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InnoCentive Investigation of the Challenge Driven Innovation Platform at NASA

An Evaluation of the Open Innovation Pilot Program between NASA and InnoCentive, Inc.

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This report is organized as follows:

I. Executive Summary

The report is an evaluation of the outcomes from a 13-month Pilot Program (September 2009 – September 2010) between NASA Johnson Space Center and InnoCentive. The reach of the program expanded to include a Challenge from Langley Research Center and collaboration on two Challenges with Glenn Research Center. The intent of the pilot program was to discover the benefits of leveraging InnoCentive's Challenge Driven Innovation methodology as a means to accelerate innovation. Specifically, the pilot was used to investigate the utility and value for NASA of InnoCentive's approach and platform, which was delivered and supported through the services of InnoCentive.

The report seeks to answer questions that are central to the evaluation of the Pilot Program:

1. ***What is the value of Challenge Driven Innovation, specifically supported by the InnoCentive Marketplace in addressing NASA Challenges? Does the platform effectively address NASA's human health and performance space flight Challenges by providing innovative ideas or solutions?***

2. ***Will a collaborative and open approach to innovation and problem solving techniques positively influence public opinion of NASA and/or other government agencies?***

3. ***Will a Challenge Driven Innovation methodology, as supported by InnoCentive, bring about the desired behavioral changes to support a culture of innovation at NASA?***

To address these questions, InnoCentive and the NASA Pilot Program team evaluated the results of seven pilot Challenges, surveyed over 2,900 Solvers who participated in these Challenges, and conducted interviews with Challenge Owners, their support teams, and the winning Solvers. In total, nineteen interviews took place with eleven NASA personnel from three Centers and eight Solvers from four different countries to record the experiences and document answers to these compelling questions.

What is the value of Challenge Driven Innovation, specifically supported by the InnoCentive Marketplace in addressing NASA Challenges? Does the platform effectively address NASA's human health and performance space flight Challenges by providing innovative ideas or solutions?

The InnoCentive process bridges internal and external resources so that NASA and its Challenge Owners can act (quickly and with legal protection) on the solutions and Intellectual Property identified in this process. Since innovation is synonymous with fresh and novel ideas and diverse thinking, these elements are best found in a broad and varied audience like the InnoCentive Marketplace. Each NASA Challenge Owner stated that the awarded solutions brought quantifiable

value to their projects. The value of the Pilot Program was expressed by the NASA Challenge Owners and their willingness to continue using the Open Innovation Challenge platform in the future. The following are comments made by two Pilot Program Challenge Owners regarding the value of the results received from using the platform:

"The winning submission was very thorough. It addresses the Challenge requirements and exceeds them with respect to forecast confidence and random prediction. Questions posed back to the Solver were thoroughly addressed. This solution holds promise and the Seeker is highly interested in working with the Solver on potential implementation into an operational framework. It appears that the Solver is from within the Heliophysics community."
Dr. Dan Fry – Scientist, Space Radiation Analysis Group

"There was a lot learned for the time and money spent - worth it.
Melvin Ferebee & Erik Vedeler – NASA Frontier Sensors Strategic Opportunity Team

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The platform results provided several areas of value through the Challenge Driven Innovation process and the InnoCentive Open Innovation Marketplace. The value was identified in multiple unique areas that could have a lasting impact for driving a culture of innovation at NASA.

1. Cost savings associated with new and rapid problem solving techniques
2. Promotes effective use of established resources
3. Increased diversity of thinking through access to an expanded network of experts
4. Efficient process for Intellectual Property transfer
5. Fostering a more innovative culture
6. Improved ability to frame problem statements or research needs

Will a collaborative and open approach to innovation and problem solving techniques positively influence public opinion of NASA and/or other government agencies?

Initial evidence of positive public opinion can be seen through the press releases and social media interest in the human interest stories of the winning Solvers. The Federal Chief Technology Officer, Aneesh Chopra, during his speech at the Personal Democracy Forum in June 2010, highlighted the success of the Data-Driven Forecasting of Solar Events Challenge (http://pdfnyc.civicolive.com/2010/06/04/rethinking-government-with-aneesh-chopra/) as an example of the direction government is taking to be transparent and collaborative with the public. The winner of the Forecasting Solar Events Challenge, Bruce Cragin, who as a retired Radio Frequency Engineer developed a solution that allows for NASA to forecast a solar flare event with 75% accuracy within 24 hours, has been highlighted in several public cases. Bruce and the NASA Challenge Owners are frequently called with requests for interviews by the press.

Positive impact can also be seen within the InnoCentive Solver community. Eight-out-of-ten (81%) of the Solvers that were surveyed reported that they had never responded to a government Challenge before, yet nearly all (98%) reported they are interested in working on more NASA Challenges. This suggests a positive experience with the Challenges, a positive opinion of NASA, and the InnoCentive processes which provides the facilitation between the parties and a trusted protection of Intellectual Property.

The greatest direct impact can be seen in the stories from the Solvers contributing to the NASA Pilot Challenges. Interviews with awarded Solvers and active participants revealed evidence of this point. The Solvers took pride in contributing to what was seen as a "win-win" for the government and for industry and the effect government can play in driving or supporting innovation within this process. The following are comments from the winning Solvers:

"The subject and Challenge really appealed to me. Think about it: To date space missions have relied upon building and deploying very complex and expensive devices, so we've had to be incredibly cautious about how, when, and why we use them. These new approaches make for conservative expeditions —less risk, yet more flexibility! It's elegant. This approach lets us take on dangerous and scientifically more interesting discoveries. It's a win-win-win—for the public, government, industry and technology."
Tad Hogg – Partially awarded Solver for the Sensor Swarms for Extraterrestrial Research Challenge

"I was not sure I would be successful, but having NASA scientists evaluate my work was a primary motivation…It is a dream to be recognized by the scientific level of NASA quality."
Yury Bodrov – Partially awarded Solver for the Improved Food Packaging Challenge

"The various Federal agencies that support basic research in the academic community play a crucial role in insuring our country's future. I fully support the President's efforts to re-invent government, and have no doubt that he will continue to be a strong supporter of basic academic research in addition to exploring these new approaches."
Bruce Cragin – Full award winner of the Data-Driven Forecasting of Solar Events Challenge

"Before moving to the US in 2005, I was born and raised in Croatia and then lived in France for 10 years and was always hoping to come to the US. The US has so much happening in science innovation and NASA has always been the center of this to me. We are very pro-American in my family and winning this Challenge is a personal achievement. Being approved and accepted by such a powerful organization as NASA reinforces my respect for them."
Milan Stengl – Partially awarded Solver of the Medical Consumables Tracking Challenge

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Will a Challenge Driven Innovation methodology, as supported by InnoCentive, bring about the desired behavioral changes to support a culture of innovation at NASA?

The InnoCentive CDI platform generated high quality, outside-the-box ideas and solutions, and in some cases, commercially viable solutions for NASA. Cultural change partially begins by celebrating these success stories and by creating an environment of acceptance for being the solution finder. This can be accomplished through strong leadership, a consistent and understandable objective, and recognition for those who are early adopters and support the strategic initiative. Establishing the leadership and environment that supports a proactive, risk-taking and collaborative culture will facilitate the growth and change required throughout the organization.

As a first step, open innovation is considered a means to perform R&D more effectively. The second step involves scaling up open innovation methodologies in all processes and incorporating internal Challenge-based platforms like NASA@Work, currently under pilot investigation. These initiatives gradually lead to changing the structure, systems and ultimately the culture of innovation. InnoCentive perceives NASA as having a clear strategy that is combining the right tools to capture the Challenges facing the organization by using the correct methodologies for Challenge Driven Innovation within the construct of InnoCentive's CDI offering. Through the continued partnership and support by NASA management, the desired behavioral changes are taking root. The following are comments by the early adopters at NASA regarding the program effect on the culture of innovation.

