.innocentive.com/ar/challenge/9933551>.

⁴ <http://wind.energy.gov/windcompetition/>

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competition has no prize purse, but winners receive a 1st place plaque, travel to the American Wind Energy Association Annual Conference, and all competitors receive real-world wind technology experience to take into the workforce.

The competition is also aligned with the central goals of the DOE, which are to catalyze the timely, material, and efficient transformation of the nation's energy system, secure the United States' leadership in clean energy technologies, and maintain a vibrant domestic effort in science and engineering as a cornerstone of economic prosperity.

Solution Type: Ideas; Business plan; Technology demonstration and hardware

Primary Goals: Other (Student Training)

Results: The inaugural competition took place in 2014 and engaged over 150 students from 10 institutions from across the country. Twelve teams, 2 more than the inaugural event, have been recruited for the 2016 competition, which will be held at the American Wind Energy Association (AWEA) Annual Conference in New Orleans, Louisiana. The National Renewable Energy Laboratory, American Wind Energy Association, and the Wind Energy Foundation partner to organize this event.

The competition introduces future young professionals in wind energy technology to the real world challenges of the wind technology market. The competition effectively engages a diverse sampling of disciplines by creating objectives that are not specific to one line of work. Through informal interviews, students expressed interest in a second competition, and therefore, the organizers are holding one in 2016 with 12 universities (an increase from the original 10).

b. H2 Refuel H-Prize Competition⁵

Summary: H2 Refuel challenges America's innovators to deploy an on-site hydrogen generation system that uses electricity or natural gas and can be used in homes, community centers, retail sites or similar locations to fuel hydrogen vehicles. The best entry, based on technical and cost criteria, wins \$1 million.

The Fuel Cell Technologies Offices established a cooperative agreement with the Hydrogen Education Foundation (HEF) to coordinate the implementation of the prize competition.

Solution Type: Technology demonstration and hardware

Primary Goals: Find and highlight innovative ideas; Solve a specific problem; Develop technology; Inform and educate the public; Stimulate a market

Results: No submissions were requested in FY 2015. Six contestants provided full submissions by the October 29, 2015 submission deadline. These contestants include individual companies, a non-profit/company partnership, a collaboration of multiple companies, and a university team.

⁵ www.hydrogenprize.org, <https://www.challenge.gov/challenge/h2-refuel-h-prize-competition/>. The H-Prize is conducted under a legislative requirement in the Energy Independence and Security Act of 2007.

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The final system testing begins in July 2016, and the competition is expected to end on October 31, 2016.

c. **Open Source Wave Analysis and Response Program (OpenWARP)**⁶

Summary: Wave energy converter (WEC) devices could extract 1170 terawatt-hours of electricity per year by harnessing ocean wave energy. One terawatt-hour equals the amount of energy consumed by 100,000 American homes in a year. By tapping into just 10% of the total extractable ocean wave energy, WEC devices could power 10 million American homes.

Through OpenWARP, the Department of Energy has launched a series of crowdsourcing contests at TopCoder to help the offshore renewable energy community develop open-source boundary element method simulation tools—including meshing, simulation, and post-processing tools—essential to the blossoming ocean energy community. OpenWARP thus uniquely links the ocean energy community to the algorithm development expertise of the coding community.

A total of \$102,000 in prize money was available, and the DOE partnered with Sandia National Laboratories, National Renewable Energy Laboratory, and Appirio-TopCoder for the implementation of this competition. DOE partnered with NASA Center of Excellence for Collaborative Innovation (CoECI) through an Interagency Agreement (IAA) to conduct the prize competition.

Solution Type: Software and apps

Primary Goals: Develop technology; Solve a specific problem

Results: OpenWARP mobilized 607 registrants (263 unique) from 48 different countries, who submitted solutions for 55 competitions. DOE has been able to accomplish a significant fraction of its objectives in less than half the time and budget allocated to Appirio-TopCoder. Because of these savings, additional OpenWARP objectives have been added, which will result in an even more complete user-friendly package than anticipated; a package that includes integrated web-based user interfaces that operate multiple modules; improved visualization; and a standardized input/output approach.

The OpenWARP project has made significant improvements to NEMOH by adding numerical algorithms and a GUI. In addition, OpenWARP results feed into the Wave Energy Converter Simulation (WEC-Sim) tool—being developed by the DOE, Sandia National Laboratories (Sandia), and National Renewable Energy Laboratory (NREL)—that will be able to model most WEC devices in operational sea states. At the end of the OpenWARP effort, the WEC-Sim team (DOE, Sandia, and NREL) will have developed an open source boundary element code, specifically for modeling wave energy conversion devices, through online coding competition. The resulting open-source BEM code will be available to the WEC R&D community, allowing the community to modify and improve the code for device-specific modeling needs.

⁶ www.topcoder.com/doi; <http://nrel.github.io/OpenWARP/>

d. ORNL Buildings Crowdsourcing Campaign⁷

Summary: Oak Ridge National Laboratory (ORNL), partnered with DOE offices including the Advanced Manufacturing Office and the Building Technologies Office, to launch the Buildings Crowdsourcing Campaign, a pilot that solicited ideas on improving buildings-related energy efficiency performance from non-traditional partners. While ORNL has partnerships with large public and private entities, the laboratory determined that a crowdsourcing platform targeted at individuals might yield novel solutions not yet identified or pursued by traditional parties. Participants were asked to submit ideas to one of three topics: envelope technologies, equipment & appliances, and sensors & controls. ORNL determined that a prize competition would be superior to alternative authorities such as contracts and grants due to the inherent flexibility, responsiveness and effectiveness in reaching the widest possible audience of non-traditional partners.

During the campaign, the ORNL Buildings Crowdsourcing Community accepted submissions, comments, and votes from entrepreneurs, innovators and end-users centered on the building technology areas of envelope, sensors and controls, and heating and cooling. Ideascale supported the implementation of this prize competition.

Solution Type: Ideas; Technology demonstration and hardware

Primary Goals: Engage new people and communities; Find and highlight innovative ideas

Results: By the close of the campaign, the competition attracted 5,000 unique visitors and 363 registered users from 44 states. Sixty percent of the users were small businesses and entrepreneurs that generated 70 valid campaign ideas. For winners, incentives included the possibility of using ORNL's 3-D printing expertise to prototype ideas and the chance to present at a laboratory-hosted Industry Day with over 300 attendees from public and private entities involved in buildings energy-efficiency. This campaign served as a successful pilot to advancing the process of innovation in Technology to Market (T2M).

A Senior Energy Conservation Engineer at Chelan County Public Utility District in Washington State, Jim White, won the Sensors & Controls campaign. Rod Stucker, an entrepreneur and owner of RM Enterprises specializing in zero net energy (ZNE) design with focus on integrated design, systems architecture, and home automation won the Envelope technologies campaign.⁸ The winners of the Equipment & Appliances campaign, James Rowland, Mark Walter, and Mathew O'Kelly, developed their idea during their graduate studies at The Ohio State University. James Rowland presented the idea on behalf of the team and is currently an engineer at Priority Designs, an industrial design and engineering consulting firm in Columbus, Ohio. Their idea is a hybrid air/water conditioner, which exploits synergies between conditioning indoor air, dehumidification, ventilation and hot water heating to reduce significantly energy expenditures associated with all of those processes. The team is currently discussing a potential cooperative research and development agreement (CRADA) with ORNL.

⁷ Buildings.ideascale.com

⁸ <http://www.achrnews.com/articles/130785-doe-announces-buildings-crowdsourcing-competition-winners-new-program>

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The other winners are currently following up on the leads and connections they developed during Industry Day that could potentially advance market adoption of their ideas. Rod Stucker submitted a Small Business Voucher (SBV) proposal to DOE EERE.

e. Solar Decathlon - 2015⁹

Summary: The U.S. Department of Energy Solar Decathlon challenges collegiate teams to design, build, and operate solar-powered houses that are cost-effective, energy-efficient, and attractive. DOE initially reviews applicants through a merit review process to receive a \$50,000 cooperative agreement with DOE, and each team supports their design, construction, and operation with these funds and with their own funds for the remaining amount (ranging from \$300,000 to \$900,000). Held biennially since 2005, the competition selects the winner from a pool of collegiate teams – primarily from schools of architecture and engineering.¹⁰ The winning team's house is selected through the completion of 10 head-to-head contests based on affordability, consumer appeal, and design excellence with optimal energy production and maximum efficiency. These 10 contests are objective demonstrations of performance of the houses, and teams can earn points three ways: (1) completing household tasks such as cooking, washing dishes, and doing laundry; (2) performing against specific criteria, such as maintaining a comfortable temperature (71°–76°F); and (3) through other features (such as aesthetics and design inspiration), which are awarded by the jurors who are experts in fields such as architecture, engineering, and communications.

One of the Department of Energy's most successful outreach efforts, the Solar Decathlon has helped accelerate the adoption of renewable energy and energy-efficient products and design by educating students and the public about the money-saving opportunities and environmental benefits presented by clean energy products and design solutions; demonstrating to the public the comfort and affordability of houses that combine energy-efficient construction and appliances with off-the-shelf renewable-energy systems; and providing participating students with unique training that prepares them for the clean energy workforce.

Solution Type: Creative (design & multimedia); Ideas; Technology demonstration and hardware

Primary Goals: Find and highlight innovative ideas; Inform and educate the public; Other (Student Training)

Results: Over the course of 8 days in October 2015, the Solar Decathlon hosted more than 64,000 visitors and 225 media sources who could tour all 14 solar-powered house final submissions. In total, outreach efforts had a total media impressions of 2.04 billion, more than 2,400 media stories, more than 1,750 online articles, more than 350 print articles in 150 publications, at least 200 television stories and 150 radio interviews, and nearly 225 media checked in onsite.

Stevens Institute of Technology won top honors overall by designing, building, and operating the most cost-effective, energy-efficient, and attractive solar powered house. There are five juried

⁹ The challenge's website is located at www.solardecathlon.gov.

¹⁰ The first Solar Decathlon was held in 2002, and the competition has been held every two years since 2005 for a total of seven competitions. The next competition is planned for 2017.

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contests in the Solar Decathlon, and Stevens and their SURE (SUstainable and REsilient) HOUSE placed first in four out of the five competitions. The SURE HOUSE is a high-performance, solar-powered house that is protected against extreme weather and can provide emergency power in the aftermath of a storm—packaged as a comfortable, beautiful shore house. The storm surge, high winds, and flooding associated with 2012's Superstorm Sandy highlighted the vulnerability of Mid-Atlantic shore neighborhoods. The SURE HOUSE therefore began with a simple idea: create a low-energy, solar-powered, storm-resilient home for vulnerable coastal communities. The notion of the “shore house” resulted in a focus on indoor-outdoor spaces, and through a simple design transformation, the SURE HOUSE doubles its usable space in the summer months by opening up to its outdoor decks. This outdoor living room complements a contemporary interior that draws on natural daylight and flexible living space to create an inviting family home.

The SURE HOUSE is based on three principles: use less energy through smart design; generate all energy needed through renewable solar electric power; and be capable of providing power during electrical outages.

After Solar Decathlon 2015, the SURE HOUSE has been delivered to Seaside Park, New Jersey, where it will become a full-time education and resiliency center, owned and operated by the town.

University at Buffalo, The State University of New York, took second place followed by California Polytechnic State University, San Luis Obispo, in third place.

Since 2002, the U.S. Department of Energy Solar Decathlon has involved 130 collegiate teams and nearly 20,000 collegiate participants; established a worldwide reputation as a successful educational program and workforce development opportunity for students; expanded from the original U.S. competition to competitions in Europe, China, Latin America, and the Middle East involving an additional 78 teams and nearly 12,000 participants; and, educated the public about the benefits, affordability, and availability of clean energy solutions by generating widespread media coverage and harnessing digital tools to reach millions of people.¹¹

No cash prize has been historically awarded for the Solar Decathlon – only a \$50,000 cooperative agreement to supplement each team’s funding and the honor of being “the most famous house in America for a day” for the winner. Starting in 2017, the Solar Decathlon expects to award prizes, totaling \$2 million, to the most successful teams. The organizers expect that instituting a cash prize will provide more incentive and motivation which will in turn lead to better designs. In its history, the competition format has encouraged only the very best designs and ideas and has leveraged collegiate institution investment and student resources to engage and enhance the Department of Energy’s goals.

¹¹ The additional worldwide engagement was achieved through the following internationally-hosted competitions: Solar Decathlon Europe 2010 (Madrid, Spain), Solar Decathlon Europe 2012 (Madrid, Spain), Solar Decathlon China 2013 (Datong), Solar Decathlon Europe 2014 (Versailles, France), and Solar Decathlon Latin America and Caribbean 2015 (Santiago de Cali, Colombia). DOE executed memoranda of understanding (MOUs) with international competition organizers to support international competitions.

D. Department of Health and Human Services

a. Aetna Foundation, HHS, and NHIT Collaborative - Innovating for the Underserved Business Plan Challenge¹²

Summary: Technology and data are crucial components to driving innovation and improvement in services in the healthcare arena. Aetna Foundation, the United States Department of Health and Human Services (HHS) and the National Health IT Collaborative for the Underserved (NHIT Collaborative) are working in partnership to leverage IT innovations to reduce disparities in health among underserved and minority communities. This challenge accepted business plan submissions to identify innovative approaches to increasing health equity and impacting chronic health issues in underserved populations. The goal of the submissions is to utilize technology to reduce disparities and address the needs of underserved and minority populations that are hampered by problems that health IT can easily solve such as access to services and information, language barriers and lack of relevant educational programs. Non-profit and for-profit companies and entities that leverage health and communication information technology and data were eligible. Submitted business plans had to address one of three key challenges – Access to Services, Child Obesity, and Connecting Data Between Systems – in underserved or vulnerable populations.

Solution Type: Business plan

Primary Goals: Find and highlight innovative ideas; Inform and educate the public

Results: In general, the types of team that submitted business plans included: (1) startups, academic and student teams, non-profits, and individuals and (2) entities that leverage health and communication information technology and data. The challenge attracted 108 pre-registered participants and awarded a \$100,000 total prize purse. Since the prize purse was supplied by Aetna, no Federal funds were used as prize awards. The challenge was conducted in two phases. In the first phase of the challenge, the judges chose four top teams from the 28 submissions to award \$5,000 each on the strength of their concept. The funding in the first phase was utilized to incentivize the teams to continue to build their solution for the second phase. The organizers estimate that at least 20 teams (~71%) had leaders who appeared to identify as women, which, in an industry where men make up the highest portion of participants, is significant.

In the second phase, the four teams that were selected to advance were asked to flesh out their concept more; provide detail on implementation methods; and elaborate on financial and sustainability models. One team did not pursue the second phase so three teams competed. The two first-place winners, Grupo Parada & Food Care, received \$40,000 each, and the runner-up, Let's Epicure, received \$5,000. In addition to monetary prizes, winners of this challenge also received and are continuing to receive recognition and promotion, support from the sponsors and Health 2.0, and opportunities to partner with the sponsors on agency initiatives.

¹² www.health2con.com/devchallenge/aetna-foundation-hhs-nhit-innovating-for-the-underserved-business-plan-challenge/

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b. CDC Dengue Fever Project¹³

Summary: Dengue is a mosquito-transmitted viral disease affecting millions of people every year, including U.S. travelers and residents of the tropical regions of the U.S. like Puerto Rico. Experts estimate that around 390 million dengue infections occur worldwide each year, including about 500,000 severe cases – mostly children – requiring hospitalization. Actual dengue predictions would help public health workers and people around the world take steps to reduce the impact of these epidemics, but predicting dengue is a hefty task that calls for the consolidation of different data sets on disease incidence, weather, and the environment.

Several U.S. federal agencies are soliciting infectious disease forecasting models from scientists to address this public health issue. As part of this effort, the Department of Commerce, Department of Defense, and Department of Health and Human Services provided free access to previously unavailable historical dengue surveillance data from Puerto Rico and Peru. NOAA also partnered in the implementation of this prize competition. This project asked participants to deliver forecasting models focusing on dengue surveillance data in San Juan from 1990 through 2009 and Iquitos from 2000 through 2009.

Solution Type: Ideas; Analytics, visualizations, and algorithms, Scientific

Primary Goals: Solve a specific problem; Advance scientific research; Engage new people and communities

Results: Sixteen teams from universities (11) and companies (5) participated in the challenge. Forecasts were judged using average log scores over the first 6 months of each season for each target. The score captures both accuracy and precision and seemed to be liked by all participants. Clearly stating quantitative criteria ahead of time was very helpful to the participants.

The challenge has had an immediate impact on the research of the participating teams who for the first time were able to compare their forecasts to those of other researchers and were able to address targets that could be used to directly help public health. The challenge also identified strengths and weaknesses in the current dengue forecasting models that can help drive future research forward. The results will be used to help better understand the needs of decision makers and improve the development of translation mechanisms. The data will also be maintained publicly allowing other groups to engage in post-challenge research (which some are already doing).

Six finalists were invited to a meeting at the White House in the fall with representatives of the National Science and Technology Council's (NSTC) Interagency Pandemic Prediction and Forecasting Science and Technology Working Group to provide their viewpoints on lessons learned and potential next steps in strengthening infectious disease forecasting. Finalists were selected based on performance in early season predictions, one for each of the 6 prediction

¹³ <http://dengueforecasting.noaa.gov>

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targets.¹⁴ A joint publication with the results of the challenge and with input from all participants is being compiled and will be published in a scientific journal.

c. CDC Health Game Jam – 2014¹⁵

Summary: According to the Entertainment Software Association, games of all types are played by 58% of Americans—by both genders and by a wide age range. Health education games have been shown to increase knowledge, change behavioral intent, and improve adherence to medical treatment. Taken together, games have tremendous potential as vehicles for health communication and education; however, developing health educational games is typically a long and costly process. The 2013 Health Game Jam demonstrated that a game jam, which brings game developers together in a competitive, time-constrained atmosphere (i.e. one 48-hour period) to produce prototype games, could be used to rapidly and inexpensively develop health education games, and to promote interest in public health careers. The goal of the 2014 event was to have designers create 5 fully playable games focusing on the primary and secondary prevention of HIV in order to see if games made in this manner can be effective health education tools for the public. The challenge organizers encouraged participants to produce games beyond the traditional platforms of console and desktop, such as exergaming, which combines exercise and gaming, mobile and spatial games, and games that utilize geolocation data to create innovative experiences. Non-digital games (e.g., board games) were especially of interest.

CDC partnered with the HHS IDEA Lab for funding through the HHS Ventures Fund, and partnered with Southern Polytechnic State University and the Georgia Game Developers Association in Georgia to host the event.

Solution Type: Software and apps, Creative (design & multimedia), Technology demonstration and hardware

Primary Goals: Solve a specific problem, Improve government service delivery, Develop technology, Inform and educate the public, Engage new people and communities

Results: Twenty-five subject matter experts and 291 team members participated in the game jam, with over half (56.6%) participating in a game jam for the first time. The 41 submitted games were judged on game aesthetics, game play, educational design principles, and completeness at the end of 48 hours. Judges selected 16 top tier groups to finalize their work over the course of one week. Five of the top games were selected as finalists and were eligible to split a \$20,000 prize pool if they completed their game within a 2 month window. If only one team finished in time, they would get the whole pot, otherwise it would be split among the teams that finished. The finalist teams were provided with assistance in the form of a volunteer producer (who worked in the health games field). All five finalist teams finished their games in time and split the pot, \$4,000 per team.