"The Challenge owners and NASA evaluators have got to be as forward thinking and visionary as the submitters to an Open Innovation Challenge. We are a NASA group with NASA evaluation processes; if a submission does not look like a NASA answer, I am not sure it would be selected without forward thinking. This is mainly because it does not look like something we are already doing or familiar to us. It is more the culture of NASA that will change us to be more visionary."
Melvin Ferebee – Langley Challenge Owner

"Cultural changes are happening in a number of areas. From a tactical perspective, Challenge Owners see this as an effective new tool that could interact with their existing tools. The successes of the Pilot and Challenge Owner testimonials are helping with the acceptance of open innovation tools. On a strategic level because of the success and visibility from GSA and the White House, our headquarters folks have adopted the language and open innovation is gaining acceptance."
Dr. Jeffrey Davis – Director, Johnson Space Center Space Life Sciences and Executive Sponsor

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II. Introduction and Overview

Since 2001, InnoCentive has helped commercial, government and nonprofit organizations to better innovate through open innovation and crowdsourcing, strategic consulting services, and Software-as-a-Service (SaaS) solutions. The company built the first global web community for open innovation where organizations or "Seekers" submit complex problems or "Challenges" for resolution to a "Solver" community of more than 250,000 engineers, scientists, inventors, business professionals, and research organizations in nearly 200 countries. Prizes for winning solutions are financial awards up to USD $1,000,000. Committed to unleashing diverse thinking, InnoCentive introduced the first integrated innovation platform which combines its leadership in open innovation with technology to enable collaborative innovation across organizations such as NASA. The use of InnoCentive's Challenge Driven Innovation (CDI) platform and strategic services provides a new organizational research and innovation model where return to NASA, citizens, taxpayers and individual passion go hand-in-hand with solving mankind's most pressing problems.

For this report, InnoCentive did an extensive analysis of the Solver community, the Challenge Owners, and performance results of the seven Challenges conducted during the pilot for NASA and the Space Life Sciences Directorate. Our performance analysis was based on the value of the solutions and intellectual property acquired and the performance of InnoCentive's Open Innovation Marketplace relative to other research and innovation tools available to solve difficult Challenges.

NASA's Johnson Space Center's Space Life Sciences Directorate developed a strategy in 2007 to pursue external alliances to establish a balanced portfolio of research and technology solutions for human health and performance areas during human space flight. They sought expertise from academia in mapping research and technology needs or gaps to the best possible collaborative strategy. Many Challenges were identified through mapping of the technology gaps (as facilitated by Gary Pisano, Professor of Business Administration at the Harvard Business School). One strategy that clearly emerged was the use of open innovation service provider platforms to seek external solutions to NASA Challenges.

Open innovation is a paradigm which assumes that organizations can and should use external as well as internal ideas and paths to finding solutions to advance their technologies. The Open Government Directive is established on three principles: transparency, participation, and collaboration. The NASA Open Innovation initiative clearly involves all three; transparency with NASA operations, participation from the public to contribute ideas and expertise, and collaboration between the public and NASA that encourages cooperation around problems that matter.

Using this open innovation strategy required NASA to refine problems in their research and technology portfolio into Challenge statements that could be addressed by a wide variety of disciplines and technical expertise external to NASA. Using InnoCentive's CDI methodology, NASA

was seeking to obtain innovative technology, research, service, and solutions through an extended community.

Starting in September 2009, NASA and InnoCentive initiated the open innovation service provider Pilot Program contract and developed the NASA Innovation Pavilion on InnoCentive.com. In November 2009, InnoCentive delivered ONRAMP (Open iNnovation Rapid Adoption Methods and Practices) professional development workshops. During the ONRAMP sessions, approximately 30 NASA personnel participated in sessions on the following topics: best practices, process and Challenge Driven Innovation principles, and the Phase 1 Challenges were identified for development. The Challenge Owners were identified and Challenge definition and development began.

The NASA Innovation Pavilion on InnoCentive.com went live December 2009 with three Challenges from Johnson Space Centers' Space Life Sciences Directorate. The Phase 1 Challenges included:

Improved Barrier Layers … Keeping Food Fresh in Space
Posted December 18, 2009 as a Theoretical Challenge and had a $15,000 award for a solution

Mechanism for a Compact Aerobic and Resistive Exercise Device
Posted December 18, 2009 as a Theoretical Challenge and had a $20,000 award for a solution

Data-Driven Forecasting of Solar Events
Posted December 22, 2009 as a Reduction to Purpose Challenge and had a $30,000 award for a solution

NASA's Langley Research Center showed interest in exploring the open innovation model and added a Challenge to the open innovation service provider pilot contract in February 2010.

Coordination of Sensor Swarms for Extraterrestrial Research
Posted February 27, 2010 as a Theoretical Challenge and had a $20,000 award for a solution

The Phase 2 Challenges of the Pilot Program were posted in May 2010. The Phase 2 Challenges included:

Simple Microgravity Laundry System
Posted May 27, 2010 as a Theoretical Challenge and had a $25,000 award for a solution

Augmenting the Exercise Experience with Audio-Visual Inputs
Posted May 27, 2010 as a Theoretical Challenge and had a $20,000 award for a solution

Medical Consumables Tracking
Posted May 27, 2010 as a Theoretical Challenge and had a $15,000 award for a solution

III. Pilot Challenges Summary

The NASA Open Innovation Pilot Program involved seven Challenges from three NASA Centers: Johnson Space Center, Langley Research Center, and Glenn Research Center. Johnson Space Center posted six Challenges; two were in collaboration with Glenn Research Center, and one Challenge from Langley Research Center. The Challenges were selected based on technology gap needs and approved by the Executive Sponsor and Program Champions. The following are summaries of all seven Challenges posted during the pilot program:

NASA Challenge: Improved Barrier Layers … Keeping Food Fresh in Space

Theoretical

NASA JSC Challenge Owner

Award: $15,000
Posted: December 18, 2009
Deadline: February 28, 2010
Awarded: May 7, 2010
Winning Solver: Yury Bodrov - St. Petersburg Russia

Challenge Description

NASA requires safe, nutritious, acceptable, and varied shelf-stable foods with a shelf life of 3 - 5 years to support the crew during future exploration missions to the Moon or Mars. Concurrently, the food system must efficiently balance appropriate vehicle resources such as mass, volume, water, air, waste, power, and crew time. New food packaging technologies are needed that have adequate oxygen and water barrier properties to maintain the foods' quality over a 3 - 5 year shelf life. Currently the packaging used for freeze-dried foods and natural form foods does not have adequate oxygen and moisture barrier properties to allow for this extended shelf life.

Project Criteria

As we go deeper into space and spend more time on the International Space Station (ISS), missions become longer, requiring food to be stored for longer periods of time with greater restrictions on size, weight and waste disposal. The new packaging must have improved barrier properties, remain lightweight and be compatible to sterilization processes and proper disposal. This requires only a written proposal and the proposal should include the following:

1. Detailed description of a packaging system that could meet the above technical requirements.
2. Rationale as to why the Solver believes that the proposed packaging system will work. This rationale should address **each** of the Technical Requirements described in the Detailed Description and should be supported with any relevant examples. This rationale will be very important in the evaluation of solutions.
3. Data should be provided as evidence that the materials could meet the barrier properties described. Previously published data is acceptable and a list of suppliers where materials can be obtained.

174 Project Rooms from 33 Countries

- Australia, Austria, Brazil, Bosnia, Canada, Chile, China, Columbia, Finland, France, Germany, Hungary, Iceland, India, Indonesia, Israel, Italy, Japan, Korea South, Latvia, Mexico, Netherlands, New Zealand, Norway, Romania, Russia, Spain, Turkey, Ukraine, United Kingdom, United States, Uruguay, Yugoslavia

22 Solution Submissions from 10 Countries

NASA Challenge: Mechanism for a Compact Aerobic and Resistive Exercise Device

Theoretical

NASA JSC Challenge Owner

Award: $20,000
Posted: December 18, 2009
Deadline: February 28, 2010
Awarded: May 14, 2010
Winning Solver: Alex Altshuler - Foxboro, MA

Challenge Description

Returning ISS (International Space Station) crewmembers exhibit losses in bone density, cardiovascular capacity, and muscle strength despite the prescribed exercise prescriptions to target these losses. The ability to provide effective hardware for exercise countermeasures use will be valuable in supporting safe and successful space exploration. NASA seeks compact multi-function (aerobic and resistive) exercise devices for the Constellation vehicles, in a small footprint and with minimal impact to the vehicle resources (unlike current ISS exercise devices). Constellation mission scenarios will require crewmembers to transit in microgravity and live and work in partial gravity for extended periods of time, initially with missions of approximately 14 days to missions on the order of months (and years with respect to Mars).

The Challenge is to come up with an engineering mechanism that can provide the appropriate resistive and aerobic exercises in space under low or zero gravity conditions. We want to emphasize that you do not need to design the whole apparatus but just the mechanism. We can always put a strap or a bar or pedals on it, but we need new ideas for the mechanism itself.

Project Criteria

NASA is looking for a novel mechanism for a compact, effective aerobic and resistive exercise device. They are not looking for you to design the complete device, but just the engineering mechanism that could deliver the proper resistive and aerobic exercises in space under very limited or zero gravity. There are very specific size and space requirements.

The proposal, which is subject to verification by the Seeker, should include the following:

1. Detailed description of a resistive mechanism that could meet the above technical requirements.
2. Rationale as to why the Solver believes that the proposed mechanism will work. This rationale should address **each** of the Technical Requirements described in the Detailed Description and should be supported with any relevant examples or data. This rationale will be very important in the evaluation of solutions.
3. Drawings of the mechanism (no hand drawings please).

564 Project Rooms from 52 Countries

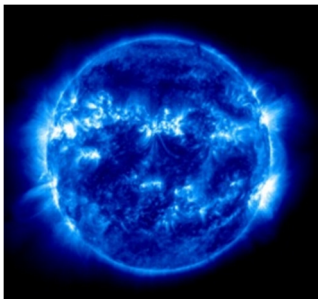
- Argentina, Australia, Austria, Bosnia, Botswana, Brazil, Bulgaria, Canada, Chile, China, Colombia, Denmark, Ecuador, Egypt, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, India, Indonesia, Israel, Italy, Japan, Kazakhstan, Korea South, Kuwait, Latvia, Mexico, Netherlands, New Zealand, Norway, Peru, Poland, Portugal, Puerto Rico, Romania, Russia, Singapore, South Africa, Spain, Sweden, Switzerland, Turkey, Ukraine, United Kingdom, United States, Uruguay, Venezuela, Yugoslavia

95 Solution Submissions from 24 Countries

NASA Challenge: Data-Driven Forecasting of Solar Events

Reduction to Practice

NASA JSC Challenge Owner



Award: $30,000
Posted: December 22, 2009
Deadline: March 22, 2010
Awarded: May 13, 2010
Winning Solver: Bruce Cragin - Lempster, NH

Challenge Description

The Challenge is posed in such a way as to broaden the base of potential Solvers to include anyone who has a mathematical and data-analysis background. Technical people from the field of physics are also encouraged to participate but the Seeker believes that some of the most intriguing insights may be gleaned from someone entirely new to the field.

The Seeker is extremely interested in seeing whether techniques such as ensemble forecasting (similar to what is used in field of meteorology), multivariate statistics and Bayesian time-series analyses may be able to provide some progress towards a solution.

The Seeker's problem lies in the fact that exposure to ionizing radiation presents one of the most significant risks to future exploration of the Solar system. It is difficult to study the radiation and the processes that generate it because a) the space field cannot truly be replicated on the ground for study; and b) measures commonly used in industry to manage occupational radiation exposure have little or no utility for spaceflight.

Project Criteria

Successful submissions will include the following components:

1. A detailed document carefully outlining the approach taken by the Solvers.
2. An example application of the approach applied to some real historical data.
3. Confidence limits of predictions for 5-10 historical SPEs.

579 Project Rooms from 53 Countries

- Afghanistan, Argentina, Aruba, Australia, Austria, Belgium, Brazil, Bulgaria, Canada, Chile, China, Colombia, Costa Rica, Denmark, Ecuador, Egypt, Finland, France, Germany, Hong Kong, Hungary, India, Indonesia, Ireland, Israel, Italy, Japan, Jordan, Korea, Latvia, Mexico, Morocco, Netherlands, New Zealand, Pakistan, Philippines, Poland, Romania, Russia, Saudi Arabia, Seychelles, Singapore, Slovenia, South Africa, Spain, Sweden, Switzerland, Ukraine, United Kingdom, United States, Uruguay, Venezuela

11 Solution Submissions from 5 Countries

NASA Challenge: Coordination of Sensor Swarms for Extraterrestrial Research

Theoretical

NASA LRC Challenge Owner

Award: $20,000
Posted: February 27, 2010
Deadline: April 26, 2010
Awarded: June 4, 2010
Winning Solvers: Simone Sergi - Modena, Italy
Fabrizio Invernizzi - Lagnasco, Italy
Tad Hogg - Mountain View, CA

Challenge Description

Within this theoretical Challenge a winning solution should provide an algorithm or protocol that describes how simple sensors (A) communicate information, amongst themselves and to a central data collector (B) make decisions about what to measure 'on the fly' or where to go if locomotion is possible. Swarming should result in emergent behavior creating "intelligence" and have distributed coordination so that there are no single (or a few) points of failure.

The Seeker is looking for designs of the optimal way of addressing the entire lifecycle of the sensor swarm. This theoretical Challenge asks Solvers to document ideas on the optimal way of deploying a swarm. Importantly, the swarming experiment should be able to succeed (collect data and likely maintain a fully connected communication network) with something on the order of a 20% survival rate of individual sensors. There should be no single point of failure (mother ship). Should any node fail, while collecting the data of its neighbors or coordinating its locomotion, then the network should elegantly replace or be able to compensate for the failed node and experience no or minimal data/coordination loss.

Project Criteria

Complete solutions will contain detailed and clearly documented ideas that address the questions listed above. Likewise, computer programs, equations or other simulations that demonstrate the effectiveness and flexibility of any algorithm would be a valuable addition to most solutions.

423 Project Rooms from 49 Countries

- Australia, Austria, Belgium, Brazil, Bulgaria, Canada, Chile, China, Colombia, Ecuador, Egypt, Finland, France, Germany, Greece, Hungary, India, Iraq, Ireland, Israel, Italy, Jordan, Korea South, Kuwait, Latvia, Lebanon, Malaysia, Mexico, Netherlands, New Zealand, Nigeria, Norway, Pakistan, Peru, Philippines, Poland, Portugal, Romania, Russia, Singapore, South Africa, Spain, Sweden, Switzerland, Turkey, Ukraine, United Kingdom, United States, Yugoslavia

37 Solution Submissions from 11 Countries

- Australia, Finland, France, India, Italy, Pakistan, Philippines, Switzerland, Ukraine, United Kingdom, United States

NASA Challenge: Simple Microgravity Laundry System

Theoretical

NASA JSC Challenge Owner

Award: $25,000
Posted: May 27, 2010
Deadline: July 27, 2010
Awarded: September 21, 2010
Winning Solvers: Alex Altshuler - Foxboro, MA

Challenge Description

This Challenge is seeking a new approach to laundry. For this Challenge, laundry refers to washing, with liquid phase cleaning agent (not necessarily water), to remove soil and odor from clothing, as well as drying to remove any residual fluid from the clothing. Although laundry systems have been previously studied, the proposed designs have been overly complex and inadequately addressed operation in microgravity.