¹⁴ Early season predictions were evaluated by best logarithmic score over weeks 0 to 24 across the four testing seasons.

¹⁵ www.eventbrite.com/e/georgia-fall-2014-game-jam-tickets-12515499195

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While only 16.6% of participants had considered a career in public health prior to the event, 65% reported interest 48 hours later. Similarly, of the 43.4% who had participated in a game jam previously, only 23.4% had ever created a health-related game.

The organizers are currently conducting a randomized control study to evaluate the impact of one finalist game on behavior and knowledge. If these results are encouraging, the organizers plan to build upon the game jam's success by hosting a similar event in a future year that would incorporate the lessons learned during the 2014 event.

d. NIH Neuro Startup Challenge¹⁶

Summary: Building upon the model set forth by the award-winning Breast Cancer Startup Challenge (BCSC), the Neuro Startup Challenge (NSC) was developed by several NIH Institutes in partnership with the Center for Advancing Innovation to address the gap between early-stage neuro-related technologies and full commercialization. Traditional partners, such as biomedical companies, are reluctant to form partnerships around early-stage discoveries because of lengthy developmental timelines and high financial risk.

In the NSC, international university teams created startups and business plans to develop and commercialize 16 early-stage neuro-related technologies invented by NIH intramural researchers. The challenge model was used because the crowdsourcing element of the challenge encourages the development of teams with unique and very different backgrounds to come together to create business plans and real startup companies around an important NIH technology.

Over the course of three phases of competition, multidisciplinary teams of students and seasoned entrepreneurs for startup companies, pitch developed business plans to judges from industry, venture capital, and the Federal sector, and for Challenge winners, are mentored by CAI to move forward with their companies and technology commercialization.

In Phase One of the NSC, teams made up of seasoned entrepreneurs and students majoring in business, law, medicine/science, engineering, and computer science were formed to create startup companies in order to compete for an opportunity to develop and commercialize NIH inventions.

No federal funds were used for the NSC. Rather, the non-federal partner, CAI, secured funding through a philanthropic partner, Heritage Provider Network; this funding allowed CAI to run the challenge and to provide support and prizes for the competing and winning teams.

Solution Type: Business plan; Other (Start-ups)

Primary Goals: Solve a specific problem; Advance scientific research; Develop technology; Stimulate a market; Other (R&D Commercialization)

¹⁶ www.neurostartupchallenge.org; this challenge was described in the FY 2014 COMPETES report, starting on page 217.

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Results: 16 winners received \$2,500 each of the \$40,000 prize purse. Two of those winners are Stephanie Cossette, Angio360 Diagnostics LLC, and J. Kent Werner, Cofounder and CEO of Cogentis Therapeutics. Angio360 Diagnostics LLC has the license in hand and is currently one year to market. Since the Neuro Startup Challenge, Cogentis Therapeutics has been recognized as a Top26 MassChallenge Finalist, which makes the company eligible for \$1.5M in cash and awards, and also won the challenge's Cydan Development Scholarship.

The utilization of the startup challenge provides an additional mechanism to find and leverage partners who can develop and commercialize potentially life-saving technologies developed by the NIH. The NSC resulted in 16 new startups and collectively the BCSC and NSC trained more than 1000 entrepreneurs. The challenge increased the volume and likelihood of moving promising NIH inventions to the market where they can have a positive impact on public health.

Based on the success of the NSC and the BCSC, NIH has launched a third startup challenge in October 2015, the Nanotechnology Startup Challenge (NSC2), for commercially viable, nanotechnology cancer-related inventions.

e. RWJF & HHS Provider Network Challenge¹⁷

Summary: The Robert Wood Johnson Foundation (RWJF) and the U.S. Department of Health and Human Services (HHS) strive to spur new innovations in health technology that help consumers make better health care decisions. The public health exchanges made available by the Affordable Care Act and private exchanges established by employers both have a need for tools that allow consumers to determine what's the best insurance and network for an individual's health care needs.

Specifically for the \$100,000 Provider Network Challenge, RWJF and HHS sought mobile application designs to allow consumers to easily identify providers that are in their insurance network and that are popular based on crowdsourced customer reviews. RWJF and HHS partnered with insurance carriers (Amerihealth New Jersey and Health Republic of New Jersey) to provide network information on New Jersey providers to participants. In addition to the carriers, Pokitdok and Doctor.com were partners of the challenge who gave the participants the chance to utilize the sites' APIs when building submissions. Both APIs provided ample data on providers across their insurance network and specific data for determining if a certain insurance network fit consumer needs.

The submitted designs were judged by how well the applications: (1) determined conveniently located providers; (2) supported a verification tool to differentiate which providers were accepting new patients; (3) crowdsourced patient reviews for providers; and, (4) as a bonus, included a provider search based on specific health needs and on available insurance coverage for specific procedures. The challenge took place in two phases. In Phase I, teams submitted concepts and wireframes for a total of \$25,000 prize money. The awardees from Phase I advanced to Phase II, which had a \$75,000 prize purse, to develop working prototypes of the apps.

¹⁷ www.health2con.com/devchallenge/rwjf-provider-network-challenge/

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Solution Type: Software and apps, Business plan

Primary Goals: Improve government service delivery; Develop technology

Results: Of the 92 participants who pre-registered for the challenge, 24 final submissions were received and approved for Phase I judging. \$100,000 was provided in monetary awards between the two phases of competition. Phase 1 provided five finalists with \$5,000 each. Phase 2 awarded \$50,000 for first place, \$15,000 for second place and \$10,000 for third place. RWJF provided all prize money. Of the three winners, Consumers Checkbook and DocSpot existed for many years prior to the competition. VeriCred was launched several months prior to the competition. All had been working on the apps prior to the competition, and created usable apps by the end of the competition. The winning apps were chosen because they displayed creativity, innovation, a user-friendly interface, and the potential to be implemented in communities nationwide and help consumers understand their insurance plan provider network options. Although the test data provided for the competition was from the state of New Jersey, the apps were developed with national intent. Many have already operated in multiple states.

Winners of this challenge are working with RWJF and HHS to develop their solution with real time data. The winners incorporate data from numerous sources and are continually revisiting and augmenting these sources to make improvements to their products. For example, DocSpot fuses data from over 600 sources into one unified interface. Sources include state medical boards, hospital and clinic physician directories, and reviews from around the web. DocSpot currently helps people find doctors in 34 metropolitan areas and plans to continue to grow.

f. HHS Obesity Data Challenge¹⁸

Summary: Two in three American adults are overweight or obese. Obesity contributes to a host of other diseases, including increased risk of heart attack, strokes and diabetes. Due to public health concerns, communities are mobilizing to address obesity, and the need exists to provide these communities with better tools and data for obesity mitigation.

Societal, economic, and cultural conditions all contribute to the obesity epidemic. These factors include (but are not limited to) personal food choices, cost and access to healthful foods, individual physical activity, genetic predisposition, and other demographic and environmental risk factors. Currently, volumes of data exist, but are not always utilized for the benefit of individual patients or their communities. Just as commonly, data are used selectively, without the full power that comes from combining data from multiple sources. Many are unaware that relevant data even exists, and few have the capability to combine or visualize data in sophisticated ways. This challenge sought to put these volumes of data to work for communities. HHS sought visualizations that could address a number of issues including how patients could be supported through informed choices using data on community access to food and physical activity.

Challenge participants were asked to utilize open data sources to develop new data visualization tools and software to provide novel methods to communities, local health officials, patients, and

¹⁸ www.challenge.gov/challenge/u-s-obesity-data-challenge/

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practitioners in order to improve public health. Solutions have the potential to enable public health and health care professionals to help patients and families address the obesity epidemic at a personal and community level.

This challenge was run in partnership with the de Beaumont Foundation, which provided all \$50,000 of award funds, and the Health Data Consortium, which helped to administer the challenge and market it at the 2015 Health Datapalooza.

Solution Type: Analytics, visualizations, and algorithms

Primary Goals: Engage new people and communities; Inform and educate the public; Develop technology

Results: The challenge received a total of 28 entries from individuals, small companies, and large companies. The monetary incentive totaled \$50,000, divided into five awards. The winners were chosen based on creativity and innovation, evidence base and effectiveness, value for the healthcare sector, usability, and functionality of the final product. Several entries linked obesity data in a way for users to view their communities; however, no entries successfully linked healthcare providers to patients for discussions about obesity to occur.

E. Department of Homeland Security

a. TSA Risk Based Security of Checked Baggage Screening¹⁹

Summary: Risk Based Security (RBS) includes multiple security layers, and one such area is the screening of checked baggage. TSA currently can designate a passenger as low risk and encode this designation in that passenger's boarding pass, which in turn can be used to determine which type of checkpoint screening that passenger, will receive (standard, TSA Pre✓[®], etc.). TSA is looking for new and innovative means to associate an individual's screening designation with his or her checked baggage within a Checked Baggage Inspection System (CBIS) environment. The passenger's screening designation has to be reliably interpreted by automated means as the bag travels through the baggage handling and security process. Improvement will allow bags to be routed for varying and appropriate levels of screening in accordance with their associated screening designation and would result in a more efficient and effective use of TSA resources.

There are currently available data exchange capabilities within airport and airline infrastructures as well as within TSA that can facilitate this concept; however, TSA would like to have new RBS concepts developed that may be an expansion of such existing capabilities or a complete departure from them. TSA would encourage ideas from other industries with similar tracking and information exchange challenges.

InnoCentive supported the implementation of this prize competition.

Solution Type: Ideas

¹⁹ <https://www.innocentive.com/ar/challenge/9933342>

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Primary Goals: Solve a specific problem; Find and highlight innovative ideas; Engage new people and communities

Results: For this specific challenge, which garnered much media attention, TSA had 361 active registered solvers and received 62 submissions upon challenge completion. Two winners were selected from the entries with each winner receiving \$7,500.

One winning submission provided two options for implementation. Option 1 relies on implementation of a reusable Radio Frequency Identification (RFID) Technology for use in conjunction with TSA Pre✓[®] program, and focused on the entire process. For this implementation option, airlines would issue a reusable RFID tag with TSA's unique ID number to the passenger paired with the Selectee Status of the Baggage Source Messaging modified to allow for the passengers status. Option 2 includes an International Air Transport Association (IATA) 10-digit license plate that can be reassigned to identify the high risk passengers and TSA Pre✓[®] passengers, respectively. Both solutions would require RFID readers as well as Automated Tag Readers (ATRs). This submittal showed tremendous knowledge of the problem TSA is trying to solve, demonstrated clear understanding of the airline industry, and the solution highlighted a very sound approach for tackling the risk-based challenge. This submittal helped TSA validate that there is a technically feasible way to solve this problem. The downside of this approach is that it would require a potential investment in infrastructure by TSA and airports/airlines. TSA is considering a pilot study to better understand the cost impacts of implementing this solution. This prize competition provided TSA with useful information regarding the breadth of ideas surrounding the application of passenger risk data with checked baggage. The results permitted TSA to validate approaches that were already under consideration but had not been implemented. The organizers believe that either reducing the scope, as well as better defining the current landscape and previous ideas that had been considered, could increase the quality, type and number of ideas submitted.

F. Department of the Interior

a. Crushed Ivory Design Challenge Prize²⁰

Summary: In November 2013, the U.S. Fish and Wildlife Service (USFWS), through the U.S. Ivory Crush, destroyed approximately six tons of illegal elephant ivory – all seized as a result of law enforcement investigations and at U.S. ports of entry. The crush was conducted to send a clear message to ivory traffickers and their customers that the United States will not tolerate the illegal ivory trade. It was also designed to educate consumers and to urge them not to buy illegal ivory products.

Subsequently, USFWS, in partnership with the Association of Zoos and Aquariums (AZA), launched the Crushed Ivory Design Challenge Prize to solicit creative ideas on how to use the crushed ivory in informative and compelling displays around the country. The goals of the winning submissions would be to use the crushed ivory to raise public awareness of wildlife

²⁰ <http://www.fws.gov/international/ivory-challenge.html>

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trafficking and help reduce the demand for illegal wildlife products through feasible designs and without adding value to the crushed ivory.

Judging was done in two rounds. The first judging panel consisted of representatives from the Service, AZA, World Wildlife Fund, Wildlife Conservation Society, and the International Fund for Animal Welfare. This panel was tasked with evaluating whether entries met the design requirements, as outlined at <http://www.fws.gov/international/ivory-challenge.html>, and then evaluating each proposal based on the specified judging criteria. This panel narrowed the list of potential winners to seven. A second panel was then convened to evaluate the seven finalists and identify a winner(s). This panel consisted of artists, marketers, and others skilled in exhibit design and communication.

Solution Type: Creative (design & multimedia), Ideas

Primary Goals: Inform and educate the public; Engage new people and communities

Results: The competition received 44 submissions from students, aspiring artists, conservationists, and design professionals. USFWS appointed a panel of experts who judged submissions based on ability to educate and inspire the public to reduce demand for elephant ivory and other illegal wildlife trade, feasibility, mitigation of security and theft concerns, and lack of adding value to the crushed ivory.

Participants were offered recognition, but no cash prize or monetary incentive. AZA will assist with the production of the award winner's designs and will help distribute the final products to zoos, aquariums, airports, and other locations as appropriate. The winners were scheduled to be announced during an event at the National Press Club on April 26, 2016. As of March 24, 2016, the winners had not been formally notified, though they are aware that they are finalists in the challenge. The submissions, and in particular the winning submissions, will achieve the aforementioned goals if placed in a prominent and publicly accessible location.

There will be two winning designs. The U.S. Fish & Wildlife Service and the Association of Zoos and Aquariums (AZA) are in the process of identifying and approaching strategic partners to host the larger of the two designs. The smaller design can be replicated at a number of zoos, aquariums, museums, and other public spaces. Specific institutions have not yet been identified, primarily because the organizers are still working out the design specifications and costs of fabrication.

G. Department of Justice

a. NIJ Data Visualization Challenge: Using Data to Improve Justice²¹

Summary: Criminal justice agencies collect a variety of information for multiple uses: police use data to identify hot spots; judges use data to impose sentences; and victim assistance staff use data to provide better services. In order to help inform criminal justice policies and practices,

²¹ <http://www.nij.gov/funding/Pages/fy14-data-visualization-challenge.aspx>

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research activities incorporate information about current capabilities and needs in the field. This information helps shape research programs and helps NIJ set research priorities.

Criminal justice datasets, however, are often large, complex, and contain a variety of geocodes and identifiers. To help harness the power and increase accessibility of existing data, the National Institute of Justice (NIJ) and Bureau of Justice Statistics (BJS) launched a collaborative Data Visualization Challenge in support of the U.S. Department of Justice (USDOJ) Digital Strategy.²² This Challenge sought data visualizations capable of expanding the use and understanding of publicly available criminal justice data.

Drawing from a list of publicly available criminal justice datasets, contestants were asked to submit concept papers creating an innovative approach for visualizing the data to increase understanding, ensure broad access, and account for the complexities found within statistical data. Contestants were encouraged to develop cost-effective, platform-independent, and publicly accessible solutions. These solutions could take the form of infographics; dashboards; and static, or interactive, data visualizations. Applicants were encouraged to incorporate publicly available data from non-criminal justice sources when such data provided insight into justice system outcomes or crime-related phenomena.

Solution Type: Analytics, visualizations, and algorithms; Creative (design & multimedia)

Primary Goals: Improve government service delivery; Solve a specific problem; Engage new people and communities

Results: The challenge received 13 submissions from a wide variety of sources. Challenge submissions were judged by a distinguished panel of individuals with expertise in one or more of the following areas: criminal justice, data analytics, visual data representation, application development. Entries were judged according to contribution (improving effectiveness, efficiency or understanding of criminal justice operations, patterns or impact; links to multiple datasets to uncover new information or enhance understanding); effectiveness (new and interesting displays; optimal viewing experience across a wide range of devices; easy but unobtrusive access to associate footnotes and methodologies), and efficiency (adaptable approach for use with a large variety of data sets; cost-effective, platform-independent technologies; use of common standards, shared services or common infrastructure; easily updated). The Challenge ended after Phase I judging because the submissions were not of sufficient quality to advance the work in the field, and no prize was awarded.

NIJ elected to issue a challenge because it offered a good value proposition for the government and taxpayers. The challenge format allows NIJ to pay only for successful solutions, spur market interest in problems relevant to practitioners, and may speed the delivery of products to the field. The minimal administrative burden of issuing a challenge was also appealing, as it allows NIJ to attract applicants who might be unfamiliar with NIJ's customary grant applications process.

In the future, the challenge vehicle may not be used because it may not be preferred for achieving knowledge goals. The major lesson learned from this challenge was that in order to

²² <http://www.justice.gov/digitalstrategy/#s1-2>

successfully launch a challenge and attract a pool of highly-qualified applicants, extensive outreach and dissemination must occur beforehand. Listing on the Challenge website did not cast a wide-enough net. In recognition of this, NIJ plans to do more extensive outreach for challenge solicitations in the future. Additionally, NIJ has learned that more extensive vetting of ideas must occur before selecting the challenge vehicle as the best strategy for obtaining results.

b. NIJ Delivering Mission Critical Voice Communications for Law Enforcement and Public Safety Responders in the COTS LTE Environment²³

Summary: Increased access to mobile broadband services is vital to law enforcement and other public safety responders. Broadband communications offer the potential for greater efficiencies and new capabilities in day-to-day operations, response to critical incidents, and management of major events. Recognizing the potential offered by broadband communications to enhance public safety, Congress directed the establishment of a nationwide, interoperable public safety broadband network in the Middle Class Tax Relief and Job Creation Act of 2012. The Federal Communications Commission (FCC) required that all networks deployed in the 700 MHz public safety broadband spectrum adopt Long-Term Evolution (LTE).

This challenge sought innovative solutions, achievable within five years of award, for providing mission-critical voice communications services to law enforcement and other public safety responders within the LTE environment using commercial off-the-shelf (COTS) technology. The proposed solution was to ensure mission-critical voice communications in all environments (e.g., urban, rural, wilderness) and infrastructure challenges, such as areas (1) where there is no terrestrial communications infrastructure; (2) where the existing infrastructure has been compromised or damaged; and (3) confined areas (e.g., subways, buildings, underground garages).

In Phase I, contestants were asked to submit written proposals with technical justification of their solutions. Up to five contestants, who scored the highest with viable solutions in Phase I, were to be invited to participate in Phase II, and submit a full proposal to describe their solutions in greater detail. A total Challenge prize of up to \$50,000 was available for Phases I and II combined.

Solution Type: Ideas

Primary Goals: Solve a specific problem

Results: In Phase 1, 69 proposals were received from teams, commercial entities, and public safety officials and were judged by a distinguished panel of judges with expertise in one or more of the following areas: law enforcement, communications, and information technology. Submissions were judged on technical feasibility according to the necessary specifications of the technology (65%) and business model feasibility of implementing the technology in law enforcement processes (35%). One Phase I applicant received a prize of \$5,000 and was invited to expand upon the proposal in Phase II. No Phase II prizes were awarded because—while highly

²³ <http://nij.gov/funding/pages/fy13-comms-challenge.aspx>; this challenge was described in the FY 2014 COMPETES report, starting on page 221.

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innovative—the proposed solution did not offer a complete solution based on the definition and requirements for mission critical voice communications articulated within the challenge.

The topic of the competition has been perceived as a particularly difficult technical challenge, so there was a fundamental need to capture ideas and concepts to determine viability before considering whether a grant or cooperative agreement was warranted. This Challenge has augmented NIJ's grant-making authorities, as it provided an opportunity to determine whether any substantial investment is warranted without having to commit to any investment other than staff labor, peer review, and incentive prizes.