Project Criteria

The Solver's proposal will be evaluated by NASA based solely on the objective factual information provided and not on unsupported speculation (i.e. 'marketing language'). NASA will evaluate based on the limited cleaning/refreshing of clothing, the soundness of the technical approach to laundry, and how well the Solver's solution has addressed integration of the laundry system to spacecraft resource requirements. It is important that the Solver provide the requested mass, volume, power, water, and other resources required. NASA uses these resources to develop an equivalent system mass for each Solver's solution. This enables widely differing solutions to be compared. The Solver should focus on the laundry system mechanisms, clothing refreshing/cleaning level, and required calculations.

This requires only a written proposal but proof of concept of mechanisms or technologies is advantageous. The proposal should include detail description of a laundry system describing general cleaning philosophy, physical description, operation, maintenance considerations, and advantages over other technologies.

a. Report should include detailed rationale addressing each of key spacecraft requirements and general requirements.
b. Report should include overall laundry system layout and sectional details of key components in high quality sketches or CAD drawings.
c. Report should include assumptions and calculations [including, if possible, watts per kg of clothing processed, crew time per kg of clothing, water per kg of clothing, mass of solvent/surfactant per kg of clothing, estimated vibration produced] required to rationalize performance expectations.
d. Report should include the mass of the equipment and consumables to clean the laundry. As an option the a list of laundry system components (and their estimated mass) that might need to be replaced over a 10 year life span would be beneficial to the Seeker.

598 Project Rooms from 50 Countries

- Argentina, Armenia, Australia, Belarus, Belgium, Brazil, Bulgaria, Canada, China, Colombia, Denmark, Egypt, Ethiopia, France, Germany, Greece, Guatemala. Hungary, India, Indonesia, Ireland, Israel, Italy, Jordan, Korea South, Latvia, Mexico, Netherlands, New Zealand, Norway, Panama, Philippines, Poland, Portugal, Romania, Russia, Singapore, Slovakia, South Africa, Spain, Sweden, Switzerland, Taiwan, Turkey, Ukraine, United Arab Emirates, United Kingdom, United States, Uruguay, Yugoslavia

108 Solution Submissions from 20 Countries

NASA Challenge: Augmenting the Exercise Experience with Audio-Visual Inputs

Theoretical

NASA JSC Challenge Owner

Award: $20,000
Posted: May 27, 2010
Deadline: July 27, 2010
Awarded: September 20, 2010
Winning Solver: Dave McMahon - Ottawa, Ontario CA

Challenge Description

The Challenge for the Solver is to come up with a system that can give a virtual audio/visual experience to the astronauts while exercising that is flexible to interface with other systems (transferring data) and is lightweight and easy to use. The quality of the visual/auditory experience is of paramount importance as it is designed to heighten sensory stimulation in an environment that is somewhat sterile. Hence the use of pleasing natural environments, people and or events is desired.

The Seeker would like to know what it would take to set up such a system. The Seeker would like the Solver to provide the details of how such a system could be made to meet the requirements of the Challenge. We are not only looking for ideas, but hard physical solutions to the Challenge.

Project Criteria

NASA is looking for a novel system that can give a virtual audio/visual experience to the astronauts while exercising that is flexible to interface with other systems (transferring data) and is lightweight and easy to use. There are very specific size and space requirements. The proposal should include the following:

1. Detailed description of a system that could meet the above technical requirements.
2. Rationale as to why the Solver believes that the proposed system will work. This rationale should address **each** of the Technical Requirements described in the Detailed Description and should be supported with any relevant examples or data. This rationale will be very important in the evaluation
3. Solvers should specifically address what will be needed in terms of; Software / Hardware, Data collection and storage, Training/education, Interface connections, Filming techniques and options for required content
4. Include a discussion concerning durability and planned lifetime of equipment. Include any maintenance and repair requirements that should be considered.
5. Preparation Estimate — several items will need to be completed before actual space travel. (e.g. filming the scenarios and background scenes) The Solver should list those action items and an estimate of time needed for completion.
6. Solvers, who have expertise or facilities to help implement a proposed system, should provide that information. Note: information should not provide personal identification of you or your company.

229 Project Rooms from 43 Countries

- Argentina, Armenia, Australia, Austria, Belgium, Brazil, Bulgaria, Canada, China, Colombia, France, Germany, Hungary, India, Indonesia, Israel, Italy, Japan, Korea South, Lebanon, Mexico, Netherlands, New Zealand, Norway, Pakistan, Peru, Poland, Portugal, Romania, Russia, Singapore, South Africa, Spain, Sweden, Switzerland, Taiwan, Thailand, Trinidad and Tobago, Turkey, Ukraine, United Kingdom, United States, Yugoslavia

18 Solution Submissions from 9 Countries

NASA Challenge: Medical Consumables Tracking

Theoretical

NASA JSC and GRC Challenge Owner

Award: $15,000
Posted: May 27, 2010
Deadline: July 27, 2010
Awarded: September 24, 2010
Winning Solvers: Milan Stengl - Charlottesville, VA
Joel Niederhauser - Liestal, Switzerland
Dan Winkelman - Amelia, OH

Challenge Description

The Challenge is to track medication and medical consumables usage from a common medical kit containing pills, pre-metered injections, and other consumable items such as bandages and splints. Items must be tracked to a specific user. Compliance must be greater than 95% so the user interface of the system must add no more than 10% to the amount of time required to access the material without a tracking system. Our experience is overly complicated user interfaces are either misused or eventually ignored due to time constraints. Compliance in the past with written systems has been low, so a standard barcode scanner is thought unlikely to deliver the required compliance. We need something that is minimal hands on by the user.

Project Criteria

NASA requires a method/process to track medication and medical consumables usage from a common medical kit. Items must be tracked to the specific user with minimal participation by the user. The system should track what has been used, by whom and which items need to be replaced due to use or expiration date. This requires only a written proposal. The proposal should include the following:

1. Detailed description of a method/process that could meet the above technical requirements.
2. Rationale as to why the Solver believes that the proposed system will work. This rationale should address **each** of the Technical Requirements described in the Detailed Description and should be supported with any relevant examples. This rationale will be very important in the evaluation of solutions.
3. List of all hardware and software needed for the system and their associated volumes and weights.
4. Drawings/Schematics of the system, if applicable.

365 Project Rooms from 47 Countries

- Argentina, Armenia, Australia, Bangladesh, Belarus, Brazil, Canada, Chile, China, Colombia, Denmark, France, Germany, Greece, Guatemala, Hungary, India, Indonesia, Ireland, Israel, Italy, Korea South, Latvia, Malaysia, Mexico, Netherlands, New Zealand, Norway, Pakistan, Philippines, Poland, Portugal, Romania, Russia, Saudi Arabia, Singapore, South Africa, Spain, Sri Lanka, Sweden, Switzerland, Turkey, Ukraine, United Arab Emirates, United Kingdom, United States, Yugoslavia

56 Solution Submissions from 16 Countries

IV. Pilot Program Outcomes

A. Challenge Results

The findings of the pilot indicate that there were significant benefits to NASA in utilizing InnoCentive's Challenge Driven Innovation methodology and platform. The ability to solve difficult technical human health and performance problems and the use of a diverse network of experts resulted in a cost savings and new capability for rapid problem solving methodologies that can be used across NASA for innovation.

From the information provided during in-depth interviews with the Challenge owners' regarding the results of the seven Challenges, we have developed a structure to conservatively identify the costs and benefits of the pilot program.

BENEFIT ITEMS

Awarded Solution Value

NASA used InnoCentive's CDI platform to address some of its most difficult technology gaps and innovation needs. These Challenges represented gaps in knowledge or technology to the organization as identified through its portfolio mapping exercise with the Harvard Business School. The Challenge owners estimated value of the solutions for this report based on what it would take to achieve similar results. While measuring the solution value is the ultimate goal, the final value realization can take years to develop.