NIJ learned a great deal about how to structure future challenge evaluation and judging criteria. The lessons learned from this challenge will help ensure that future challenges reach out to an even broader pool of applicants, with more fine-tuned targeting of potential applicants.

c. NIJ Randomized Controlled Trial Challenge in Criminal Justice Agencies²⁴

Summary: NIJ was created in 1968 to facilitate research and scientific inquiry to help state, local and tribal governments address crime problems and challenges in the American criminal justice system. Of the various scientific methods of inquiry available, randomized controlled trials (RCTs) are the scientific gold standard for evaluating programs. They are pervasive in medicine and marketing as part of the standard process for making decisions and advancing the field. The criminal justice system has been slow to adopt RCTs as the standard process for testing programs, and could do more with RCTs to determine whether a strategy or intervention makes a meaningful difference.

NIJ issued this challenge for timely and innovative RCTs that address meaningful criminal justice problems. This competition aimed to create incentives for criminal justice agencies to use low-cost RCTs as a standard and straightforward approach to answering their questions and conducting their day-to-day business operations. For this Challenge, NIJ strongly encouraged potential contestants to establish partnerships with independent researchers or research agencies/institutions. This encouragement came in an attempt to allow contestants to obtain support to use rigorous research methods to craft solutions to the problems they face.

A \$300,000 prize purse was available for this challenge.

Solution Type: Scientific; Ideas

Primary Goals: Advance scientific research; Other (encourage the use of RCTs in the criminal justice field)

Results: Fourteen submissions were accepted on a rolling basis over the course of 18 months. The number of criminal justice agencies that applied to participate in the RCT Challenge was much smaller than the NIJ anticipated. As a result, NIJ cancelled the challenge and is re-

²⁴ <http://nij.gov/funding/pages/rct-challenge.aspx>; this challenge was described in the FY 2014 COMPETES report, starting on page 222.

examining effective strategies to encourage the development of rigorous evidence of what works in policing and criminal justice.

NIJ is attempting to determine whether the requirement to establish partnerships with independent researchers or research agencies and institutions hindered successful participation in the challenge. NIJ continues to promote the need for rigorous evaluation to inform criminal justice policy and practice, and continually gather input from the field about their readiness to engage in research, including RCTs. NIJ will continue to help criminal justice agencies and their research partners understand the role of RCTs as well as the potential need for partnerships between practitioners and researchers. The information from the Challenge did not provide any distinctive insights into how to address these issues.

d. NIJ Ultra-High Speed Apps: Using Current Technology to Improve Criminal Justice Operations²⁵

Summary: The expansion of ultra-high speed (UHS) networks offers increased opportunity for the development of “disruptive” criminal justice apps that can change the way services and information are delivered to criminal justice and other public safety practitioners. New UHS apps now have the potential to provide ubiquitous, real-time, individually tailored information and decision support for criminal justice and public safety practitioners in rapidly evolving emergency situations; and the increased capacity of UHS systems now makes it possible to merge and manipulate data allowing for the development and use of powerful analytical and management tools.

Through this challenge, NIJ sought to encourage the development, use, and evaluation of UHS apps capable of improving criminal justice and public safety efficiency and/or effectiveness; and develop models for measuring and quantifying the specific impact of these apps. This challenge attempted to accelerate the development and deployment of UHS applications in other fields. Submissions were accepted in two phases. In Phase I, applicants submitted prospectus papers that outlined the ideas for their apps. The applicants that were selected for Phase II then created short videos that described and demonstrated their app prototypes. A total prize purse of \$150,000 was offered.

Solution Type: Software and apps; Creative (design & multimedia); Ideas

Primary Goals: Develop technology; Build capacity

Results: NIJ received 15 proposals in Phase I. From these 15 proposals, 5 contestants were selected to compete in Phase II. These contestants demonstrated the potential for measurably improving services and operations in areas such as school safety, crime mapping, video technology, and data streaming. They were invited to develop a working prototype of their proposed app. Final decisions regarding the proposals were made in early 2015; and the first, second and third place winners were announced in July, 2015. The first place winner, City of Ammon, received \$75,000 for their school emergency screencast application, which works with

²⁵ <http://nij.gov/funding/pages/fy13-ultra-high-speed-apps-challenge.aspx>; this challenge was described in the FY 2014 COMPETES report, starting on page 224.

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a school's existing camera systems, UHS bandwidth, and gunshot detection hardware to report gunshot fire immediately to first responders. The second place team, City of Torrence, received \$50,000 for their UHS mapping application, which empowers individual businesses, schools, and other building owners to share their location and other data, such as maps, floor plans, parking structures, video, and dangerous chemicals list, with first responders. The third place team, Logic, Inc., received \$25,000 for their LEAP network video application that connects public CCTV with law enforcement records and open-source GIS platforms.

Challenge submissions were judged by a distinguished panel of individuals with expertise in one or more of the following areas: criminal justice, public management, application development, emergency management, and network management. Entries were judged according to the contribution of the application towards improving the effectiveness and/or efficiency of criminal justice services (60%); ease of implementing the application by state and local criminal justice agencies, including considerations of platform, and time and cost requirements (15%); practicality of dataset selection in terms of relevance, ease of acquisition, and ongoing access (15%); and feasibility of evaluation methodology and impact measurement (10%).

H. Department of Veterans Affairs

a. Innovation Creation Series for Prosthetics and Assistive Technology²⁶

Summary: The VA Innovation Creation Series was a set of three challenges that aimed to facilitate the development of personalized technologies to improve care and quality of life for veterans. Designers, engineers, and other solvers contributed design solutions to the posted challenges. The VA Innovation Creation Series culminated in a 2-day “make-a-thon” event at the Richmond VA Medical Center on July 28 to 29, 2015 where Veterans, makers, and clinicians co-created, built, and tested the designs to showcase how they meet the needs of Veterans.

Partnerships through America Makes and The Girls Lounge allowed VA to collaborate with Google.org, GE, Toyota, Stratasys and 3D Systems to triple the amount of investment and capital involved with the Innovation Creation Series.

VA worked with NASA Center of Excellence for Collaborative Innovation (CoCEI) to conduct the second challenge on InnoCentive. VA provided CoCEI \$31,406.06 to conduct the challenge on InnoCentive, which included the prize amount \$10,000 and platform fee, along with the 14% overhead charge for NASA CoCEI. The other two challenges (#1 and #3) were conducted on GrabCAD.

Solution Type: Creative (design & multimedia); Ideas; Technology demonstration and hardware

Primary Goals: Solve a specific problem; Build capacity; Engage new people and communities

Results: Awards were made for three individual challenges totaling \$26,000, \$16,000 for the two challenges on GrabCAD and \$10,000 on the InnoCentive Challenge. These solutions as well as

²⁶ <http://innovation.va.gov/challenge/>

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other competitors then participated in a two-day make-a-thon event where additional prizes were awarded to the most impressive ideas and technology. In total, the make-a-thon awarded \$26,000 in addition to the individual challenge purses, for a total of \$52,000 prize purse over the three challenges and event.

The organizers achieved their mission of open-sourcing designs, which can be found on the challenge platforms and on the NIH 3D Print Exchange.²⁷ There are 18 open sourced designs featured on the NIH 3D Print Exchange and 141 open-sourced designs featured on GrabCAD. This challenge helped raised awareness for veterans faced with disabilities and also improved VA employee morale. Most importantly, veterans participating as part of this challenge felt served and their stories were amplified nationally on platforms such as the *Washington Post* and Fox News, along with the White House Blog and local news outlets.

1) Challenge #1: Develop novel upper extremity prosthesis devices for everyday usage.²⁸

Summary: Veterans with upper extremity amputations have a host of unique challenges that are difficult to manage with traditional healthcare strategies and resources. Upper limb amputees now account for 22% of all new amputees, and while scientists have greatly improved prosthetic legs during the past decade, improvements to artificial arms have not kept pace.

This challenge directed the GrabCAD Community to create an attachment or accessory to a prosthetic arm that would improve the user's quality of life. It could help a user, for example, with personal maintenance and grooming, with household chores, or with allowing participation in a favorite activity. The attachment needed to connect to the end of the prosthetic arm via a threaded receptor, which required a threaded screw. Submissions included a design (including STL files), renderings, and description of the proposed design.

GrabCAD supported the implementation of this prize competition.

Solution Type: Creative (design & multimedia); Ideas

Primary Goals: See Series Description

Results: In total, 93 individual contributors completed submissions. Six winning designs received a total prize purse of \$3,000 and were chosen based on simplicity, ease of use, safety, durability, and aesthetics.

2) Challenge #2: Create a way to reassign motions and buttons on gaming controllers to provide alternative access for veterans who are using them in therapy to improve eye hand coordination, fine motor control and/or range of motion.²⁹

Summary: Many veterans and their supporters play video games as recreation and sometimes for exercise. For some differently-abled veterans, motion tracking game controllers, such as the Wii

²⁷ The NIH 3D Print Exchange is located at <http://3dprint.nih.gov/>.

²⁸ <https://grabcad.com/challenges/va-innovation-creation-series-challenge-1>

²⁹ <https://www.innocentive.com/ar/challenge/9933769>

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controller, are difficult to use due to exacting motion requirements and buttons required by the game. These veterans are faced with a number of complex conditions, each with specific limitations. These conditions can impact their ability to utilize their hands and arms, such as limited to no grasp and finger dexterity. These limitations prevent them from pushing little buttons or manipulating controllers in very active ways.

Organizers emphasized that a general solution, rather than a “one size fits all” approach, given the myriad of conditions of the potential end users. Solvers were asked to be specific about their ideas and devices.

InnoCentive supported the implementation of this prize competition.

Solution Type: Creative (design & multimedia); Ideas

Primary Goals: See Series Description

Results: Challenge #2 attracted 191 active solvers with 17 complete submissions, and awarded \$10,000 in prize money to three winners. Successful solutions balanced form and function while keeping cost reasonable and matching design specifications. Preference was given to configuration interfaces that displayed on the same screen as the video game.

3) Challenge #3: Create a device that can dampen tremors when someone is performing fine motor tasks.³⁰

Summary: Essential tremor, which impacts hundreds of millions of people worldwide, is a common neurological disease and the most common movement disorder. Tremors are an “involuntary shaking movement that is repeated over and over” and when they occur in the hand, can be cumbersome and make daily tasks difficult. This challenge asked participants to design a device to remove, reduce, stabilize, or cancel tremors. Proposed solutions could include mechanical dampening of tremors, viscous resistance to motion of the wrist, or the use of active stabilization technology.

GrabCAD supported the implementation of this prize competition.

Solution Type: Creative (design & multimedia); Ideas

Primary Goals: See Series Description

Results: Challenge #3 received 48 complete submissions. Six winning designs were chosen for the \$3,000 total prize purse based on simplicity, ease of use, and aesthetics of the final design. Specifically, winning devices reduced a range of tremors, fit under a shirt, required no power source, and permitted a full thumb, finger, wrist, and forearm motion.

³⁰ <https://grabcad.com/challenges/va-innovation-creation-series-challenge-3>

I. Environmental Protection Agency

a. Nutrient Sensor Challenge³¹

Summary: The Nutrient Sensor Challenge will accelerate the development and deployment of affordable nutrient sensors to reduce the cost and complexity of collecting nutrient data and allow for better measurement and tracking of nutrients throughout ecosystems. The goal is for next-generation sensors developed through the challenge to be easy to use in maintenance-free deployments of up to three months, cost less than \$5,000 to purchase, and be commercially available by 2017. This challenge has several Agency contributors, known as the Challenging Nutrients Coalition, which includes NOAA, USGS, and NIST. EPA collaborated with USGS, USDA, NOAA, NIST, Everglades Foundation, Tulane University, the Partnership on Technology Innovation and the Environment (PTIE), and the U.S. Integrated Ocean Observing System (IOOS). NOAA is supporting the implementation of this prize competition through a cooperative agreement with the Alliance for Coastal Technologies (ACT).

The Nutrient Sensor Challenge is a market stimulation and innovation effort to accelerate the development, adoption, and use of affordable, reliable, and accurate nitrate and orthophosphate sensors. In order to score highly in the competition, entries must be affordable and easy to use, operate over a wide range of concentrations, and be both accurate and precise.

Solution Type: Technology demonstration and hardware; Scientific

Primary Goals: Advance scientific research; Develop technology; Stimulate a market; Engage new people and communities

Results: The organizers chose a prize competition to find ideas from outside the typical disciplines, interact closely with collaborators, and reward non-monetary benefits to participants for their efforts in this market stimulation challenge. In FY15, The Nutrient Sensor Challenge had a highly successful Challenge Summit in Washington, D.C. in August 2015 where the 29 challenge participants gathered to learn, network, and demonstrate their abilities. After the summit, all 29 submissions were beta-tested and served as a resource to enhance the ability of all registered participants to prepare for the final challenge verification testing in 2016. The teams registered to participate in beta testing at three different field sites (Chesapeake Bay, Huron River, Hawaii). Several of the teams that beta tested have qualified for final verification testing and have promising technologies that detect both nitrate and orthophosphate.

In FY16, competitors will participate in a protocol workshop and field verification testing of their submissions. Final verification reports will be published and the awards announced in December 2016.

³¹ <http://www.act-us.info/nutrients-challenge/index.php>

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b. TRI University Challenge – 2015³²

Summary: The 2015 Toxics Release Inventory (TRI) University Challenge aims to increase awareness of the EPA TRI Program and data within academic communities; expose students to TRI data, tools, and analysis; and generate innovative programs, activities, recommendations, or research that improve the accessibility, awareness, and use of TRI data.

EPA is looking to academic institutions to help build a diverse portfolio of practical and replicable projects that benefit communities, the environment, academic institutions, and the TRI Program. EPA welcomes the submission of any project proposal that advances the knowledge, use, and understanding of TRI data and related information, specifically in the following themes:

1. Turning environmental data into understanding: Stimulate the analysis and transformation of data to usable knowledge that promotes the use and understanding of TRI and related data
2. Pollution prevention and sustainability: Promote the use of TRI as a sustainable development tool and the adoption of pollution prevention (P2) technologies and practices
3. Community engagement: Cultivate relationships among stakeholder groups and improve the communications of TRI-related information

Solution Type: Scientific; Other (University program)

Primary Goals: Find and highlight innovative ideas; Advance scientific research; Engage new people and communities; Other (Student training)

Results: The challenge received 8 proposals. Winning submissions receive a year-long one-on-one collaboration with an EPA subject matter expert who assists each academic partner with the research project; promotion for the academic partners on the TRI University Challenge webpage; and the experience of collaborating with EPA on an extended, focused research project. Research proposals were chosen based on clarity and effectiveness of proposed approach, project outcomes, and partner capabilities.

The three new proposals³³ that were selected for the 2015 TRI University Challenge came from faculty at the following academic institutions: 1) Indiana University-Purdue University-Indianapolis – IU Fairbanks School of Public Health; 2) Mercyhurst University – School of Health Professionals and Public Health; and, 3) University of North Carolina, Charlotte – Department of Computer Science.

In addition to these new projects, EPA will continue partnerships with three multi-year projects selected in the 2014 challenge: 1) Southeastern Louisiana University – Department of Computer Science and Industrial Technology; 2) Tennessee State University – Geographic Information Science Laboratory; and, 3) University of South Carolina – Department of Geography.

³² <http://www2.epa.gov/toxics-release-inventory-tri-program/2015-tri-university-challenge-0>; the previous iteration of this challenge was described in the FY 2014 COMPETES report, starting on page 232.

³³ <http://www2.epa.gov/toxics-release-inventory-tri-program/2014-15-tri-university-academic-partners>

c. Visualizing Nutrients³⁴

Summary: The EPA, the U.S. Geological Survey (USGS), and Blue Legacy asked challenge solvers to use Federal government open data sources to create compelling, innovative, and comprehensible visualizations about nutrient pollution and inspire them to reduce nutrient levels that cause algal blooms and hypoxia in local watersheds. Data visualization submissions were expected to both a) inform individuals and communities of one or more threats, causes, consequences of, facts about, or solutions to nutrient pollution, and b) through compelling visualization, drive those individuals and communities to take action.

InnoCentive supported the implementation of this prize competition.

Solution Type: Creative (design & multimedia); Analytics, visualizations, and algorithms

Primary Goals: Inform and educate the public; Engage new people and communities

Results: The challenge received 20 submissions from which judges chose a first place award (\$10,000) and a Blue Legacy award (\$5,000). The winning visualization, *A Resource Out of Place: The Story of Phosphorus, Lake Erie, and Toxic Algal Blooms*, used USGS monitoring data to inform individuals and communities about phosphorus runoff to Lake Erie. The authors sought to “inspire multiple stakeholders to strive toward both better resource management and improved environmental quality.” Runners up were identified for demonstrating creative use of open water data and effective storytelling.

J. Intelligence Advanced Research Projects Activity

a. Automatic Speech recognition In Reverberant Environments (ASpIRE) Challenge³⁵

Summary: ASpIRE challenged teams to apply and refine state-of-the-art speech-to-text (STT) techniques to transcribe recordings of native speakers of American English. Participants were expected to build automatic speech recognizers that were trained on English conversational telephone speech but could then accurately transcribe speech recorded in a variety of unknown acoustic environments and recording scenarios without access to any other training or matched development data.

Typically, speech recognition systems are trained on speech recorded in environments very similar to those in which they are expected to be used. The ASpIRE challenge tackled the harder problem of building accurate systems for automatically transcribing speech recorded in noisy and reverberant environments without any training data that resembled the challenge’s final test conditions – and without knowing anything about the recording devices used, the placement of the talker relative to the recording device, or the acoustics of the rooms where the speech was recorded.

³⁴ <https://www.innocentive.com/ar/challenge/9933113>

³⁵ <http://www.iarpa.gov/index.php/working-with-iarpa/prize-challenges/306-automatic-speech-inreverberant-environments-aspire-challenge>

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MIT Lincoln Laboratory provided help with data preparation, solution evaluation, solution validation, and analysis of results, and InnoCentive supported the implementation of this prize competition.

Solution Type: Software and apps

Primary Goals: Solve a specific problem; Advance scientific research; Find and highlight innovative ideas; Engage new people and communities

Results: The challenge's public web page received approximately 1600 unique views. The challenge attracted 167 registered solvers, of whom 48 downloaded the training and development data; 16 teams submitted development results for scoring and posting to the leaderboard; 15 were tested on the evaluation set; and 4 were validated on a second set of data to check consistency before winners were announced.

Challenge entries were scored under two evaluation conditions, the single microphone condition and the multiple microphone condition.

Solutions were evaluated based on accuracy. All systems produced a speech recognition transcript for the evaluation data. These transcripts were scored by MIT Lincoln Laboratory against reference transcripts for word error rate (WER). WER is the standard measure of accuracy for speech recognition systems; lower WER scores indicate more accurate systems.

Three winners were chosen in the single microphone category and awarded \$30,000 each, and one winner was chosen in the multiple microphone category and awarded \$20,000. All funds were provided by ODNI/IARPA. All winning teams that had at least two institutions involved in the submission, including universities and large corporations. The three ASpIRE challenge winners in the single microphone condition delivered systems with between 44.3% and 44.8% WER, which represents more than a 50% reduction compared to the IARPA baseline system. The winner of the multiple microphone condition further reduced the WER to 38.5%. The winning solutions were significantly more accurate than IARPA's baseline system. Hence, the ASpIRE challenge revealed better solutions to the problem. In addition, further analysis of the factors affecting the performance of winning and non-winning systems provide insight into the efficacy of the various technical approaches for recognition of speech recorded in noisy reverberant conditions without matched training data.

The challenge attracted significant attention, and IARPA has observed sustained interest from the research community in working with the data set following the close of the challenge. ASpIRE succeeded at focusing attention on this kind of high-risk, high-payoff research, which is important to IARPA's mission.

K. National Aeronautics and Space Administration

a. 3D Printed Habitat³⁶

Summary: Shelter is among the most basic and crucial human needs, but packing enough materials and equipment to build a habitat on a distant planet would take up valuable cargo space better used for other life-sustaining provisions. The ability to manufacture a habitat using indigenous regolith in combination with material that would otherwise be waste from the spacecraft would be invaluable. NASA's 3D Printed Habitat Challenge offers a total of \$2.25 million in prize money and is designed to advance the additive construction technology needed to create sustainable housing for Earth and beyond. NASA Centennial Challenges Program (CCP) has partnered with the not-for-profit organization, America Makes, to manage the challenge. America Makes designed a separate challenge website, and CCP hosted a challenge page on the NASA portal with basic challenge info and a link to the external site.

The NASA 3D Printed Habitat Challenge prize purse is divided into three major areas: (1) a design competition offering \$50,000 in prizes for the top three designs; (2) a structural member competition (Level 1) offering \$1.1 million in prizes to competitors who can demonstrate a recycling additive manufacturing system that can create structural components; 3) an onsite habitat competition (Level 2) offering \$1.1 million in prizes to competitors who can complete a sub-scaled habitat using an additive manufacturing system and indigenous materials.

A panel of 16 judges (two per submission) assessed and scored compliant submissions in order to down select to the final 30 competitors. The 30 finalists were directed to 3D print their design for display at the New York City Maker Faire. The public was invited to vote for their favorite design. A judges panel reviewed the final 30 displayed and determined the top three for NASA awards. America Makes distributed additional prizes and awards.

Solution Type: Technology demonstration and hardware

Primary Goals: Develop technology

Results: The 3D Printed Habitat Challenge received a total of 167 entries with 94 meeting all the requirements for the design competition. A total of 538 people participated including 145 students from 43 universities and colleges. These entries included inputs from many architectural schools and firms, and those from more artistic backgrounds than the historical inputs from teams with heavy STEM and technical backgrounds. The top 30 entries were invited to attend the New York City Maker Faire held September 25-27, 2015 for final judging. Competitors were also featured in “After the Challenge” reports to highlight their successes in developing and commercializing their technologies. The NASA web page received 55,562 hits for this challenge— more than any other challenge during that fiscal year. The NASA Prize Twitter account received 456 likes, 344 Retweets and 823 engagements; Facebook received 7.6K likes and 9.3K engagements, with the most popular post being the announcement of the winners, which received 937 likes and 466 shares. Press coverage included more than 230 unique press stories, and those in turn were picked up and republished by other outlets. For the first time, the

³⁶ www.nasa.gov/3DPHab

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Allied Organization incorporated public voting as a way to allow the public to be engaged and to look at the models that were created for the challenge. The public vote was used to select a “People Choice Award” that had a prize awarded by the Allied Organization. The winners of the challenge, the ones that received Centennial Challenges Prize Purse Awards, were not selected or influenced by those votes. The winner of the People’s Choice Awards was not made public to the judges prior to the time they sent the final selection to the Allied Organization.

Team Space Exploration Architecture and Clouds Architecture Office scored well enough to earn first place and was awarded \$25,000 in the Design Competition. Team Gamma from Foster + Partners scored well enough to earn second place and was awarded \$15,000 in the Design Competition. Team Lava Hive scored well enough to earn third place, but was not eligible for the monetary prize since the team was comprised of foreign nationals.

The partnership agreement with America Makes expired in December 2015. Centennial Challenges is working to get support outside of the Agency for Phase 2 (Level 1 and Level 2) of the challenge. Challenge details (for second phase) will be announced in September 2016 if support is secured by July 2016.

b. CineSpace: NASA Imagery³⁷

Summary: NASA has film footage publicly available and collected from 50 years of exploring the universe. This competition offered filmmakers from around the world a chance to share their work inspired by and using that imagery. Participants searched through NASA archives to find what inspired them, downloaded the imagery, and created their short work. Those works were then submitted and selected to be shown to audiences at the 2015 Houston Cinema Arts Festival (HCAF) hosted by the Houston Cinema Arts Society (HCAS).

InnoCentive supported the implementation of this prize competition, and the total award was \$26,000.

Solution Type: Creative (design & multimedia)

Primary Goals: Inform and educate the public

Results: The competition attracted 194 total submissions from individuals and teams. Submissions were screened based on the criteria agreed to by NASA and included specific guidelines for storytelling, creativity originality, technical quality, and engagement. All films required usage of at least 7 minutes of NASA footage and that footage had to be used within NASA guidelines. Finalists were reviewed by academy award nominated director, producer, screenwriter Richard Linklater who recommended the top three winners. Film makers from 22 countries competed for cash prizes, other recognition, and the opportunity to have their films shown to audiences both on and off the Earth.

Five films were selected for each of the prize areas and are now publicly available.

³⁷ <http://cinespace15.org/>

c. Cube Quest Challenge³⁸

Summary: CubeSats are a type of cubic miniaturized satellite used in space. CubeSats are small, light, inexpensive, and often utilize commercial-off-the-shelf (COTS) components for their electronics and structure. Because of their versatility and ease of use, CubeSats have been used to demonstrate functionality in areas ranging from Earth observation to life sciences to space tether experiments. However, the farther these small spacecraft get from low-Earth orbit, the more difficult it is for them to survive and function. Communications from great distances to Earth, long-range propulsion systems, navigation at distances where GPS cannot reach, and protection for the extreme cold and radiation environments are very difficult in deep space. These limitations are exactly the capabilities this challenge seeks to advance. The Cube Quest Challenge seeks to develop and test subsystems necessary to perform deep-space exploration using small spacecraft. Advancements in small spacecraft capabilities will provide benefits to future missions and also may enable entirely new mission scenarios, including future investigations of near Earth asteroids.

NASA's Cube Quest Challenge offers a total of \$5.0 million in prize money and is divided into three areas: (1) Five Ground Tournaments (GT-1, GT-2, GT-3, GT-4, GT-5)) (\$500,000) to determine who will have the ability to fly on the first integrated flight of NASA's Orion spacecraft and Space Launch System (SLS) rocket; (2) Deep Space Derby (\$1.5 million) for demonstrating communication and CubeSat durability at a distance greater than 2.5 million miles (10 times the distance from the Earth to the moon); and, (3) Lunar Derby (\$3 million) for demonstrating the ability to place a CubeSat in a stable lunar orbit and demonstrate communication and durability near the moon.

NASA Ames Research Center, the NASA center that is executing the challenge, formed a partnership with San Jose State University. San Jose State University (SJSU) supports Cube Quest by setting up a virtual meeting place and conducting a series of technical workshops relevant to Cube Quest for the teams to attend. The virtual meeting space facilitates self-organization of challenge teams; offers challenge-related services; organizes bulk purchases of CubeSat components to amortize costs across teams; and fosters general dialogue in the CubeSat communities relevant to Cube Quest. The workshops are a series of at least six technical topics proposed and selected by NASA. Topics may include radiation tolerance, navigation at the moon, and other topics relevant to Cube Quest. A SJSU student leads the workshops.

A launch as a secondary payload on the SLS rocket for selected teams is also an important part of the structure of the prize. This incentive is the first time NASA has offered a ride on a rocket through a prize, which shows a more serious use of prizes for in-space technology demonstration. Alternatively, teams could choose to use private companies to launch their CubeSats. The SLS launch is considered a priceless incentive because there are few launch opportunities that could get those CubeSats into a good trajectory for the lunar elements of the challenge.

Solution Type: Technology demonstration and hardware

³⁸ www.nasa.gov/cubequest/

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Primary Goals: Develop technology

Results: NASA Centennial Challenges Program hosted the first Cube Quest Summit at Ames Research Center in January 2015. The purpose was for teams, judges, subject matter experts and NASA personnel to get acquainted, ask questions, form teams, and present their ideas. As of September 2015, there have been 10,251 Cube Quest website views and over 130 people registered for the Cube Quest Challenge Virtual Summit in November 2015. 13 teams competed in GT-1. Five were awarded prize money of \$20,000 each for their design and presentations. All thirteen teams are eligible to compete in GT-2; however, additional teams can also participate in GT-2 without the requisite of GT-1 participation.

A panel of five judges (two NASA civil servants and three outside-Agency subject matter experts) will assess and score entries during the ground tournaments and hold the final determination of prize award winners.

The Cube Quest Challenge began registration in November 2014, and the challenge will run for an estimated four years.

d. Disruption Tolerant Networking Challenge Series³⁹

Summary: This was a series of challenges to develop data networking protocols that can extend the Internet into the Solar System. Building on the prototype implementations of the Disruption Tolerant Networking (DTN) protocol suite, these challenges help improve the security, performance, and application of network protocols that can withstand the time delays due to the immense distances between planets and the disruptions and non-contiguous paths of the space communications links. The series of challenges included two completed challenges in 2013, one challenge in 2014, and three challenges in 2015:

1) Astronaut Email

This challenge was to fix an existing problem with the International Space Station (ISS) email system for astronauts by developing an architecture that uses the DTN protocols to solve the problem. This challenge was started in 2014 and completed in 2015. The Astronaut Email challenge awarded a total of \$23,638.

2) Neighbor Discovery Protocol

This challenge was to add IP Neighbor Discovery (IPND) protocol to JPL's DTN software. This protocol enables the JPL software to be able to work with other organizations' DTN software and automatically work together to "discover" computers on a network running the DTN protocol. The Neighbor Discovery challenge awarded \$45,572.

³⁹ <http://www.topcoder.com/dtn/>; previous challenges in this series were described in the FY 2014 COMPETES report, starting on page 237.

3) DTN Dashboard

This challenge was to design and develop a User Interface (UI) that is easy to use, intuitive, and provides capabilities to manage a disruption tolerant network. The DTN Dashboard challenge awarded a total of \$14,656.

These challenges challenge were launched using the NASA Tournament Lab contract with Harvard University, who partnered with Appirio, Inc. to launch each challenge on the TopCoder platform. For each challenge, NASA provided Appirio with its requirements for the products that it expects out of these challenges. Appirio then breaks the challenges into multiple contests, each with its own success criteria. These success criteria are based on the technical requirements provided by the DTN team. There are often multiple winners for each of these contests in support of a single challenge. Often the products from each contest build upon each other until there is a holistic solution that meets the requirements of the challenge. The community-based project manager manages the selection of winners for each contest from submissions with input from the NASA technical lead (as required). This approach maintains a fairly low overhead for NASA participation and has worked well to get a good product from the platform.

Solution Type: Software and apps

Primary Goals: Develop technology; Solve a specific problem

Results: These three challenges posted 34 different contests with a total of 651 registrants across all contests. To date, these DTN challenges have had 68 different winners. All of the Appirio-TopCoder participants work as individuals and not as teams. The results of these challenges are providing cost effective, usable products that NASA can utilize.

The results for each challenge were:

Astronaut Email: The Astronaut Email challenge received 24 entries for 18 contests and awarded 12 prizes to 6 unique winners. The Astronaut Email software will begin the process of flight certification for eventual use on the ISS. This software will fix a known issue with large file attachments on the current email system on ISS. If this issue had been fixed in-house, it would have cost \$193,000. In the challenge format, this challenge cost NASA about \$81,000, less than one-half of the cost of other means.

Neighbor Discovery Protocol: 148 coders contributed to the Neighbor Discover challenge through 13 contests and 10 were chosen as winners to 6 unique participants. The Neighbor Discovery challenge has resulted in fully functional code that is currently being incorporated into the official DTN software code base maintained by NASA's Jet Propulsion Laboratory. This DTN software code base is the core of what is used for spaceflight applications.

DTN Dashboard: Fifty-three coders participated in this challenge through 3 contests with 15 winners, including 13 unique participants. The DTN Dashboard prototype displays are the basis of ongoing development of the network management features of DTN.

e. Earth Science Climate Resilience Data Challenge⁴⁰

Summary: What would the world do without the need to download code or data from NASA, but simply invoked functions over the web instead? What sort of ingenuity would appear in consumer applications? The Climate Data Initiative is a broad effort to leverage the federal government’s extensive, freely available climate-relevant data resources to spur innovation and private-sector entrepreneurship in order to advance awareness of and preparedness for the impacts of climate change.

The Challenge was conducted in the following three phases: idea generation, design concepts, and prototype assembly. Each of the three phases was separately judged, and competitors were tasked with providing ideas for Climate Resilience (e.g., societal benefit themes like coastal flooding, sea level rise, food security, and public water utilities). In the idea generation phase, competitors were tasked with describing an idea for an application that addresses a problem described in the National Climate Assessment and with describing what data infrastructure is needed to create impactful products. In the design concepts phase, the competitors created design concepts and visual ideas for an application to be used by the general public to implement the ideas selected in the idea generation phase. In the remaining prototype assembly phase, the competitors built the user interface for an app based on each design concept and prepare it for demonstration and backend integration. Competitors were judged based on data from the following three sources: NASA’s Earth Observing System Data and Information System (EOSDIS) data, federal government climate data, and open-access climate data.

This challenge was launched using the NASA Tournament Lab contract with Harvard University, who partnered with Appirio, Inc. to launch the challenge on the TopCoder platform. Participants in this challenge came from three distinct communities for each of the phases. The Idea Generation phase was directed to the data-science community within Appirio-TopCoder to assess and ideate the utility of various datasets. The Design Concept phase was directed to the Appirio-TopCoder studio community for GUI look-and-feel design. The Prototype Assembly phase was directed to more conventional code designers.

NASA coordinated all outreach with the White House Office of Science and Technology Policy (OSTP) and the U.S. Geological Survey (USGS). The total award for this challenge was \$31,133.

Solution Type: Software and apps; Ideas

Primary Goals: Develop technology; Engage new people and communities; Inform and educate the public

Results: There were a total of 384 registered solvers and teams, with 180 unique registrants from 26 countries, resulting in 68 total proposal submissions. Twenty-four unique winners from nine countries were selected for the 14 contests. Winners were reflective of the three different targeted communities: data sciences, design, and coding and assembly.

⁴⁰ <http://www.topcoder.com/earthscience/crdc/>

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Six NASA and five USGS judges evaluated each stage of the contests in three classes that corresponded to the criteria-based data categories (NASA EOSDIS, Federal data, and open data). Judging was conducted on a 0-5 scale against the following four criteria: scientific grounding; innovative use of data; relevance to the NCA; and compelling concept.

Covariance was calculated across the judges to measure how tight the score variance was. A judges' consensus session was conducted to establish final rankings. All judges expressed satisfaction that the resulting winner was appropriate and reflected a compelling concept. In the NASA EOSDIS category, there was some concern that the resolution of available data might not support the proposed utilization, and judges agreed that it would require significant scientific investigation to validate the data applicability.

The results of this contest produced ideas, storyboards, lightweight clickable prototypes, and site map flowcharts. All products were deployed with Apache2 license to Github. Resulting ideas around climate data and use of APIs to access that data were put into a shareable form to evangelize and garner increased utilization for Earth Science to address problems of Climate resilience. A clickable prototype was produced for the TAWA and Permafrost Apps, which were developed for Open Data and the NASA EOSDIS, respectively. As funding becomes available, the NASA and USGS earth science communities hope to expand TAWA and Permafrost Risk Evaluator into full applications.

The Cyanobloom App was developed for US Federal Data. NASA has no plans to further develop the Apps at this time. Through discussions with EPA, it was agreed that the Cyanobloom prediction might be used to extend EPA's existing HAB app. Further discussions are occurring with EPA, but that effort will be run as a new challenge.

f. Flexible Sealing Device Challenge⁴¹

Summary: NASA is currently researching new flexible hatch seal device concepts for use within a new class of ultra-lightweight deployable hatch concepts for space vehicle application. Current metallic hatches require a large stowage volume and impose a large mass penalty during launch and throughout the mission. NASA desires to mature flexible seal technology to enable the development of new lightweight deployable hatch concepts to meet stringent mass and volume requirements for future space missions beyond near earth orbit.

This challenge tasked competitors with developing concepts for a flexible seal device for ultra-lightweight deployable space hatches on spacecraft and habitat systems. This effort is part of a new concept of inflatable membrane-based space modules which can be deployed when needed to provide expandable working and living space for astronauts. Target applications for the flexible seal device incorporated into a membrane-like hatch range from space station airlocks, Orion spacecraft, various exploration spacecraft habitation modules, and Lunar and Mars surface habitation modules. The device will be integrated in an inflatable airlock to facilitate extravehicular activity (EVA).

⁴¹ <https://www.innocentive.com/ar/challenge/9933747>

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The total award for this challenge was \$15,000 and InnoCentive supported the implementation of this prize competition.

Solution Type: Ideas

Primary Goals: Develop technology

Results: A total of 448 registered solvers and teams submitted 109 total proposal submissions. This ideation challenge awarded a first place \$7,500 prize and three \$2,500 runner-up prizes ushering in four new technologies for possible advancement through NASA's Space Technology, Game Changing Development (GCD) Program. The development of a new flexible seal device will enhance the capabilities of future space missions by reducing mass and volume parameters. The GCD Program intends to further pursue at least two of the concepts to incorporate into elements of future airlocks and inflatable structures.

g. Future Engineers 3D Space Design Challenges⁴²

Summary: Through a series of two Future Engineers 3D Space Challenges, students aged 5-19 years old focus on solving real-world space exploration problems and submit 3D model designs of 3D printable objects for an astronaut to theoretically use in space. Submissions were judged on innovation and creativity of the solution, the ability to advance human space exploration, the ability to communicate the design and quality of 3D model through a text description or an interview.

The two challenges were launched in partnership with the American Society of Mechanical Engineers Foundation. The Future Engineers Platform supported the implementation of these prize competitions:

Space Tools Design Challenge: Students were asked to use their imagination to design and 3D model of a tool that they think astronauts could 3D print and use in space.

Space Container Design Challenge: Students were asked to use their imagination to design and 3D model of a container that they think astronauts could 3D print and use in space.

Solution Type: Ideas; Creative (design & multimedia)

Primary Goals: Inform and educate the public; Engage new people and communities

Results: See individual challenges for results. Since this is the first year of these challenges, comparison to previous years is not available. NASA is continuing the challenges and increasing the problem difficulty so comparisons should be possible in the future.

1) Space Tools Design Challenge

Results: The Space Tools Design Challenge received 470 submissions from participants in 31 states and the District of Columbia across two age groups 5 to 12 years old (Junior Engineers)

⁴² <http://www.futureengineers.org>; this series of challenges was described in the FY 2014 COMPETES report, starting on page 239.

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and 13 to 19 years old (Teen Engineers). The ten semi-finalists from the Junior Engineers age group each received a \$50 gift certificate to Shapeways to allow entrants to print a design if they do not have access to a 3D printer and the grand prize winner received a 3D printer for his or her school. The winner of the Junior Group designed a space planter that could be used to grow plants on the ISS while conserving water. In the Teen Engineers category, the grand prize winner received a trip to NASA Payload Operations in Huntsville, AL to watch a 3D print of their winning entry on the International Space Station and a Shapeways Designer Spotlight. The winner from the Teen Group designed a multipurpose precision maintenance tool for use by astronauts aboard the International Space Station (ISS).