Reduced Internal Resource Burden

InnoCentive provides a Client Services team of consultants and scientists to professionally develop the Challenges and manage the program for the NASA Challenge Owners while using the InnoCentive Open Innovation Marketplace. A significant burden was lifted from the NASA Challenge Owners by the InnoCentive Client Services team allowing the Challenge Owners to focus their time on other pertinent and important NASA tasks and on the key part of the pilot program: solutions evaluation. The success of each of the Challenges was improved greatly by the professional support from InnoCentive's Client Services team in applying their extensive experience and skills in Challenge Driven Innovation methodologies to supporting NASA, the Challenges, and the Solvers. During the posting period, Challenge Owners were freed to address NASA specific tasks thereby increasing the opportunity for successful programs. Additionally, legal resources from NASA were not required to create the contracts and agreements with the Solvers, resulting in significant cost savings to NASA.

The value of the program is shown by the response to the solutions awarded. Challenge Owners provided direct feedback regarding the solutions provided by winning Solvers. The comments on winning solutions included:

NASA Challenge: Improved Barrier Layers … Keeping Food Fresh in Space

Challenge Owner's comments regarding Yuri Bodrov's partially awarded winning solution:

> *"The idea of using graphite foil as a barrier layer in packaging films is very novel and could provide the barrier requirements needed by NASA. Although it will not provide a transparent material, which is a preference for space food packaging, it could help with some other issues such as incineration. The thinnest foil listed on the specification is slightly thicker than the one currently used in NASA packaging and would have to be evaluated in a laminate made specifically for space food packaging. We would have to confirm that the laminate would not delaminate during the processing of the food and that the laminated material would not flex crack. We understand that the barrier properties are excellent but we would need to test the material for the actual WVTR and OTR prior to use in our NASA missions."*

NASA Challenge: Data-Driven Forecasting of Solar Events

Challenge Owner's comments regarding Bruce Cragin's fully awarded winning solution:

> *"The submission was very thorough. It addresses the Challenge requirements and exceeds them with respect to forecast confidence and to random prediction. Questions posed back to the Solver were thoroughly addressed. This solution holds promise and the Seeker is highly interested in working with the Solver on potential implementation into an operational framework. It appears that the Solver is from within the Heliophysics community. This submission is approved."*

NASA Challenge: Mechanism for a Compact Aerobic and Resistive Exercise Device

Challenge Owner's comments regarding Alex Altshuler's fully awarded winning solution:

> *"A very well outlined proposal, the information on sizing and trades for loading versus mass were well described. Vacuum systems require a steady atmospheric pressure so there is some load variation but the Solver did at least use ISS min pressures to size the device and did a good job designing the sliding friction seal interfaces. It is an advantage that the device can perform concentric and eccentric or concentric only exercises. This proposal technology will need to be built, bench-tested and evaluated to determine the full benefits of the solution."*

NASA Challenge: Coordination of Sensor Swarms for Extraterrestrial Research

Challenge Owner's comments, in order, regarding the partial awards to the Simone Sergi, Fabrizio Invernizzi, and Tad Hogg:

"An interesting concept presented is the Game-Theory communications algorithm: 'learning what your neighbors are doing.' It would be interesting to learn more about this algorithm and the expansion of the concept beyond communications, to areas such as data sharing, decision making and such. Issues would include: how does this scale? How does it handle 'jammed' areas (lots of nodes in a small geo-spatial area)? - Provides comprehensive solution to optimal deployment of sensor network."

"This solution defines a behavioral characteristic, 'shyness' for optimally distributing sensor network where shyness results in 'uncrowding' of the distribution and is worth establishing contact with the Solver. - Lacking somewhat in details, compared with other winners. - The 'Shyness' idea is interesting."

"A well written paper, compared to other submissions, which presents a good overview of the problem and presents a structured, engineering analysis of the possible solution space. The pre, during and post deployment phases were interesting and well understood, and provides a notion of how imaging might be achieved. Has clear understanding of and meets the requirements of the call."

NASA Challenge: Simple Microgravity Laundry System

Challenge Owner's comments regarding Alex Altshuler's partial award solution:

"The Solver proposes a fixed roller wringer and a continuous ring bag that moves and has a built in three way toggle valve. Concerns would be even loading such that pockets of clothing did not cause jamming. Additionally assuming the clothes are uniformly loaded is not accurate and there will be many inter-voids of clothes and bag that will increase the water/clothing efficiency and ability to extract water during the draining. These can become free water when the bag is open. More details or calculations of how the bag can have both sufficient friction to be pulled by the rollers and low enough friction to slide around in a square."

NASA Challenge: Augmenting the Exercise Experience with Audio/Visual Inputs

Challenge Owner's comments regarding Dave McMahon's partial award solution:

"Solver showed excellent grasp of problem as well as experience in producing 'point of view' video for multiple sports, including with elite athletes. The proposal covers a wide range of potential applications. Solver has an excellent sense for video composition and effect of natural environment and the psychology of isolation and confinement. The Solver, however, did not meet all the requirements to provide a system. Such as, how the components would be integrated, how it would interface with other systems, and the collection and storage of data."

NASA Challenge: Medical Consumables Tracking

Challenge Owner's comments regarding Milan Stengl's, Dan Winkelman's and Joel Niederhauser's partial award solution:

"Overall the best proposal received, but it did not merit a full award because of concerns over mass and volume (requirement #6) and the possibility that the person accessing the

medication may intentionally misidentify the end user (requirement #4). Using RFID in a blister pack with an electrical conductivity option or backup was novel and elegant."

"The submission addressed the problem in a manner that was different than the vast majority of proposals received; that was good. There are concerns about requirements though, such as, the ability to detect amount used is a concern. The concept of the aluminum box with springs is unquestionably robust, and gravity independent, but is likely to be much bulkier than would be indicated by the requirements."

"While the solution was relatively simple, which is good, the concept presented about providing the data to a physician were sketchy, and viewed to be less than reliable in NASA applications. Therefore, several requirements were partially met at best."

In summary, the full and partial awarded solutions have been utilized by the development teams as unique approaches for consideration or solutions to immediately prototype and test. The two fully awarded solutions offer the full benefits of Challenge Driven Innovation: a highly valued solution in a rapid and parallel process. The partially awarded solutions offer insights to be explored and the opportunity for NASA to build relationships and further develop the concepts with the Solvers validated through the InnoCentive verification process. A unique value is created for the NASA Pilot Program Challenge Owners through not only the solutions, but the identification of new collaborators found throughout the diverse open innovation marketplace.

B. Solver Diversity

In total, the seven Challenges attracted over 2,900 Solvers from over 80 countries as shown in the map below. The NASA Challenges averaged 419 Solvers per Challenge; a typical Theoretical-IP Transfer Challenge attracts an average of 381 Solvers. This represents a 10% increase in Solver interest over a typical InnoCentive Challenge of similar scope.

NASA Challenges were of high interest to the InnoCentive global Solver community and Solvers were clearly not intimidated by the difficulty of these problems. The high interest did translate, more importantly, into solutions being submitted. A total of 221 solutions were delivered to the NASA Challenge owners for evaluation. These solutions came from a diverse and global (30+ countries) community. The Solvers' unique view of the Challenges, in light of their experiences and background, provided the open innovation pilot program many solutions to consider.

C. Challenge Owner & Sponsor Feedback

The Challenge Owners from the seven pilot program Challenges were asked a series of questions during a 60-75 minute closeout interview by Cynthia Rando of Wyle and Steven Domeck of InnoCentive. The questions ranged from general in nature, to inquiry on the process steps, and results specific to the Challenge.