The Space Tools Challenge reached 40.79 million social media impressions across 54,000 media outlets.

2) Space Container Design Challenge

Results: The Space Container Design Challenge received 400 submissions from participants in 36 states across two age groups 5 to 12 years old (Junior Engineers) and 13 to 19 years old (Teen Engineers). In the Junior Group, the ten semi-finalists received a \$50 gift certificate for to Shapeways to allow entrants to print a design if they do not have access to a 3D printer, the four runner-ups received a one-week scholarship to Space Camp in Huntsville, AL, and the grand prize winner received a 3D printer for her school. The winning container from the Junior Group was a Flower Tea Cage, which uses the surface tension of liquids in a microgravity environment to allow astronauts to make tea. In space, liquids form spheres and adhere to things they touch.

In the Teen Group, the ten semi-finalists received a \$50 gift certificate for 3D printing, the four runner-ups received a full scholarship to Space Camp in Huntsville, AL, redeemable within one year, and the grand prize winner received a private tour of the Space Shuttle Endeavor with an astronaut. The winner of the Teen Group designed the ClipCatch that will allow astronauts on the space station to clip their fingernails without worrying about the clippings floating away and potentially becoming harmful debris.

h. Galactic Cosmic Ray Theoretical Challenge⁴³

Summary: Galactic Cosmic Rays (GCR) pose a significant health risk to astronauts traveling in space. Unlike the short duration exposures presented by Solar Energetic Particles (SEP) and the trapped particles of the Van Allen belts, which can be mitigated through modest amounts of passive shielding, trajectory selection, and operational procedures, the GCR present a ubiquitous and omnidirectional radiation source that requires much more sophisticated reduction techniques. This Challenge seeks solutions for the reduction of GCR exposure to astronauts by utilizing configurations of passive shielding, active shielding, or a combination of both. The focus is to maximize radiation protection while keeping mass as low as possible.

A prize purse of \$29,000 was available to winning solutions. InnoCentive supported the implementation of this prize competition.

Solution Type: Ideas

⁴³ This challenge was also called “Reducing Galactic Cosmic Rays to Enable Long Duration Deep Space Human Exploration.” <https://www.innocentive.com/ar/challenge/9933638>

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Primary Goals: Solve a specific problem; Develop technology

Results: A total of 1,142 registered solvers and teams submitted 215 total proposals. The NASA GCR team provided all evaluation and judging of submissions. Solutions were evaluated through a scoring mechanism that divided the Radiation Shielding Effectiveness (RSE), a value determined by technical standards, by the Integration Complexity Factor (ICF), a value for the difficulty of integrating the proposed solution into existing technologies.⁴⁴ This ratio of RSE to ICF incorporates feasibility with today's technology by referencing specifications of existing components that could reasonably operate, or could be slightly modified to operate in the space environment.

No concepts or solutions were found that the GCR team was not already aware of and working, and the cash prize was not awarded. This challenge validated the NASA GCR team's current approach to addressing this very difficult issue.

i. Handrail Clamp Assembly Challenge⁴⁵

Summary: Last year, NASA manufactured the first parts ever made in orbit with the International Space Station's 3D printer, paving the way for future long-term space expeditions. To be successful, deep space explorers will need the ability to also design the parts for use in different environments. This capability may decrease cost and risk on the station, which will be critical when space explorers venture far from Earth, and will create an on-demand supply chain for needed tools and parts. Data and experience gathered in this challenge is expected to improve future 3D manufacturing technology and equipment for the space program, allowing a greater degree of autonomy and flexibility for astronauts.

NASA sought to challenge the GrabCAD community, a site specializing in 3D CAD design, by sponsoring an open competition where participants utilize the new additive manufacturing capability on the International Space Station (ISS). Competitors were asked to create a 3D design for printing a complementary Handrail Clamp Assembly (HCA), which is currently utilized by astronauts to provide rigid mounting locations required in a microgravity environment for normal daily operations. The printed part will be analyzed to further understanding of the effects of microgravity on the fused deposition method of manufacturing.

The prize purse for this challenge totaled \$2,000. The GrabCAD Platform supported the implementation of this prize competition.

Solution Type: Technology demonstration and hardware; Creative (design & multimedia)

⁴⁴ Radiation Shielding Effectiveness (RSE) is the ratio of additional vehicle mass to total dose equivalent. Total dose equivalent is calculated according to National Council on Radiation Protection (NCRP) 60 using the GCR spectrum as defined by the 2010 Badhwar-O'Neill Model at 1AU for Solar Minimum of 1977 (Phi = 474). An Integration Complexity Factor (ICF) of 1.0 was used for passive shielding solutions, and an ICF of 1.2, 1.3, or 1.5 was used for active shielding solutions with high technology readiness level (TRL) 8-9, mid-TRL 5-7, or low-TRL 2-4, respectively. Hybrid solutions (utilizing both active and passive shielding methods) were given the same ICF as active-only solutions based on the technologies required by the active portion of the solution.

⁴⁵ <https://grabcad.com/challenges/nasa-handrail-clamp-assembly-challenge>

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Primary Goals: Solve a specific problem; Develop technology; Build capacity

Results: Over 300 participants submitted 492 designs. NASA awarded five winners with 1st through 5th place. The winner was a freelance mechanical engineer from Vancouver, Canada. The other winners were from Germany, the United Kingdom, Pennsylvania, and the Netherlands. The resulting five designs provide a structurally diverse range of approaches for designing a 3D printable handrail clamp. Some used 2 or 3 pieces that slid together while others used snap-in approaches.⁴⁶ These five innovative approaches provided NASA’s In-Space Manufacturing project with an excellent range of designs to test against. The contest overall proved that this type of contest was very effective in getting a large range of high quality, innovative designs for very little cost. To obtain the same amount and number of CAD designs in-house, NASA would have spent over \$200,000, instead of the \$3,000 that the prize competition cost.

j. Human Exploration Rover Challenge – 2015⁴⁷

Summary: The 2015 NASA Human Exploration Rover Challenge gives students in high school and college the opportunity to design, construct, and test technologies for mobility devices to perform in extraterrestrial environments. The Rover Challenge also provides valuable experiences that engage students in the technologies and concepts that will be needed in future exploration missions.

This challenge has become a community event and partnerships have been formed with the Chamber of Commerce, the Huntsville/Madison County Convention and Visitor’s Bureau, and the U. S. Space & Rocket Center. The total prize purse of \$10,500 was provided by corporate sponsors of the event. These corporations include Boeing, Lockheed Martin, Jacobs, the American Institute of Aeronautics and Astronautics (AIAA), ATK Aerospace Systems, Inc., Aerojet Rocketdyne, Booz-Allen Hamilton, Davidson Technologies, Science Applications International Corporation (SAIC), Teledyne Brown Engineering, and the Tennessee Valley Chapter of the Systems Safety Society, Inc. Other corporate sponsors, such as Northrop Grumman Corporation, contribute through in-kind support for trophies and plaques for awards, tents, banners, and volunteers.

Solution Type: Technology demonstration and hardware

Primary Goals: Find and highlight innovative ideas, Inform and educate the public, Build capacity, Other (Student training)

Results: Preparation for the race begins in the classroom where students and faculty design, build and test a vehicle conforming to certain vehicle specifications. The race requires each team to collapse its rover into a specific volume, unfold it as the clock runs, and then complete a half-mile course of simulated extraterrestrial terrain including “craters”, rocks, “lava” ridges, and inclines.

⁴⁶ Over 460 of the designs are posted on the following webpage: <https://grabcad.com/challenges/nasa-handrail-clamp-assembly-challenge/entries>

⁴⁷ www.nasa.gov/roverchallenge; the previous iteration of this challenge was described in the FY 2014 COMPETES report, starting on page 240.

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The second annual NASA Human Exploration Rover Challenge was held on April 17-18, 2015 at the U.S. Space & Rocket Center (USSRC) in Huntsville, AL. More than 600 students comprising 81 teams from 19 states and Puerto Rico registered for the race. Of the total 81 teams, 39 (48%) were college students and 42 (52%) were high school students. Ten international teams from Germany, India, Russia, and Mexico also participated in the challenge. Of the 600 students who competed, 156 Rover Challenge participants were female, 122 were Hispanic, 44 were Black or African American, 11 were American Indian or Alaska native, 55 were Asian, and 1 Rover Challenge participant was native Hawaiian or other Pacific Islander. Further outcomes based on surveys of competitors:

- 56 percent of high school participants reported that as a result of participating in the race, they were more interested in a career at NASA. Of all students surveyed, 69 percent expressed an interest in a career in Science; 83 percent a career in Technology; 77 percent a career in Engineering; and 63 percent a career in Mathematics.
- 93 percent of college student participants agreed that their race participation helped build their interest, skills, and knowledge in science, technology, engineering and mathematics.
- 66 percent of college students agreed it helped them clarify their career plans.
- 95 percent of faculty participants agreed they could immediately apply what they learned from their race experience to their teaching about STEM.
- 91 percent of faculty said they would be more effective at teaching STEM concepts introduced in the Rover Challenge experience.

While there are several corporate prizes associated with the Rover Challenge, the first, second, or third place prizes in each division for both high school and college students are awarded based on the fastest overall time of assembly and traversal of the course. First place in the college division was the International Space Education Institute – Team Russia of Moscow, and the first place in the high school division was the University Gardens High School of San Juan Puerto Rico.

k. International Space Apps Challenge⁴⁸

Summary: Since the first Space Apps Challenge in 2012, the International Space Apps Challenge has become the biggest global hackathon with over 14,000 participants in 133 cities and 62 countries. For the 2015 event, NASA focused on Women in Data to engage more women in the data science discipline. In order to attract more women to Space Apps, NASA created a pre-event to introduce newcomers to the concepts of data, hardware, problem-solving, and solution story-telling. The aim was for teams of technologists, scientists, designers and entrepreneurs to develop answers to some of the most pressing challenges on earth and space using publicly available data.

⁴⁸ www.spaceappschallenge.org, and <https://open.nasa.gov/explore/space-apps>; this challenge was previously described in the FY 2014 COMPETES report, starting on page 242.

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Each Space Apps challenge has had the same goal: provide innovators with all of the information they need to learn about a topic, understand the challenge statement, and craft a solution in less than two days. Thirty five new challenges were offered in four categories (Earth, Humans, Robotics, and Outer Space) in 2015. Additionally, an overarching goal of the event was to increase awareness and interest in space exploration and aeronautics by opening up NASA's extraordinary data.

Challenges encouraged the development of software applications, hardware projects, data visualization, and citizen science platforms. A concerted effort was made to include ideas with well-defined requirements and specific deliverables, as well as more open-ended, creative projects. The key Global Collaborators for the International Space Apps Challenge included NASA, the White House Office of Science and Technology Policy, the European Space Agency, the U.S. Department of Agriculture, and the Met Office UK. Additional partnerships were developed by event leads at the local level to support community event implementation.

Solution Type: Software and apps; Analytics, visualizations, and algorithms; Technology demonstration and hardware

Primary Goals: Find and highlight innovative ideas; Advance scientific research; Develop technology; Engage new people and communities

Results: Nearly 14,000 global citizens in 62 countries and 133 cities engaged directly with NASA to design innovative solutions to global challenges in software development, citizen science, hardware, and data visualization. Five teams were awarded Best in Class awards (Best Use of Data, Best Use of Hardware, Best Mission Concept, Galactic Impact, and Most Inspiring) and one was awarded People's Choice. This year, the challenge received 56,000 votes during the two-week People's Choice public voting process. NASA added a voting widget to the Space Apps website so that voting was contained in one place.

With each successive Space Apps Challenge, NASA has continued to engage actively with the Space Apps community, domestically and around the world in gathering lessons learned and improving processes and structures from year to year. In 2015, 76 of the 133 cities joining Space Apps had participated previously. Many of those experienced local organizers shared their experience from prior events, supported, and mentored organizers of new locations.

NASA enhanced Space Apps this year by adding a focus on Women in Data, creating a Project Accelerator Toolkit to enable local hosts to incubate promising local Space Apps projects in their community, and live streaming for three days from the Space Apps website. With the Women in Data focus, NASA added a Data Bootcamp pre-event at the New York City main stage, resulting in 49% women attending the NYC hackathon, as opposed to one in four internationally. 47% of the top global award finalists had at least one woman in the project team. The largest event – 700 participants in Cairo – was led by two female students. Three Space Apps organizing teams in Nairobi, Guatemala, and Dakar are undertaking local Space Apps Accelerators. NASA will have more to report next year. For the livestream from New York City and 22 international Space Apps locations, over 11,000 viewers tuned in remotely to participate during the three days, beginning with the Data Bootcamp and ending with local project judging.

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Some 2015 Space App successes from challenge partners and participants include:

- NYSpaceTag, selected as the Best Use of Data, was created at Space Apps New York City in response to the Data Treasure Hunting challenge. The NYSpaceTag is a tagging system that extracts natural keywords from titles and descriptions associated with NASA’s data. The solution allows users to explore concepts, see related concepts in different datasets, and drill down directly into the data. The NYSpaceTag is currently working with NASA to apply the team’s algorithm to data.nasa.gov as well as offer it to other federal agencies as an open source solution for their data tagging efforts.
- Valkyrie, selected as the Best Use of Hardware in response to the SpaceGlove challenge, was created at Space Apps Sofia as an innovative approach to gesture and voice recognition using a sophisticated “smart” glove and mobile device that can be used in the home or in space to control devices such as a robot arm and robots using WiFi, BLE, or V-API. The Valkyrie team is preparing their product for the commercial market.
- Arachnobee, selected as the Best Mission Concept in response to the ZERO GEE Bee challenge, was created at Space Apps Limassol as a drone with the ability to work in airless (or any other gas) environments and move around a facility in an efficient and adaptable way. The drone has both spider and bee-like capabilities – hence the name. Members of the team met with NASA subject matter experts at the Kennedy Space Center to explore their concept.
- CROPP, selected as Most Inspiring in response to the Crop Alert challenge, was created at Space Apps Rome. Cultures Risks Observation and Prevention Platform (CROPP) is an easy and user-friendly application designed to help farmers monitor their land. The team completed a sensor-bot prototype to collect short term measurements from the local area, coupled with macroscopic satellite Earth observation images of specific farming areas.
- Tracking and Sensing, selected for greatest Galactic Impact in response to the Sensor Yourself challenge, was created at Space Apps Kathmandu as a mobile robot platform that is capable of extracting data from nearby objects using on-board sensors present in an Android smartphone.
- NatEv Explorer, selected as the People’s Choice following public voting for two weeks and a total of 56,000 votes, in response to the Volcanoes, Icebergs, and Cats from Space challenge, was created at Space Apps Pristina. NatEv is an interactive web-based globe with the most interesting/hazardous natural events shown at the user’s location. Users have the ability to view additional data, get inspired to explore other events, and submit them to the web application through crowd-sourced principles.

l. Mars Ascent Vehicle Challenge⁴⁹

Summary: The Centennial Challenges Mars Ascent Vehicle (MAV) Prize is helping to advance the technology to return samples from Mars. The challenge simulates and focuses on the autonomous technology required to get the samples from the Martian surface to Mars orbit for collection and return to Earth. Current mission scenarios for returning samples from Mars envision sending a robot to collect a variety of samples and cache them at a location for pick-up by a follow-up mission. The MAV will need to navigate to the sample cache site, collect the samples, and place them in orbit for return to Earth. Teams in this challenge were tasked with building a robot that can locate and collect a cache of samples and launch them to 5,280 feet into a simulated orbit around Mars. Teams were to demonstrate a lightweight, low-volume, autonomous system that could possibly be used in the MAV to collect the sample cache.

The Mars Ascent Vehicle Challenge offered a total cash prize purse of \$50,000, and NASA partnered with the NASA Student Launch Education program. NASA benefited by sharing the necessary resources to conduct the challenge, thus reducing the cost required to execute the competition for both projects.⁵⁰

Solution Type: Technology demonstration and hardware

Primary Goals: Develop technology

Results: This challenge was designed to attract university sponsored student teams. Twenty-three teams registered and 15 teams competed in the 2015 competition. Competitors were required to demonstrate achievement of contest requirements. A judging team coordinated by NASA subject matter experts throughout the robotics field measured the robot cache retrieval performance. The scoring methods were objective based: the ability to collect, store, and launch the cache.

The competition was held April 7-12, 2015. Four teams successfully loaded the cache sample and erected their rockets, but only two scored high enough to receive cash awards. The University of North Dakota team completed the challenge with human assistance. The Cornell University team completed the challenge beyond the time limitation. The Tarleton State University team completed the challenge and scored well enough to earn second place for a prize of \$15,000. The North Carolina State University team completed the challenge and scored well enough to earn first place for a prize of \$25,000.

The second annual Mars Ascent Vehicle Challenge opened in late FY15.

m. Mars Space Pioneering: Achieving Earth Independence⁵¹

Summary: NASA's current horizon for human exploration includes the establishment of a human presence on the surface of Mars. Planning efforts supporting this objective focus on a period of

⁴⁹ <http://www.nasa.gov/mavprize>; this challenge was previously described in the FY 2014 COMPETES report, starting on page 243.

⁵⁰ The Student Launch Challenge is discussed on page 2-281 in this document.

⁵¹ <https://www.innocentive.com/ar/challenge/9933746>

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time beginning now and extending past the first human landing on Mars (estimated to occur in the 2030s) through the 2050s. Within the broad context of pioneering space, reaching this long-range horizon includes identifying the necessary steps (including investments by government or other entities) to enable a continuous human presence on Mars that is both technically achievable and economically sustainable. Achieving this continuous human presence is not colonization, which is defined in this context as a one-way trip to Mars with no opportunity to return. Instead, it is the application of the broad principles of pioneering space, providing a gradual transition from current operations in low Earth orbit (LEO) to a permanent human presence on Mars.

For this challenge, participants were asked to focus on those particular elements of pioneering space needed to establish a continuous human presence on Mars. For example, food will be required for four to six people for an extended period of time. Given limitations on weight and volume (less is better) and a minimum 500 day period between resupply opportunities, how can food requirements be met, sustainable, and established on Mars? The challenge required participants to describe one or more Mars surface systems and capabilities and operations needed to achieve this goal that are, to the greatest extent possible, technically achievable, economically sustainable, and minimally reliant on support from Earth.

Solution submissions could consist of proposed campaigns, architectures, or systems and capabilities, and were technical in nature, including the assumptions, analysis, and data that justify their value.

InnoCentive supported the implementation of this prize competition, and the total prize purse for this challenge was \$15,000.

Solution Type: Ideas

Primary Goals: Find and highlight innovative ideas

Results: The challenge received a total of 4,812 registered solvers and teams and 772 total proposal submissions. The challenge awarded three winners \$5,000 each. The winners and their concepts included new or expanded concepts to consider in future Mars Mission planning. The winners were:

- A 45-year-old ex-NASA/Johnson Space Center flight controller who now lives in Toronto, Ontario for his submission “Mars Igloo: An ISRU habitat”, a mylar-encased ice for building structures;
- A 29-year-old genetics and plants biologist from Urbandale, Iowa for his submission “Starch from the Micro-algae Chlorella as the Main Food Source for a Self-Sustaining Martian Colony”, a way to extract starch from algae as a food supplement; and
- A team of college students from North Lake College and Riverside, CA for their submission “Approaches to Mars Settlement”, which proposed integrated bio-regenerative life support. It’s interesting to note this team also submitted to NASA’s Climate Resilience Data Idea

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Generation challenge and placed third, demonstrating that some solvers will continue to engage on future NASA challenges in different subject areas.