General

The general questions were targeted in an effort to frame the length of time the Challenge had been a problem, how critical it was, and what other means had been used to solve it. Five of the seven Challenges were in a significant technology gap area identified during the portfolio mapping exercise by NASA SLSD, which was facilitated by Dr. Gary Pisano at Harvard Business School. These gaps represented problems that the teams had, in some cases, been working on for many years. In the case of the Forecasting of Solar Events Challenge, it was a 30 year old problem. These Challenges represented a significant value opportunity if solved or advanced in a unique direction not previously considered. The sixth Challenge was a collaboration between Johnson Space Center and Glenn Research Center for exploration of methods to track medical supplies in space and had been deeply explored through traditional NASA trade studies over the last 18 months. The seventh Challenge, Sensor Swarming

submitted by Langley Research Center, was dissimilar and provided a unique opportunity to test the use of Challenge Driven Innovation in a relatively green field of research looking for a possible new and lower cost direction to complete exploration initiatives. The Challenge owners for this Challenge felt that this was a good topic to "get out there" and see what other people have done in this area. It resulted in bringing unique approaches, and ultimately new Solver community connections, in a field of research that NASA is growing into.

Apart from the Sensor Swarming Challenge, each Challenge had used other methods to solve the problem, including SBIR's, academia, internal resources, consultants, and research institutions. The Challenges had found technical gaps, extended timelines, or burdensome processes by other means. The Pilot Program directed the Challenges to the core of the problem and clearly defined success criteria which reduced complexity and noise (unfocused solutions) in the process of finding solutions.

Process

The process questions were designed to gather insights as to what worked well and what are areas for improvement. A universal strength identified by the Challenge Owners was the guidance, Challenge writing, and program support by the InnoCentive Innovation Program Managers (IPM's) throughout the Challenge lifecycle. This included answering and screening questions from the Solver community and providing a first pass review of the submissions received. Challenge owner DeVon Griffin noted that with his IPM (Mike Albarelli) handling extraneous details, his burden was lifted to attend to technical aspects that only a NASA person can address. The time invested by Challenge Owners and their support team in the CDI Platform supported through InnoCentive ranged from 50 to 140 hours over the six month Challenge period. This time investment was considered to be minimal, and is projected to be significantly reduced during the next Challenge. In summary, the process strengths included the speed at which solutions were found and the time involved in the process.

Challenge Owners expressed mixed feedback regarding the submission evaluation process and the evaluation scorecard. The standard format provided was a valuable starting point but viewed as not optimal for the NASA specific requirements. All agreed that a NASA specific document could be created to enhance the process of evaluations and the standardized format feed directly into the NASA Review Panel. NASA provided a review panel staffed by the Director of SLSD, Innovation Program Managers, NASA Legal, and an ad hoc member for the Challenge Owners to present their findings and review of award criteria. This gated step was generally seen as an important step to keep in place.

Process improvement areas to consider beyond the Pilot Program include creating a template for Solvers to follow to standardize what the Challenge Owners need to evaluate. In some

cases, dictating a page limit to encourage concise descriptions of the solutions should be considered for future Challenges.

Results

Finally, the results questions were asked to frame the quantitative and qualitative outcomes from these Challenges. Each Challenge produced an award for a valuable solution. A discussion on the details of these results can be found in the NASA public report.

In summary, the results show that all seven NASA Challenges found solutions to award, either fully or partially. The solutions contribute to closing the NASA technology and knowledge gaps and the results further documented as testing and validation continue over time.

The Executive Sponsor and the Program Champions were also interviewed to gain their high level input into the results of the program. A 60-minute closeout interview by Lisa Reinhold of InnoCentive was held with Dr. Jeffrey Davis, Dr. Jennifer Fogarty of NASA JSC, and Cynthia Rando of Wyle. The questions were designed to garner insights as to the CDI Pilot Program supported by InnoCentive and whether it was meeting the objectives of the program team and the future direction of the program.

It was clearly understood that the program had succeeded at addressing NASA Challenges and supporting the cultural acceptance of open innovation tools. On a strategic level, success is shown in the visibility from GSA, the White House, and NASA Headquarters adopting the language of open innovation.

NASA and InnoCentive formed a cohesive team that effectively managed the day-to-day aspects of the Pilot Program. The frequent communications, planning, and in-process adjustments were keys to the success of the program.

Training provided over longer stretches of time and available in various mediums such as video, WebEx, mentoring, and on-site was seen as an area to enhance the program going forward. Focused adjustments in process, documentation, and IP options will benefit the program as it continues to develop.

In summary, it is seen that NASA had successfully added to their business model in opening up the Solver space. The expansion of NASA problem solving capability is enhanced by adding an effective tool such as InnoCentive's Challenge Driven Innovation Platform.

D. Solvers Survey Data

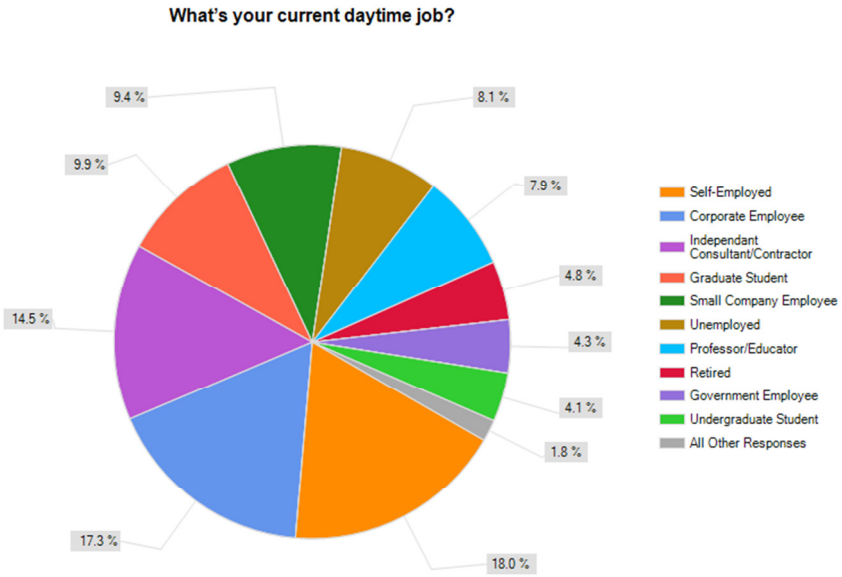
Summary of Key Findings

As mentioned earlier, NASA Solvers are *very* engaged (10% more Solvers opened Project Rooms for NASA Challenges than the average InnoCentive Challenge). Likewise, we received 493 responses to our survey, representing a 17% response rate, which is significantly higher than the average 4% rate for most surveys. (Please note, a drawing to win a Kindle™ for Solvers that completed the survey was offered.) This high level of responsiveness stands out in its own right: Solvers are genuinely and consistently intrigued by, engaged, and interested in contributing to NASA-oriented activities. Below is a summary of our learnings, followed by the data and analysis:

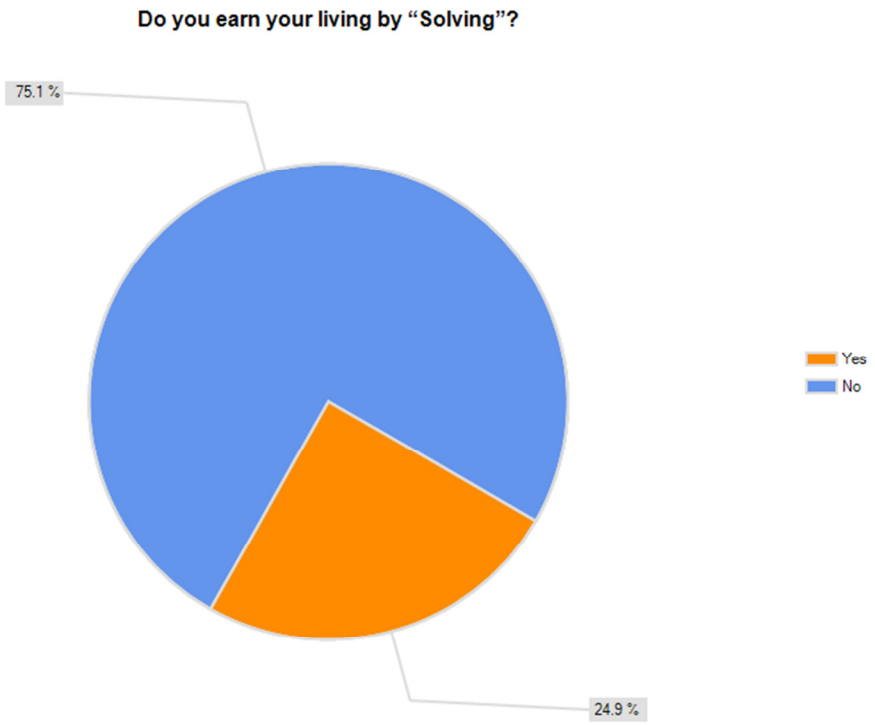
1. A relatively high percentage of respondents (one in four) revealed that they *solve* for a living, which suggests winning solutions are often found outside the traditional corporate workplace.
2. A significant number and percent of NASA Solvers, and winning Solvers, reported that their expertise is not directly within the Challenge discipline, which reinforces the value proposition of *diversity* in solving NASA's Challenges.
3. Although NASA Solvers by and large had not attempted to solve government Challenges prior to the NASA Challenge, a full 98% of NASA Solvers would like to work on more NASA Challenges in the future.

Employment

The survey found that 50% of NASA Solvers that opened project rooms are self-employed (18%), independent consultants (14.5%) or corporate employees (17.3%). A further 14% are graduate students (9.9%) and undergraduates (4.1%).

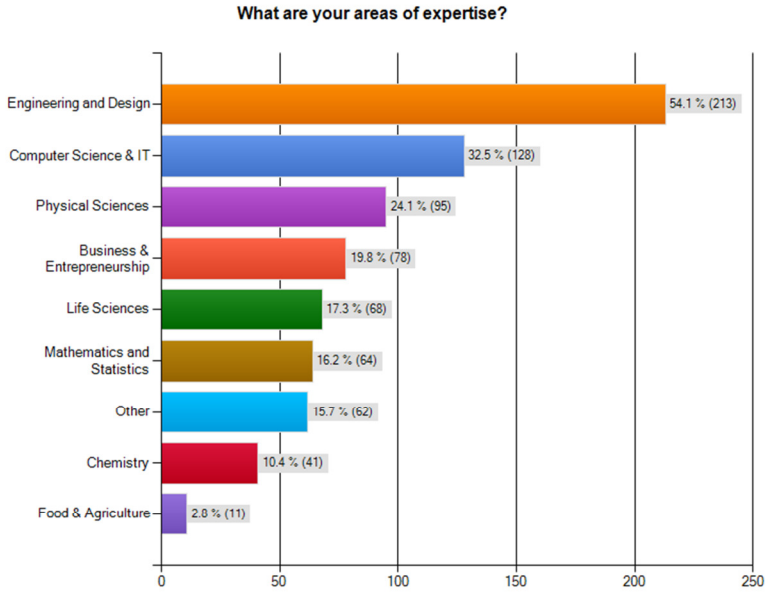


One in four (24.8%) NASA Solvers reported earning their living by "Solving" (as a distinct work activity), which suggests that many solutions are to be found outside the boundaries of the corporation.



Expertise & Relationship to the Challenge Discipline

NASA Solvers possess a wide range of expertise, with half reporting a background in Engineering and Design and more than 33% reporting expertise in Computer Science & IT.

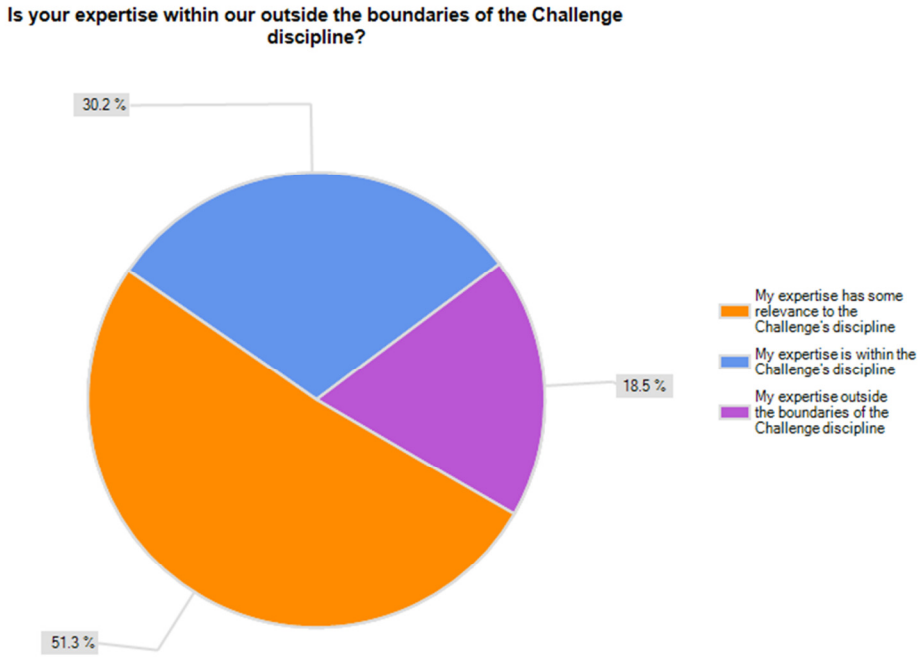


Almost one in five (18.5%) of NASA Solvers reported their area of expertise was outside the boundary of the discipline of the Challenge they worked on, and about half of NASA Solvers (51.3%) reported their expertise had some relevance to the Challenge's discipline.

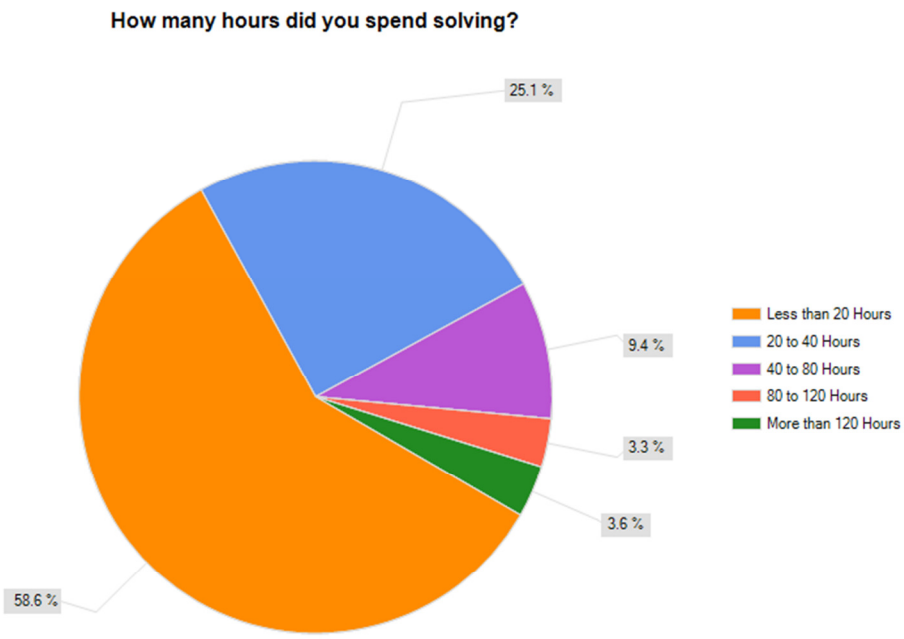
These findings provide strong evidence that interest and quality solutions often come from the edge of a Challenge area, which provides strong support for the practice of looking beyond traditional teams or specialists for solutions.

A further 30.2% of Solvers reported their expertise was within the Challenge's discipline.

Of the winning Solvers that have been interviewed to date, three out of four reported their expertise and background was not specifically relevant to the Challenges they won.