For the NASA Human Architecture Team that works these Mars architectures, this challenge validated many of the approaches NASA has considered within the Evolvable Mars Campaign. This team was interested in seeing how much was out there that they had not considered. The challenge did identify potential areas to reconsider based on recent technology and operational maturity. Given that this challenge was aimed at the very strategic level (50 year time frame), these solutions did help to make sure that NASA is investing in the right technologies and concepts are aimed in the right direction and not missing something key.

n. Micro-Purchase Pilot Project Challenges⁵²

Summary: This pilot project conducted a series of challenges on Freelancer.com to determine if low cost challenges could yield quality products and outcomes. NASA’s current procurement-based challenges normally require thousands to hundreds of thousands of dollars and several months to execute. The government purchase card program provides a streamlined acquisition opportunity for any purchases under \$3,000 (for FY15 and \$3,500 for FY16). The question that this pilot sought to ultimately answer was “is it possible to obtain valuable results from challenges that cost less than \$3,000 and can be purchased using a government p-card?” The project conducted 22 separate challenges in FY15 in various product areas, such as robotic arm architecture and branding initiatives.

- Logos and graphics for several projects including NASA’s Evolutionary Xenon Thrust-Commercial (NEXT-C) project, Disruption Tolerant Networking (DTN) team, Logistics Reduction (LR) project, NASA Human Health and Performance Center (NHHPC), and Gondola for High Altitude Planetary Science (GHAPS) project
- Fourteen high-resolution 3D models for Robonaut simulations
- 3D Printable Design for NASA@work project
- Idea for Software Application using DTN for the DTN project
- Concept for an astronaut smartwatch app for the engineering displays project

Freelancer supported the implementation of this prize competition. The total amount awarded for all 22 challenges was \$4,075.

Solution Type: Other (Pilot Project)

Primary Goals: Improve government service delivery

⁵² <http://www.nasa.gov/feature/nasa-tournament-labs-ntl-micro-task-challenges-pilot-project> and <https://www.freelancer.com/contest/challenges/nasa>

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Results: A total of 1,535 submissions from Freelancer community members were submitted to the 22 challenges, and each challenge awarded one winner a prize ranging from \$50 to \$1,500. Several of the winners, 6 of the 22, joined Freelancer just to work on the NASA challenges based on publicity around the contests. The Smartwatch UI challenge winners read about the contest on Engadget/CNET. The NASA contest landing page on the Freelancer website received over 110,000 visits in the first two months of the pilot.

The pilot demonstrated that there is potentially high value to NASA using micro-purchase challenges. For several products, like graphics and 3D models, the pilot demonstrated 85%-95% savings with very high quality in the deliverables. Additionally, the pilot showed that even challenges that go beyond the normal freelancer tasking, such as ideation and conceptualization challenges, can result in valuable products at a fraction of traditional challenge costs. The NASA brand had a very strong effect in the Freelancer community. This effect was stronger in some of the more unique, technical challenges and less pronounced in standard production challenges (i.e., graphics). The brand along with external marketing by Freelancer drew in public participation by many who did not previously belong to the Freelancer.com community. The public engagement on these 22 challenges was very high worldwide. Various aspects of the pilot challenges were featured on over 100 online news outlets including *Time*, CNET, *Wired*, Bloomberg (video), MSN, *Forbes*, and CNN Money.

The cost and schedule for these challenges compared very favorably to both in-house development and other NTL challenge platforms. Generally, the cost and schedule savings for challenges on this platform were significant. However, for these challenges there were little or no challenge definition services, solution filtering services, or judging assistance services that are sometimes provided with challenges on other platforms.

o. Planetary Data Systems Storyboard Challenge⁵³

Summary: NASA has recorded over 100 terabytes of space images, telemetry, models, and other data from all the planetary missions over the past 30 years. The data stored is within NASA's Planetary Data System (PDS). The goal of the Planetary Data Storyboard Challenge was to create an online collaborative environment for scientists, researchers, and students to expose PDS data and make it accessible to all.

The goal of this challenge was to develop prototype technology. The specific goal was to build out a clickable prototype of the Planetary Data Storyboard in which users would be able to post images and content on storyboards as well as search, tag, and like other posts. This project focused on linking PDS data to the storyboard to show a preliminary model of how this new and exciting concept could work.

Harvard University, who partnered with Appirio, Inc. to launch the challenge on the TopCoder platform, supported the implementation of this prize competition. The total award for this challenge was \$19,000.

Solution Type: Software and apps

⁵³ <http://www.topcoder.com/solarsystem/cassini/>

Primary Goals: Develop technology; Solve a specific problem

Results: The challenge received a total of 1,033 registered solvers and teams and 154 total proposal submissions. Thirty-four winners split the \$19,000 prize purse. The challenge successfully developed a pilot version of a Pinterest-like app for data science. This proof of concept utilized the open source Pinterest clone, <http://www.mynna.com/>, as a base to create the PDS Storyboard Prototype. The front end was basic and similar to an existing interface due to budget constraints. The challenge allowed users to create storyboards and tag boards with PDS data and show that this outlet would be the best way to expose and make accessible the PDS data.

To date, the challenge developed a simple prototype to present to the NASA Science Mission Directorate and PDS management council as a proof of concept to receive continued funding to complete the challenge. The future includes developing an operational storyboard with connections to the PDS data.⁵⁴

p. **Quest for Quakes (QuakeFinder)**⁵⁵

Summary: A long history exists of research into the causes of distinct, ultra-low frequency (~0.01 Hz) electromagnetic signals emanating from the earth near earthquake epicenters in the weeks leading up to some moderate and large events. The connection between electromagnetic signals and earthquakes is still debated. One theory suggests that fracturing rock in the earth's crust creates an electrical charge migration (or pulses) that travels to the land surface. There, it manifests as a small change in the local magnetic field that is detectable with sensitive magnetometer sensors. However, a number of natural and manmade sources of electromagnetic signal noise exist, such as lightning, solar storms, electric rail, and even nearby traffic that can mask or mimic electromagnetic signals that may or may not be associated with earthquakes.

The overall goal of this challenge was to develop a software algorithm to uniquely identify the electromagnetic pulses that may precede an earthquake by days to weeks. Contestants were provided electromagnetic signals collected over a three-month period from multiple sensors in close proximity of past earthquakes. Control data with no earthquakes was also contained within the data set. Members were tasked with writing an algorithm to extract the signals and identify the earthquakes. To be successful, submissions should demonstrate through defined statistical analysis that the provided data provide any measurable predictability. Additionally, wrong guesses would be penalized. The organizers aim to have at least one approach, which would improve upon the lack of current capability.

The data for this competition was provided by the QuakeFinder group, a humanitarian research and development project by Stellar Solutions, Inc. of Palo Alto, CA. QuakeFinder has 125 sensors in California and 40 sensor suites around the world. These ultra-low frequency magnetometers collect and transmit high-rate data to Stellar Solutions' data center for management and evaluation. Over 65 terabytes of data have been collected from sensors along

⁵⁴ The link to the prototype is located here: <http://explore.igpp.ucla.edu>

⁵⁵ <https://www.topcoder.com/blog/make-a-difference-win-prizes-in-nasas-quest-for-quakes/>

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the San Andreas Fault and other faults in California, Chile, Peru, Greece, Indonesia and Taiwan. Amazon Web Services (AWS) has contributed a research grant for approximately three terabytes of high-frequency magnetometer data and computational resources to be used by contestants. Harvard University, who partnered with Appirio, Inc. to launch the challenge on the TopCoder platform, supported the implementation of this prize competition. Amazon Web Services (AWS) has contributed a research grant for approximately three terabytes of high-frequency magnetometer data and computational resources to be used by contestants. The total award for this challenge was \$41,100.

Solution Type: Analytics, visualizations, and algorithms

Primary Goals: Solve a specific problem

Results: The challenge had 364-registered solvers and teams and received 55 total submissions. Algorithm winners produced algorithms that statistically identify precursor signals prior to earthquakes. Further results are pending while detailed analysis is performed. The main challenge was conducted via Marathon Match, with scores objectively generated through a defined scoring algorithm. After the first challenge, reviewers questioned whether the data had overlap that might permit algorithms to successfully train on noise. Appirio-TopCoder re-segmented the data and re-ran the Marathon Match with the top five winners of the first match. At the time this contest was run, there was no current capability like this available. Subsequently, an independent capability has been developed by a researcher in Chile, but there is no head-to-head comparison available. QuakeFinder is working to integrate the TopCoder result with the Chile research to form an operational solution.

q. Rice Business Plan Competition – 2015⁵⁶

Summary: The Human Health and Performance Directorate (HH&P) at Johnson Space Center has supported a \$20,000 award annually since 2008 at the Rice Business Plan Competition (RBPC). This program is an internationally recognized student business plan competition held at Rice University in Houston, Texas. Forty-two student teams are selected to enter the competition each year. The NASA HH&P award focuses on new and emerging health and performance based technologies. It represents the recognition of the development of a new business, small business innovation, and the entrepreneurial spirit. Each company is commercializing a health-related technology that will improve medical care capabilities on Earth and have potential application to human spaceflight.

NASA through its various HH&P activities is consistently seeking new ideas for health-related technologies that will improve medical care capabilities on Earth and have potential application to human spaceflight. Traditional means for identifying such ideas include contracts, grants, and SBIRs. Because these methods require knowledge of the federal government's business practices to submit an idea, other mechanisms that allow for broader engagement are also valuable. A business plan competition provides another means to find new innovative technology ideas that complement current methods in addressing the health-related technology needs of NASA.

⁵⁶ <http://alliance.rice.edu/rbpc.aspx>; the previous iteration of this challenge was described in the FY 2014 COMPETES report, starting on page 244.

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The goal of the RBPC is to provide the best overall educational and entrepreneurial experience of any business plan or new venture competition. Rice University administers the competition.

Solution Type: Business plan

Primary Goals: Find and highlight innovative ideas; Engage new people and communities

Results: This year marked the fifteenth year for the competition. From its inception, the competition has grown from nine teams competing for \$10,000 in award money to 42 teams from around the world competing for more than \$1,500,000 in cash and awards.

The 42 student teams were selected to enter the competition by Rice University based on the quality of their executive summary. Those selected to participate submit a written business plan, prepare oral presentations and elevator pitches for the three-day, face-to-face competition, and submit an optional video presentation. The winners for the HH&P NASA award were chosen based on their executive summaries, business plans, and oral presentations. The 2015 NASA HH&P prize went to Veritas Medical, LLC from the University of Utah. Veritas is a medical device company that developed a groundbreaking technology using light to sterilize medical devices and prevent hospital-acquired infections. The Light Line Catheter uses high-intensity visible light to kill bacteria while leaving human cells unharmed. The device also sterilizes medical instruments while remaining inside a patient. For health care, this device could prevent catheter infections for patients. For NASA, this technology could be used for sterilization for surfaces, clothing, and medical procedures on the International Space Station (ISS) and missions beyond Low Earth Orbit. The team finished in fourth place in the entire competition and won \$137,100 in total prizes.

r. Sample Return Robot Challenge – 2015⁵⁷

Summary: Current mission scenarios for returning samples from Mars envision sending a robot to collect a variety of samples and cache them at a location for pick up by a follow-up mission. The return robot will need to determine its precise location, navigate to the cache site, and return to the landing site. In this challenge, teams were tasked with building a robot that could autonomously locate, identify, and collect a variety of samples and then return the samples to a designated point without reliance on GPS or other terrestrial navigation aids.

The Sample Return Robot Challenge offered a total cash prize purse of \$1,500,000. Competitors are awarded \$5,000 for the successful completion of the Level I competition. Level II monetary awards are based on competitor's final score from the respective two-hour attempt. The 2015 challenge is the fourth of the series, and the fifth and final challenge is scheduled to take place in 2016.⁵⁸

NASA partnered with Worcester Polytechnic Institute (WPI) to manage the competition. WPI has invested over \$1,000,000 to conduct the challenge.

⁵⁷ <http://www.nasa.gov/robot> and <http://wp.wpi.edu/challenge/>

⁵⁸ The 2013 and 2014 Sample Return Robot Challenges are discussed in the FY 2013 and FY 2014 COMPETES Prize Reports, respectively, starting on pages 133 and 245 in each report.

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Solution Type: Technology demonstration and hardware

Primary Goals: Develop technology

Results: Twenty teams registered for the June 2015 competition and 15 teams participated in the Level I competition. Eight of those teams were composed of private citizens not associated with a school or university. All of the teams had at least one person with either an engineering or a science background.

Two teams were eligible to compete in Level II of the challenge, and competed for the larger prize purse of up to \$1,500,000. West Virginia University collected enough samples and points for \$100,000 in prize money. The other team, Team Survey, did not collect enough samples and points for a monetary prize. NASA/JPL hosted the winning team for a day of technology information exchange on autonomous rovers. This is part of NASA's technology infusion path. NASA also provides information about other programs, such as the SBIRs and other small business information, for the teams to pursue if interested.

The 2015 competition had two teams compete in Level II who had completed Level I requirements in 2014. This is one example for how the competitors demonstrated significant progress toward achieving the challenge goals in this competition over the last one. Nearly all competitors were able to initialize their positions without GPS or magnetic compasses and initiate their search sequences. The prize competition organizers expect that the next and last iteration of the competition in 2016 will see an increase in the number of competitors qualifying and competing in Level II since many 2015 Level I participants were close to meeting requirements to compete in Level II.

WPI was experienced in public outreach and created a robotics science and engineering expo to draw public interest in the competition. The expo and competition event drew over 12,000 individuals. Significant efforts were made to inform the public and garner media attention through various advertising efforts and media outreach. NASA provided a number of exhibits for the expo and the event was documented and later broadcast on the NASA 360 vodcast and featured on This Week @ NASA. The video has been reposted and broadcast through numerous public and commercial media channels. The NASA SRR site drew 5,529 hits in FY 2015. The large-scale public outreach effort provided NASA with the opportunity to educate the public on NASA robotics and Mars exploration efforts.

s. **Student Launch Challenge**⁵⁹

Summary: The NASA Student Launch (SL) is a research-based, competitive, and experiential exploration project that provides relevant and cost-effective research and development to support the Space Launch System (SLS). SL connects learners, educators, and communities with NASA-unique opportunities that align with STEM challenges under the NASA Education Science, Technology, Engineering, and Mathematics (STEM) Engagement line of business. The project

⁵⁹ <http://education.msfc.nasa.gov/slp>; this challenge was described in the FY 2014 COMPETES report, starting on page 247.

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involves reaching a broad audience of middle schools, high schools, informal organizations, colleges, and universities across the nation in an eight-month commitment to design, build, launch, and fly payloads and vehicle components that support NASA research on high-power rockets to an altitude of 5,280 feet above ground level (AGL). While the middle school and high school component is not a competition, the college and university challenge is based on team selection of up to seven different experiments and a Centennial Challenge (CC) option that consists of designing and building a Mars Ascent Vehicle (MAV).⁶⁰

After a competitive proposal selection process, participating teams are required to build and maintain a team website; submit and present a series of design reviews to a panel of NASA engineers, scientists, and educators; and engage other students in hands-on educational activities. Teams are scored on various aspects throughout the year including vehicle design, payload design, project reviews, presentation skills, educational engagement, website design, safety, budget, schedule, and professionalism. Additionally, teams are scored on the successful launch and recovery of their rocket and payload, launch altitude, range safety on launch day, and documentation of results. Orbital ATK gives prizes for categories. The overall winner of SLS is based on the highest scoring team in all categories, and receives a check for \$5,000 from Orbital ATK.

The Centennial Challenge portion of the competition assesses additional areas for their overall winner, including creativity, accuracy of the launch angle, and successful completion of all components of the Mars Ascent Vehicle (MAV) challenge.

Solution Type: Technology demonstration and hardware

Primary Goals: Develop technology; Find and highlight innovative ideas; Solve a specific problem; Engage new people and communities

Results: All registered teams submitted a proposal to participate in SL. This year, 44 teams submitted proposals. Forty teams from 24 states plus Puerto Rico were selected to participate in the 2014–15-project year. Streaming the event on NASA TV and Ustream resulted in thousands of unique viewers watching the event live.

In addition to the development of a rocket and research requirements, SL teams are challenged to educate others in the areas of science, technology, engineering, and mathematics (STEM). Teams complete these project requirements in a variety of ways including classroom visits, presentations, rocketry challenges, and hands-on STEM activities with students and teachers in their communities. Although middle school students and educators are prioritized, participants of all grade levels are impacted by the team's Educational Engagement (EE) events. In 2015, teams were required to engage a minimum of 200 participants (with at least 100 of those being middle school educators or students) in hands-on STEM activities. With 40 teams in 2015, this would equate to a minimum of 8,800 students or educators reached; however, the SL teams go above and beyond expectations each year, and reached more than 32,512 students in fiscal year 2015.

⁶⁰ The Mars Ascent Vehicle Challenge is also discussed on page 2-272 in this document.

For the third year in a row, Vanderbilt University in Nashville, TN, earned the top prize in the NASA Student Launch challenge.

L. National Nanotechnology Initiative

a. EnvisioNano⁶¹

Summary: EnvisioNano is a nanoscale image contest administered by the National Nanotechnology Coordination Office (NNCO) on behalf of National Nanotechnology Initiative (NNI) member agencies. EnvisioNano asks students to demonstrate how beautiful the nanoscale can be and explain how the research behind their image may lead to nanotechnologies that benefit society. The goal is for students to envision where their research is headed and explain how “seeing” at the nanoscale is important to reaching that vision. To this end, EnvisioNano is more than a simple science image contest. Participants submit both an image and a brief statement explaining why they acquired the image and how the image fits into the future applications of their research. This contest is regularly occurring in order to help raise awareness of the NNI and continually showcase the nanotechnology research being done in the United States.

Solution Type: Creative (design & multimedia)

Primary Goals: Inform and educate the public

Results: The two rounds of EnvisioNano held in FY15 received 43 submissions from 16 students representing 6 institutions, with each round producing a single winner. The winning submissions are spotlighted on the NNI website for one month and are chosen, in part, by public vote.

The combined number of public views of the submitted images totaled 41,059 (based on visits to the Google+ albums). There were 1,087 votes cast during public voting and the traffic to Nano.gov (the official website for the NNI) increased by 50% the week following the opening of public voting for the first round of the competition.

EnvisioNano will continue to occur twice annually.

b. Tiny Science. Big Impacts. Cool Videos. Contest⁶²

Summary: The National Nanotechnology Coordination Office (NNCO) administers the video competition *Tiny Science. Big Impacts. Cool Videos.* on behalf of National Nanotechnology Initiative (NNI) member agencies. *Tiny Science. Big Impacts. Cool Videos.* asks students to make short videos (2.5 to 3 minutes in length) explaining how their nanotechnology research may impact our daily lives by bringing solutions to real-world problems.

Solution Type: Creative (design & multimedia)

⁶¹ <http://www.nano.gov/EnvisioNano>

⁶² <http://www.nano.gov/StudentVideoContest>

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Primary Goals: Inform and educate the public

Results: *Tiny Science. Big Impacts. Cool Videos.* received 3 submissions from students at the University of Puerto Rico, San Piedras Campus; University of Wisconsin-Milwaukee; and Drexel University. One winner was awarded from these submissions. The goal of *Tiny Science. Big Impacts. Cool Videos.* is to increase awareness of the NNI among scientists conducting nanotechnology research and the general public in order to inform them about nanotechnology research being done in support of the NNI. To date, the combined number of public views on YouTube of the submitted videos totals 1,209. The voting page on Nano.gov received 299 unique visits and 441 votes were cast during public voting. The plan is for *Tiny Science. Big Impacts. Cool Videos.* to occur twice annually.

M. National Science Foundation

a. Beyond the Box Digitization Competition (Bug Box)

Summary: Insects are an amazingly diverse group of organisms that represent an overwhelming amount of living biological diversity on Earth. There are hypothesized to be more than 1,500,000 species of insects on Earth, three times the number of all other animal species combined. These species are documented through specimens in natural science collections. Unfortunately, many of these specimens remain unknown to science, education, natural resource and public health managers, and the general public. Quite simply, they have been locked away in cabinets and therefore are a set of potentially useful, but publicly inaccessible and unusable “dark data.”

At least one billion biological specimens are housed in more than 1,000 natural history museums, universities, and botanical gardens in the United States. Insects are the most numerous of these specimens, and their associated data are critical for research, education, and decision-making about the environment, public health, food security, and commerce. Unfortunately, most collections data are underutilized because only about 10 percent of the data are accessible online in digitized form. Digitization of specimens will make specimen images and associated data available online, for use by researchers, teachers, and students around the country and the world. A key goal of this competition is to accelerate the digitization and improve access to data about these organisms.

The Beyond the Box Digitization Competition planned to award up to \$1 million to the person or team who created an automated technology that increased the speed and accuracy of digitization of a drawer of insect specimens and their associated data. The competition was a joint effort of the U.S. National Science Foundation (NSF) and the American Institute of Biological Sciences (AIBS), with NSF serving as the Sponsor and AIBS serving as the Organizer.

Solution Type: Creative (design & multimedia); Technology demonstration and hardware; Analytics, visualizations, and algorithms

Primary Goals: Solve a specific problem; Find and highlight innovative ideas; Develop technology; Engage new people and communities; Advance scientific research; Build capacity; Inform and educate the public

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Results: Fifteen teams pre-registered for the competition, and 327 individuals subscribed to the e-mail list for updates. The competition closed on September 4, 2015 with no completed applications submitted. As a result, the competition was terminated and a survey of the registered participants was conducted to determine why no completed applications were received. Those registered participants who responded indicated that required up-front costs, technology barriers, and lack of development time as the primary hurdles to completing the application. One respondent identified an alternative approach currently in place in Finland that, while not directly responsive to the challenge, could be modified to help solve the problem, and several others identified existing technologies that could be combined to solve several of the sub-challenges outlined in the prize competition. Thus, while the competition did not result in a winner, it did result in the identification of a number of possible solutions that could be modified to help solve the problem.

b. ERC-Wide Perfect Pitch Competition⁶³

Summary: During poster sessions at conferences and at the Engineering Research Center (ERC) annual meetings, organizers observed that ERC students often were unable to spontaneously and succinctly explain to others the big-picture relevance of their research. Realizing that the ability to conduct excellent research does not necessarily translate into effective communication skills, NSF decided that the ERC experience should include activities that develop and/or improve the student's communication skills. To address this goal, NSF began the Perfect Pitch Competition where ERC students are required to make a 90-second pitch (using one slide) to a panel of judges at their home ERC. Each ERC selects one local winner to represent the Center in the national ERC-wide competition during the ERC Program's annual meeting. In the ERC-wide competition, a panel of judges consisting of people from industry and academia with entrepreneurial experience, selects the overall first, second, and third-place winners. The pitch must describe the problem or opportunity, the proposed solution, and the potential impact. Contestants are judged on their apparent expertise, the potential impact of the technology, the visual appeal of their slide, their style and poise, and the extent to which their pitch is compelling.

Solution Type: Creative (design & multimedia); Other (Communication of Research – Perfect Pitch)

Primary Goals: Other (Student Training)

Results: In FY 2015 the ERC Program mobilized all 17 of the ERCs that had active student leadership organizations to compete. All ERC students (both graduate and undergraduate) who were engaged in doing research at one of the actively funded NSF ERCs were eligible to compete in this competition. The total number of students involved in local competitions was 274. Of that number, 83% were graduate students and 6% were undergraduates. In some of the local competitions, post-docs were allowed to compete in order to enlarge the pool of contestants. As a consequence, 11% of the contestants were post-docs.

⁶³ For background information about the competition and its goals, go to <http://erc-assoc.org/programs/pitch>. Competition material for students resides at <http://erc-assoc.org/content/perfect-pitch-guidelines>

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The student winners of the 17 ERC local competition, consisting of 65% men and 35% women, competed in the final national competition. The first-place winner at the 2014 annual meeting (in FY 2015) was a male graduate student at the Stanford University, who received a \$5,000 award. The second and third place student pitches also received cash prizes of \$2,000 and \$1,000, respectively.

c. **The Vizzies: Visualization Challenge**⁶⁴

Summary: The Visualization Challenge (The Vizzies) is a national contest developed to broaden the visual and conceptual images of science and engineering to scientists, engineers, and the public. The competition launched in 2003 to demonstrate how visualization could be used to express what the scientist or engineer is unable to convey verbally. It expresses a human dimension and helps create a universal language that will enable people around the world to exchange knowledge and to more fully understand the work.

In this single challenge, NSF asks participants to submit creative, science visualizations that promote understanding of research results.

The total cash prize is \$15,000.

Solution Type: Creative (design & multimedia); Scientific

Primary Goals: Inform and educate the public; Engage new people and communities; Advance scientific research

Results: The competition received 277 entries this year, consisting of both individual and team submissions from academia and private organizations. This is slightly fewer entries compared to the previous year (303 entries), but the number of entries has generally increased year to year. The slight reduction in entries may be due to changing submission guidelines to only accepting submissions from U.S. citizens, nationals, or permanent residents. The competition received entries from participants living in 36 U.S. states and 9 countries. Winners will be announced in February 2016 and are chosen based on visual impact, effective communication, and freshness and originality.

The competition is still underway, but to date, NSF saved \$12,000 by using a partner to promote the challenge. The public vote participation rate increased by 40 percent.

The Vizzies social media campaign resulted in excellent numbers. At the completion of last year's competition, there were 541,664 Twitter impressions and 1,307,416 Facebook impressions. This year, the current, ongoing social media campaign results are as follows:

⁶⁴ <http://nsf.gov/news/vizzies>; this challenge was described in the FY 2014 COMPETES report, starting on page 249.

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- Facebook: seven posts resulted in 93,173 reaches and 1,854 likes, shares and comments
- Twitter: eight posts resulted in 139,505 reaches, 2,212 engagements, 207 retweets, and 151 likes
- Vine: four vines resulted in 102,766 loops, 153 likes and 39 re-vines

Winners were announced February 23, 2016, in the March/April 2016 issue of *Popular Science* magazine, on popsci.com and on nsf.gov/news/Vizzies. This partnership brought a greater level of exposure for the competition through *Popular Science*'s 1.3 million print subscribers and 3-4 million unique visitors to popsci.com.

N. National Security Administration

a. Codebreaker Challenge⁶⁵

Summary: The NSA Codebreaker Challenge, developed by the NSA's Signals Intelligence Directorate (SID) Security Education Academic Liaison (SEAL) program, was designed as an educational opportunity that provides students with an avenue for learning software reverse engineering (SRE) and a realistic, NSA-mission-centric scenario through which to hone their SRE abilities. SRE is a skillset that is often utilized to carry out the agency's mission but is only slowly being adopted into traditional Computer Science curricula. As such, the SID SEAL program launched several initiatives aimed at bolstering available resources on SRE, with the broadest reaching of these being the Codebreaker Challenge. The primary goal of the challenge is skills development with a secondary goal of recruitment of students with appropriate skills.

The Challenge was divided into 4 tasks, which needed to be completed in order (e.g., successful completion of the first task enabled students to proceed to the second task): (1) determine how to execute the hidden functionality in the software application provided; (2) bypass an authentication check in the software application provided; (3) create a specially-encoded message file capable of being decoded by the provided software application; and, (4) create a specially-encoded message file that successfully bypasses all authentication checks in the provided software application. After successful completion of the fourth task, the student completed the entire challenge. The NSA recruitment team provided small-value NSA-branded items to the first 50 students that solved the challenge.

In addition to skill development and recruitment, the Codebreaker Challenge aimed to positively influence the public perception about the NSA and the work done to carry out its mission by presenting an unclassified storyline that demonstrated the technical skills required to carry out NSA mission work.

The Challenge was hosted on its own website and included an institutional leaderboard which showed in near real-time the progress of each university with at least one student registered on the site.

⁶⁵ <https://codebreaker.ltsnet.net/>

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Solution Type: Software and apps

Primary Goals: Inform and educate the public; Other (Improve SRE skills of students; recruitment of NSA candidates)

Results: Making it all the way through the challenge was a significant accomplishment, requiring a mix of reverse engineering, problem solving, programming, and vulnerability analysis. The challenge itself tests the skills of the participants by providing tasks that increase in difficulty and test specific reverse engineering skills. Many students indicated that the challenge helped them develop reverse engineering skills, and in at least a couple instances, students had no previous experience prior to attempting the tasks. Additionally, at least one professor is developing a reverse engineering course based on the formalized process presented in the challenge.

Students possessing the required skills are clearly top candidates for NSA recruitment. The SID SEAL program worked closely with the NSA recruitment organization to develop and execute a plan aimed specifically at recruiting these individuals to the greatest extent possible. Of the 2,217 students signed up from 329 educational institutions, 71 students submitted a correct Task 3 solution, and 54 students submitted a correct Task 4 solution. Those who completed Task 3 were contacted by NSA, which resulted in 7 conditional internship job offers and 2 full-time job offers. Several more job offers are anticipated from this round of competitors. Students were mostly computer scientists and computer or electrical engineers ranging in education level from freshmen in undergraduate study to PhD students.

In addition to the main challenge, the Codebreaker Challenge included three other incentive structures: inter-institutional competition, avenues for extra credit, and technical accomplishment. The website hosted an institutional leaderboard, which highlighted progress at the university level to enable students to achieve recognition for an entity larger than themselves. Due to the structure of the challenge, some professors incorporated the challenge into their existing courses as a course assignment or as an extra credit opportunity. This further incentivized students to work through the challenge. Finally the opportunity to test technical abilities is a driving force by itself. The final tasks provided appropriately difficult challenges for students to overcome.

Previous iterations of the Codebreaker Challenge were conducted without a centralized website, so challenge files had to be distributed manually, all task submissions were received via email, and each of these was verified by hand. In order to expand for the 2015 Codebreaker Challenge, new infrastructure was developed to provide an online, automated method of distributing the challenge-related files, accepting user submissions, and grading them.

For the 2016 Codebreaker Challenge, the organizers will greatly consider leveraging the America COMPETES Act prize authority to add additional incentives for student participation. Additionally, the challenge.gov platform could aid in the roll-out of these challenges.

O. United States Agency for International Development

a. All Children Reading: A Grand Challenge for Development (ACR GCD)

Summary: USAID’s All Children Reading: A Grand Challenge for Development is sourcing technology-based solutions to improve the literacy outcomes for children in developing countries. For ACR GCD, prizes solicit the development of a specific product, approach, or application that complement grant innovations and fill gaps in addressing child literacy. For USAID, prizes are one tool they apply to their grand challenge activities, which also include grant making and other partnership activities. In FY 2015, USAID helped implement five prize competitions in support of this grand challenge.

1) Big Ideas@Berkeley – Mobiles for Reading Prize Competition 2014 - 2015⁶⁶

Summary: Literacy unlocks human potential and is the cornerstone of development. It leads to better health, better employment opportunities, and safer and more stable societies. However, a 2013/2014 UNESCO report indicates that 250 million children across the globe are not learning basic literacy and numeracy skills. Of these, 57 million children—a disproportionate number of whom are from disadvantaged backgrounds, live in conflict-afflicted countries, are disabled, or are girls—are not enrolled in school at all. In addition, there is a shortage of 1.6 million teachers.

Since 2006, the Big Ideas@Berkeley contest has inspired innovative and high-impact student-led projects aimed at solving problems that matter to their generation. USAID started partnering with this contest in 2015. USAID’s category of the competition challenged participants to develop new or further existing mobile technologies to enhance reading scores for early grade children in developing countries.

The University of California – Berkeley (UC Berkeley) coordinated the entire competition—the prize platform, marketing, judging, workshops, events, etc.—with funding of \$50,000 from World Vision on behalf of ACR GCD. In the past, this prize has solely targeted Higher Education Solutions Network (HESN) universities, and with the partnership with USAID and ACR GCD partners, UC Berkeley expanded its network of eligible campuses for the first time to two Australian schools—Monash University and University of South Australia.

USAID, World Vision, the Australian Government, Global Development Lab, Higher Education Solutions Network (HESN), and UC Berkeley partnered for the implementation of this prize competition. The ACR GCD partners (USAID, World Vision, and the Australian Government) funded the challenge and the prize purse of \$28,000.

The competition occurred in two phases: pre-proposal and full proposal. Rather than requiring fully fleshed-out proposals, the Big Ideas competition invited raw ideas, then provided assistance for the interdisciplinary teams of student contestants to elaborate upon the original proposals. The most promising ideas were designed by finalists and then nurtured by the competition

⁶⁶ <http://bigideas.berkeley.edu/contest/reading/>; this challenge was described in the FY 2014 COMPETES report, starting on page 250.

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organizers. Finalists were paired with mentors from the university, private companies, or nonprofits who assisted teams for six weeks in developing full proposals. The competition organizers held workshops in proposal-writing, budgeting, and even how to get the most out of their mentor. The high touch support strategy, especially the one-on-one proposal feedback the competition provides to teams through advising, judging, and mentoring, is commonly cited as the most valuable part of the contest

Solution Type: Ideas; Other (Pitch)

Primary Goals: Find and highlight innovative ideas; Solve a specific problem; Engage new people and communities; Develop technology

Results: 18 universities—or teams with at least one student from those 18 universities—were eligible to participate. Matriculated students at other universities around the globe were encouraged to apply in collaboration with students from eligible campuses. The 2014-15 contest saw more submissions, participants, winners, mentors, judges and award funding than any other year in its history. Among the 6 finalist teams participating in the Big Ideas Grand Prize Pitch Day (the full competition) was the 1st place team from the Mobiles for Reading category (the USAID-supported category).

This category-winning team, “Creating Decodable Readers in Haitian Creole,” from the College of William & Mary was flown to UC Berkeley, mentored by Big Ideas staff on their presentation and pitch skills, and won the overall 2nd place, \$3,000, Grand Prize Pitch Day award. The solution is a software application that enables teachers and students to read, write, and share books using a local digital library and a kid-friendly storytelling application. The project featured a strong research component, in which the progress of a group that used the technology was compared to another that read the same books and learned the same lessons using paper methods. The winning team worked with teachers in Haitian elementary schools in 2015 to integrate the software onto existing laptops and trained them to use it with their students, children aged 7 to 10 years old. No software like this had previously been used to teach in Haitian-Creole.

2) Big Ideas@Berkeley – Mobiles for Reading Prize Competition 2015 - 2016

Summary: See 2014 – 2015 competition summary

Solution Type: See 2014 – 2015 competition summary

Primary Goals: See 2014 – 2015 competition summary

Results: The competition is still underway. The Big Ideas judges are currently reviewing the four pre-proposal submissions.

3) Enabling Writers Prize Competition⁶⁷

Summary: One of the main barriers to improving children’s reading skills is the lack of appropriate and engaging reading materials in mother tongue languages, which means children are unable to practice reading in the language they speak and understand. An analysis of data from 22 developing countries and 160 language groups revealed that children who had access to instruction in their mother tongue were significantly more likely to be enrolled in and attending school, while a lack of education in a first language was a significant reason for children dropping out (Smits et al., 2008).⁶⁸

The Enabling Writers Prize Competition aimed to drive the creation of new software technologies and the improvement of existing programs that make writing high-quality early grade reading materials that follow tested reading instruction methodologies easier, more cost-effective and efficient. The prize organizers offered a total \$100,000 prize for these software solutions. Solvers were challenged to develop an easy-to-use, open source software application that would facilitate the production of large sets of leveled and decodable texts for early grade reading instruction. The resulting software would combine an easy-to-use text generation software for decodable readers in multiple languages and scripts and publishing software for the development of those titles.

The competition had two phases: solvers submitted their initial software solutions, and the finalists’ solutions underwent 4-country field testing review process. Testing teams in Cambodia, Jordan, Ethiopia and Bangladesh used the software to write books in their mother-tongue language and then completed a software evaluation based on their experience.

InnoCentive supported the implementation of this prize competition.

Solution Type: Software and apps

Primary Goals: Solve a specific problem; Develop technology; Engage new people and communities; Find and highlight innovative ideas

Results: The competition had 39 registered entrants and drew nine submissions. Entrants came from the Bahamas, the United Arab Emirates, the United States, Ghana, Tanzania, South Africa, and Germany. Three finalists were chosen for the field testing stage (receiving \$12,000 each), and a grand prize winner was awarded an additional \$100,000. The 3 finalists were comprised of 2 non-profits and one small tech startup.

The winning solution allows for easy book writing in any language and it is the goal that it will be used to support writers globally in creating new local language content. The software, Bloom, is already being used by groups like World Vision and Save the Children. It is also anticipated that it will be used by many other groups producing early-grade reading material in local

⁶⁷ https://www.omnicompete.com/enabling_writers.html; this challenge was described in the FY 2014 COMPETES report, starting on page 251.

⁶⁸ Improving Learning Outcomes through Mother Tongue-Based Education. Research Triangle Institute. Page 1. http://www.rti.org/brochures/eddata_ii_mother_tongue_instruction.pdf

languages. In addition, it is being introduced to university students in the United States as an opportunity to draw in international students to write stories for their respective home countries. It is an open-source product as dictated by the competition, and at some stage, it may become a commercial product.

The competition reached nearly 100 countries, which raised the profile of All Children Reading, as a partnership and an agency initiative, in the education technology space. Profiling the Bloom software at events has opened the door for discussion and awareness building of the need for early grade reading materials globally. The Bloom software is unique in two ways: 1) its simplicity, which allows individuals with limited technology skills to utilize the software without extensive training; and, 2) it provides writers with the ability to level and decode books with pre-set parameters, which enhances the quality and appropriateness of a book for a child's reading proficiency. Globally, there is an insufficient supply of mother-tongue early grade reading materials. Writing and publishing books in these languages is an ongoing challenge and the Bloom software is a tool that will help make this process easier for authors in any language.

A 10 country roll-out plan is under development for the winning innovation. The roll-out plan is being administered by University Research Co (URC) under a contract with USAID's Office of Education. These funds are dedicated to rolling out technologies ACR GCD sourced through its prize competitions. The Bloom software roll-out plan aims to attract groups in developing countries that can mobilize writers, effectively link with the Ministry of Education, and ensure that books created are printed and get into the hands of early grade children. USAID in-country missions and World Vision National Offices have expressed interest in hosting Writer's Workshops using the Bloom software. The first of these workshops will be held in January 2016 with over 20 local writers across three languages, publishers, and Ministry of Education representation.

USAID learned that targeted outreach is very important and that the prize method is effective in reaching non-traditional implementers. For example, two of the software submissions came from organizations that had never received USG-support.

4) Technology to Support Basic Education in Crisis and Conflict Settings Ideation Challenge⁶⁹

Summary: The disruption of basic education services due to crisis and conflict situations has long-term consequences for students' educational attainment and development. Even once the crisis or conflict subsides, this interruption can impact student enrollment and retention in school as well as their cognitive, academic and socio-emotional development. This means educational gains in affected regions can quickly be stalled or even reversed as a result of crisis and conflict. As a result of missed schooling, a large number of students are over age per grade level (i.e., older than the average age of those in the same grade level).

This Ideation Challenge sought to source ideas for innovative, technology-supported approaches for children to maintain access to basic education despite disruptions experienced in one or more

⁶⁹ <https://www.omnicompete.com/crisisandconflictedtech.html>; ACR GCD is short for "All Children Reading: Grant Challenge for Development"

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of the following crisis or conflict situations: Health Crisis, Natural Disaster, and Conflict Zone. Participants were asked to create solutions that would be usable within the first six months after the onset of the crisis or conflict and within the context of a developing country.

The ACR GCD partners (USAID, World Vision and the Australian Government), with partners Norwegian Agency for Development Cooperation (NORAD) and the United Nations High Commissioner for Refugees (UNHCR) partnered on this prize competition.⁷⁰ InnoCentive supported the implementation of this prize competition. The competition offered a \$106,000 prize purse.

Solution Type: Ideas

Primary Goals: Find and highlight innovative ideas; Solve a specific problem; Develop technology; Engage new people and communities

Results: All Children Reading received 127 eligible submissions from around the globe for the challenge, broken down by three focus areas: conflict zones, health crises, and natural disasters. The initial prize purse was \$26,000, split up among 4 winners (\$5,000 prize each) and 4 honorable mentions (\$1,500 prize each). The four 1st place ideas were offered seed funding (an additional \$20,000 for a 6 to 12 month project), based on a submitted proposal, to pilot their ideas in 2016. Results will be available in 2017.

A few of the prize winners were either tech startups, social enterprises, or directly from the private sector. The organizers are excited to see how the technology innovations have a social impact in the developing world and look forward to see the results of the pilot projects.

One of the winning ideas, Engaging Personalised Learning for Refugees in Kenya, was the result of a partnership between the Xavier Project and Eneza Education, who provide educational content to out-of-school refugee children for free, ensuring that children access good education even in an emergency situation. Eneza provides engaging and learner-centered educational content relevant to the local context via basic mobile phone technology. Xavier Project enrolls refugee children onto the platform for free. After a successful pilot in Nairobi this program is spreading to the Dadaab refugee camp, home to almost 500,000 refugees, where barely 50% of refugee children have access to primary education.

This competition produced a stronger engagement between ACR GCD and NORAD, evident in the ongoing partnership in next year's EduApp4Syria prize competition.⁷¹

⁷⁰ <http://www.norad.no/en/front-page>, <http://www.unhcr.org/cgi-bin/texis/vtx/home>

⁷¹ A Norway-led coalition announced the launch of a 15 million Norwegian Kroner (approximately US\$1.7 million) competition to help displaced Syrian children continue their education during the protracted conflict. The EduApp4Syria competition will select up to five initial winners to develop a smartphone application that can build foundational literacy skills in Arabic and improve psychosocial well-being for Syrian refugee children aged five to 10. Up to two applications will be chosen for worldwide release after comprehensive development and testing. Applications close on April 1, 2016.

The competition is coordinated by the Norwegian Agency for Development Cooperation (NORAD) and is being launched in cooperation with the Norwegian University of Science and Technology (NTNU); All Children

5) Tracking and Tracing Books Prize Competition⁷²

Summary: Books are essential to early grade reading instruction. However, often when books (both textbooks and supplemental reading materials) are ordered for low income countries, they do not end up in the hands of the students who need them. Textbooks and materials can go astray at any stage in the delivery process--from the point-of-entry for imported textbooks, to central warehouses for nationally produced materials, to transportation across difficult and sometimes insecure routes, or even during final distribution to regional offices and classrooms.

To address this problem, ACR GCD launched the Tracking and Tracing Books Prize Competition, which sought innovations to track books destined for early-grade classrooms and learning centers in low-income countries and to allow stakeholders, ranging from parents to Ministries of Education (MoEs) and donor agencies, to quickly and easily access tracking information.

The competition sought innovations with four main components: a process for tracking and tracing books, associated software, associated hardware and devices, and a method for engaging and easily interfacing with users. Moreover, the proposed solutions were required to cover the whole supply chain, from the point where the books are ordered to delivery in the classroom or early-learning center.

USAID partnered with World Vision and the Australian government in this prize competition. InnoCentive supported the implementation of this prize competition, and a total prize purse of up to \$220,000 was offered for the grand prize winner.

All Children Reading provided a number of non-monetary incentives to attract innovators, such as global recognition, communications and marketing support, invitations to exclusive events, exposure to new partnerships through the ACR GCD partner network, and expert feedback on solvers' software from child development and digital education specialists.

Solution Type: Software and apps; Ideas

Primary Goals: Improve government service delivery; Find and highlight innovative ideas; Solve a specific problem; Develop technology; Inform and educate the public; Engage new people and communities; Build capacity

Results: There were three phases to this Prize Competition. In Phase I, after an initial screening process, ACR accepted 31 entries deemed worthy of evaluation. The evaluation resulted in two applications moving to Phase II: Community Systems Foundation (CSF) and John Snow Inc (JSI). In Phase 2, up to \$100,000 of prizes are available in the stages of creating prototype development plans (\$25,000), demonstrating the prototype (\$25,000), and after the scoping trip

Reading: A Grand Challenge for Development, a partnership including the United States Agency of International Development (USAID), World Vision and the Australian Department of Foreign Affairs and Trade; mobile operator Orange; and the Inter-Agency Network for Education in Emergencies (INEE).

⁷² http://allchildrenreading.org/innovation/prize-winners/#tracking_tracing_books

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for preparation of field testing, a prize will be awarded for the product being ready for market and all enhancements made and tested post field testing (up to \$50,000).

The two teams that moved to Phase II were:

- CSF is a non-profit organization applying technology for sustainable development. CSF has been awarded \$10,000 for their open source solution, OpenEMIS Logistics, a software platform that tracks the delivery of textbooks to schools. This tool leverages existing OpenEMIS technologies to provide MoEs with an integrated system for data collection, management and analysis that can be easily customized to meet the specific needs of member countries.
- JSI has been awarded \$10,000 for their software system. With the use of simple barcodes it will support tracking and tracing of textbooks by education officials throughout the system and enable parents, teachers, and local officials to receive up-to-date information on the status of books and materials.

The Tracking and Tracing Books team believes that both solutions should be fielded as products for MoEs, multi-lateral and bi-lateral agencies, and international non-government organizations. The creation of two, independent systems allows for the desired end goal to be realized in more locations, since one solution might fare better than another in a particular country. In addition, competition between two solutions should produce better and more cost effective products in the future. The location for field testing has yet to be determined.

The competition website received 6,174 total unique views from 27 countries.

b. The Desal Prize⁷³

Summary: The Desal Prize is the “second call” of the Securing Water for Food Grand Challenge, a \$33.3 million commitment between USAID and the Swedish International Development Agency (SIDA) and the Ministry of Foreign Affairs in the Netherlands. Small-scale desalination systems are expensive, inefficient, and environmentally unsustainable. The Desal Prize will award a total prize purse of \$400,000 to the top 3 brackish water desalination systems based on their ability to produce a high percentage of usable product water for humans and crop irrigation while greatly reducing the amount of brine concentrate waste. The solution must be powered solely by renewable energy and provide a daily volume of potable and irrigation water suitable to support a small holder farm in Jordan despite high levels of salt and other contaminants in the groundwater.

The judging panel evaluated the applications on the online platform and, after narrowing the applications to the top 12, worked with USAID staff to identify the semifinalists who would be invited to the second phase of the competition. Five semifinalist teams were selected based on the innovations proposed in their applications. These teams received seed funding (\$13,500) to

⁷³ www.thedesalprize.org; this challenge was described in the FY 2014 COMPETES report, starting on page 251.

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prototype their desalination technology. The 5 teams met for the first head-to-head demonstration competition in April 2015 at the U.S. Bureau of Reclamation Brackish Groundwater National Desalination Research Facility in New Mexico to win up to \$200,000 in funding. The technology demonstration is valued at \$500,000, which was provided to the semifinalist teams at no cost.

In addition to the international funding partners, the Desal Prize benefited from a collaborative partnership with the U.S. Bureau of Reclamation, which has provided technical assistance and an in-kind donation of the use of the Brackish Groundwater National Desalination Research Facility as the phase 2 demonstration location for the prize competition.

The decision to conduct a challenge-based prize approach to source new desalination technologies was determined based on extensive due diligence and a state of innovation analysis which revealed that, although several small-scale brackish water desalination technologies currently exist, a highly efficient and cost-effective technology powered by renewable energy is not available on the market. A competition was determined to be a potentially impactful approach to move the pace of technology development forward while showcasing the best technologies based on actual proven side-by-side performance.

Solution Type: Technology demonstration and hardware; Scientific advancement

Primary Goals: Solve a specific problem; Develop technology; Education and public outreach; Engage new people and communities

Results: Communication and outreach around the Desal Prize resulted in more than 600,000 impressions on social media during the week of the final technology demonstration competition; more than 30 press placements with a total circulation (online and print) of 670 million; over 210,000 shares of press placements; and more than 5,000 unique page views of the Desal Prize website and related content during the month of April.

For Phase 1, the challenge received 68 applications from 29 different countries (19 were developing countries) and 88% of the applicants had not previously applied for USAID funding.

From the applications 8 semifinalists were selected – 5 United States-based teams, and 3 international teams. For Phase 2, the 5 U.S. semifinalists were selected for the head-to-head technology demonstration competition in New Mexico. Of the 5 semifinalists, two winning solutions received monetary awards, MIT/Jain Irrigation Systems (\$140,000) and the University of Texas El Paso (UTEP) (\$60,000). MIT/Jain Irrigation Systems designed a photovoltaic-powered electro dialysis reversal (EDR) system that desalinates water using electricity to pull charged particles out of the water and further disinfects using ultraviolet rays. The system was designed for low energy consumption, limiting costs especially in off-grid areas. The UTEP team designed a Zero Discharge Desalination (ZDD) technology that reduces water waste in the desalination of groundwater by conventional processes. Electrodialysis uses voltage to remove undesirable ions from water. At the time of the initial stages of the competition the state of the art technology had a freshwater recovery rate of about 55-70%. The Desal Prize competitors had to reach a recovery rate of 85%, and both UTEP and MIT/Jain did so.

The initial two phases of the competition are now complete with the monetary prizes awarded, and the piloting phase will complete in May 2016. The winning team (MIT/Jain Irrigation Systems) is piloting their technology in India. The team conducted site visits and heard feedback from farmers about the value of a desalination system, but the team is still exploring solutions to make the system more affordable. UTEP may pilot its technology in Honduras.

For the final piloting phase, the total prize purse available (including implementation grants) is \$400,000: \$275,000 for the grand prize winner, and \$125,000 for 1st runner-up.

c. **Fighting Ebola Open Ideation Challenge**⁷⁴

Summary: In partnership with the White House Office of Science and Technology Policy, Centers for Disease Control and Prevention, and Department of Defense, USAID launched Fighting Ebola: A Grand Challenge for Development in September 2012 to help health care workers provide better care and contain the devastating virus.

Ebola spreads through human-to-human transmission via direct contact with the blood, secretions, organs, or other bodily fluids of infected individuals. Due to insufficient resources, health care workers have been infected while treating patients who are Ebola positive, often occurring through close contact when precautions are not strictly practiced or when equipment malfunctions. A major challenge that was identified during the Ebola response was the limitations of the current personal protective equipment (PPE) worn by healthcare workers. The PPE that health care workers currently wear is incredibly hot and the goggles are prone to fogging in West Africa's humid climate. Therefore, health care workers must take frequent breaks, forcing them to doff PPE with greater frequency, and increasing their risk of infection.

Additional challenges faced by health care workers include a lack of adequate health centers, difficulty in tracking person-to-person transmission, the absence of rapid point-of-care diagnostics, and a need to accommodate traditional burial ceremonies involving direct contact with a deceased body. The Fighting Ebola Grand Challenge sought out solutions to combat the above challenges. The Challenge held both a formal platform for idea submission, via a Broad Agency Announcement (BAA), as well as an informal platform via OpenIDEO, where participants were asked to contribute tangible ideas and actionable solutions in one of four mission areas.

An open ideation challenge was a critical component and first step of the Fighting Ebola Grand Challenge. This open ideation challenge was launched through the OpenIDEO platform to crowdsource innovative and bold ideas for solutions, with the goal of answering the question, "How might we rapidly equip and empower the care community to fight Ebola?" The purpose of the open ideation challenge was to engage a wide variety of creative thinkers with diverse expertise around the globe to rapidly source and develop potential solutions to this epidemic. There was no monetary prize purse. Using the OpenIDEO platform, the ideas were collaboratively developed, commented on, and continually focused on human-centered design

⁷⁴ <https://openideo.com/challenge/fighting-ebola/>

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principles. A number of in-person workshops were held around the U.S. and Europe to complement the online portion of the challenge.

Solution Type: Ideas; Technology demonstration and hardware

Primary Goals: Find and highlight innovative ideas; Engage new people and communities

Results: The Fighting Ebola Challenge on OpenIDEO selected “Highlighted” ideas for recognition only. A number of eligible ideas (those submitted by organizations or companies) were encouraged to apply to the funded grants portion of the rest of the Grand Challenge. The primary motivation for most individuals seemed to be a humanitarian desire to contribute to a collective effort to combat this disease, as well as to build their skills and reputation within the online ideation community. For the number of manufacturers of off-the-shelf products who submitted ideas, the platform was largely seen as an opportunity to advertise their products to potential procurers.

The large number of submitted ideas, diversity of participants, and level of media awareness all contributed to accomplishing the goal of sourcing and highlighting innovative and novel ideas by engaging new voices. As an example of the diversity of ideas and the reach of the challenge, the founders of a sportswear apparel start-up learned about the Fighting Ebola Grand Challenge on Twitter and believed their wearable cooling packs for athletes could be adopted for use by health care workers. Initially hesitant to apply to the funded grants, they posted about their product on the open ideation platform. Overwhelmed by the positive feedback they received, and flagged by USAID as being a unique solution eligible for funding, they were encouraged to apply to the grant competition. Only two weeks after finding out about the challenge, they pitched their product in front of experts at the pitch session, and were ultimately among those selected to undergo rigorous testing of their product.

- Of the 606 ideas submitted, 92% of the submissions were from individuals who did not designate an affiliation to a larger organization. Four percent of the submissions were from representatives of for-profit companies, and 4% were from individuals representing non-profit organizations or university groups. People from 62 different countries submitted their ideas.
- In total, the ideation challenge site received 23,500 unique visitors and 91,000 unique page views. Thirty-eight percent of engagers on the OpenIDEO platform were referred through the ebolagrandchallenge.net website, 33% came from OpenIDEO and IDEO, 14% from Facebook, and 12% from Twitter. Over 1,000 social media mentions with audience exposure of 4.7 million were identified.

A number of in-person workshops were held around the world in response to the challenge. This includes a workshop at the start of the challenge organized by USAID and the White House Office of Science and Technology Policy, which galvanized interest around the topic, allowed experts to share crucial background information on the existing problem, and laid the groundwork for future collaborations. Throughout the lifecycle of the challenge, universities and

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innovation hubs – a number in direct partnership with OpenIDEO – hosted more than 12 workshops to rapidly brainstorm and prototype promising ideas, collect feedback from users of the proposed solutions, and drive submissions to the open ideation platform.

Four individual solvers who submitted promising ideas around improved PPE were invited to present their ideas at a pitch session with expert reviewers. This pitch session was not intended to produce funding for the innovators, but rather to give their ideas visibility to those who may have the ability to develop them further.

Between the OpenIDEO and BAA platforms, the Fighting Ebola Grand Challenge sourced over 1,500 ideas and potential solutions. These ideas underwent a rapid, rigorous review process by U.S. government experts and international partners. Through this process, 14 innovations were selected and funded for their potential to reinforce the response to current and future Ebola outbreaks. The selected awardees fell into the following six categories: improving PPE, cutting-edge tools for enhanced patient care, reimagined health care settings, decontaminants, behavior change, and information communication technology solutions.

d. Wildlife Crime Tech Challenge⁷⁵

Summary: USAID's Wildlife Crime Tech Challenge (WCTC) was launched on April 22, 2015, Earth Day, and called on the global community to harness the power of science and technology to address wildlife crime. An open-innovation competition targeting “non-traditional” solvers from science and technology communities, the Wildlife Crime Tech Challenge sought solutions to four critically important wildlife crime issues: detecting transit routes, strengthening forensic evidence, reducing consumer demand for wildlife products, and tackling corruption along the supply chain.

All participants were asked to submit a concept note based on a well-defined template requesting information on the proposed solution, its stage of innovation, potential for scale, and more. Selected participants were asked to submit a full application expanding on the information requested in the concept note template. Prize winners will be chosen from the full applications. In addition to receiving a prize package—including financial, recognition, and technical assistance awards—prize winners will also be eligible to apply for a “grand prize,” which will include significant acceleration support and a financial award. WCTC included four concurrently run challenges addressing the four critically important wildlife crime issues. Success and evaluation metrics were equally divided between potential for impact and potential for scale.

Within USAID, WCTC is a partnership between the Office of Forestry and Biodiversity (FAB) and the Global Development Lab. Beyond USAID, WCTC is a partnership with the National Geographic Society, the Smithsonian Institution, and International Union for Conservation of Nature (IUCN) TRAFFIC (an NGO focused on combatting wildlife crime). External partners supported WCTC primarily through communications and outreach and some technical assistance in prize design and evaluation.

⁷⁵ <https://wildlifecrimetech.org/index>

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Integra LLC, a third-party contractor, supported the implementation of this challenge. About \$1 million of prizes were offered to solvers, \$240,000 in prizes and \$800,000 in grand prizes. Grand Prize applications will be due in March 2016 and Grand Prize winners will be announced in late spring 2016.

Solution Type: Software and apps; Creative (design & multimedia); Technology demonstration and hardware; Analytics, visualization and algorithms; Scientific

Primary Goals: Find and highlight innovative ideas; Develop technology; Engage new people and communities

Results: The Wildlife Crime Tech Challenge received 300 applications from individuals, NGOs, universities, and the private sector representing 52 countries: 67% from outside the U.S., 86% new to USAID, and 53% new to the issue of wildlife trafficking. From the pool of 300, 44 finalists were selected through a rigorous technical review and high-level judging panel to advance to the next stage in the competition. The finalists represent 17 countries, 72% of whom are new to USAID and 32% are new to the issue of wildlife trafficking. Solutions ranged from portable, handheld DNA sequencers to electronic “noses” that can identify illegal cargo to mobile apps that identify illegal wildlife in markets.

In January 2016, WCTC will announce approximately 15 prize winning innovations that have potential to significantly disrupt wildlife crime activities and their negative impacts on wildlife, local nature based tourism economies, and rule of law. The planned acceleration and scaling support will increase the impact of the innovations sourced. Each winner will receive \$10,000 in technical assistance and networking support, and the opportunity to apply for up to 4 Grand Prizes totaling \$800,000 (likely 1-\$500,000 prize and 3-\$100,000 prizes).

WCTC successfully engaged solver communities outside those who normally address wildlife trafficking. This not only led to a greater variety of proposed solutions, but has expanded awareness of the issue among critical science and technology audiences.