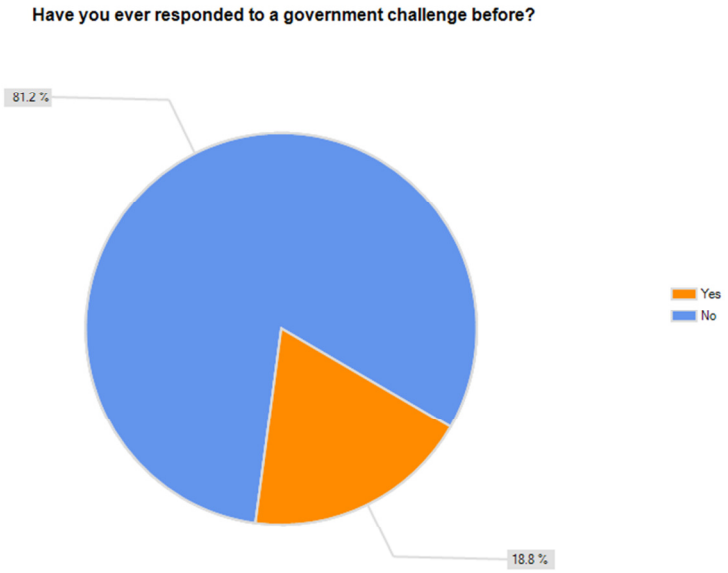


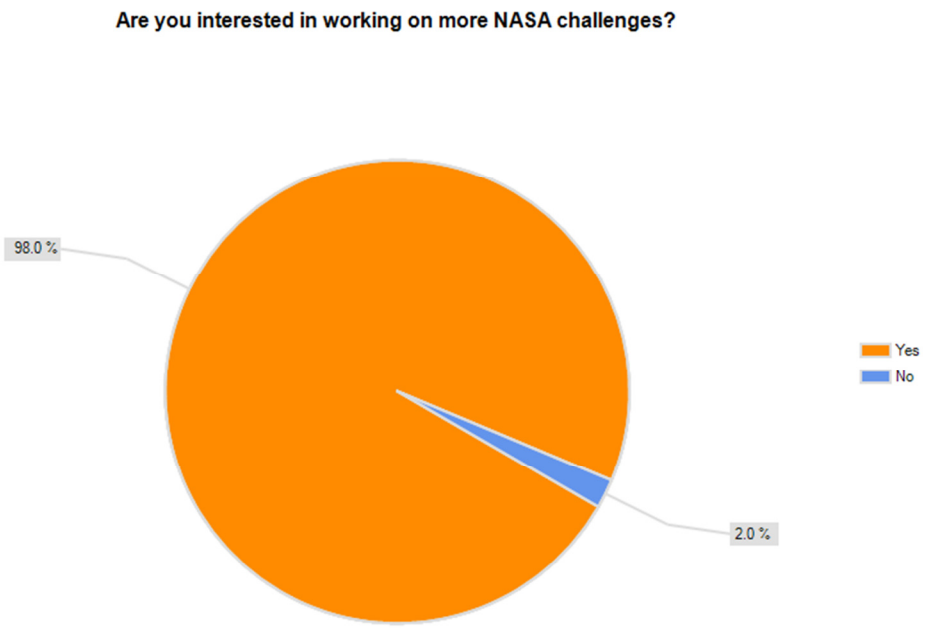
While almost 60% of NASA Solvers surveyed reported spending less than twenty hours working on a solution, 16.3% spent more than forty hours, of which 3.6% spent more than 120 hours. Utilizing the hours estimated by the 394 survey respondents only, the responding Solver community invested over 82 man-months on the seven NASA Challenges. Considering the results of the Challenges were delivered in only 10 months, the Open Innovation Marketplace of InnoCentive delivered significant value to the NASA Challenges.



Solvers' Experience with Government Challenges

Most NASA Solvers that were surveyed reported they had never responded to a government Challenge before (81.2%), but nearly all reported they are interested in working on more NASA Challenges (98%), suggesting a very positive experience with the Challenges and the processes, which is borne out in the next section.





E. Human Interest Stories and Awarded Solver Data

How does it feel to win a NASA Challenge? The human interest stories of Solvers from around the world provide a fascinating insight into the mind of an innovator and the effect these Challenges have to the image of NASA and possibly other government agencies. These stories are told due to the transparency of NASA, the invitation to participate in a meaningful way, and the power of Challenge Driven Innovation.

Yuri Bodrov, partial award winner of the "Improved Barrier Layers" Challenge

Yury Bodrov, from St. Petersburg, Russia, has been a Solver since 2006 and had won 9 awards before the NASA Challenge.He found the NASA Challenges while browsing new Challenges on the InnoCentive website.

He said the ideas for solutions to three Challenges came to him immediately as he read the detailed descriptions, and he decided to work on all three ("Improved Barrier Layers," "Mechanism for a Compact Aerobic and Resistive Exercise Device," and "Medical Consumables Tracking". He "transformed" his ideas into solutions over time, working about 40 hours on each solution.

Yury was not sure of his success, but he said that having NASA scientists evaluate his work was his primary motivation: "When I was a boy, we heard lots about NASA and space travel in Russia. I always thought it is the greatest direction and exploration in science and that it was the best way to bring people together from around the world. I dreamed of NASA from childhood, like kids everywhere. I was very excited to do work for this kind of organization."

Yury was most hopeful about his solution for the "Improved Barrier Layers" because he felt strongly that it was a "novel and competitive approach" to the Challenge. He had heard of using graphite-based materials

for holding volumes but never for this particular application, but he felt it was a perfect match for the Challenge requirements.

Yury remembers the feeling when he learned his solution was a winner: “I felt a wholeness… It was very exciting. I’m married and have two children (2 months and 7 years). I was hopeful but not completely sure about success. I told my friends and they all were very excited for me and gave big congratulations! It was a dream to be recognized by the scientific level of NASA quality.”

Yury rated the “Improved Barrier Layers” as a 3 out of 5 in difficulty, and he believes his educational experience (organic chemistry) is far from the boundary of the Challenge, and he explains that his wide and varied work experience has provided him with many different perspectives, which he believes helped him see the solution immediately.

Yury felt deeply rewarded by the experience on a professional level because of his high regard for NASA science, and on an emotional level because of his lifelong interest in NASA and space Challenges and the quest for human meaning. And he really enjoyed winning the money. He said the experience—and winning—gave him “confidence in my own possibility as I try to develop activity in my own science projects in nano-technology. I need good equipment and a better lab, which I don’t have today,” he said, “but the NASA Challenge gave me great confidence.”

Dave McMahon, winner of the “Augmenting the Exercise Experience with Audio-Visual Inputs” Challenge

Dave McMahon had the perfectly prepared mind for NASA Challenge # 9455001.

The phone rang late Sunday night. “Hello?”

“Dave— we all know how you like a Challenge …check out this website.”

“A Challenge?” asked Dave? “What do you mean?”

“Yes, a $20,000 Challenge. Go to www.innocentive.com, and navigate to the Challenges section. There’s a NASA Challenge that is out of this world.”

That was just over a week before the submission deadline. Dave hung up and read Challenge #9455001’s title, “Augmenting the Exercise Experience with Audio-Visual Inputs.” - very cool!

Dave reviewed the Challenge overview, registered on InnoCentive—he’d never heard of the company—and signed the NDAs and agreements that night so he could delve into the Challenge details.

One week later, after spending 20 hours in fits and starts, Dave submitted the winning solution.

“I did a competitive analysis right away—wanted to see who my competition was going to be for this. I included the analysis in my solution, actually; I had a pretty good idea that major film companies could do it, but it would cost them a lot because the various resources they’d need would be spread across their organization—it’d also be too hard for them to coordinate resources in such a short timeframe. I also figured someone in academia or a hardcore science field might have a shot, but they might have problems with the IP piece of the Challenge—might be hard for a professor or scientist to sign IP away. So I figured I had a sixty to seventy percent shot.”

Dave earned a Bachelor of Computer Engineering from Royal Military College of Canada (RMCC). His day job is senior engineer for a large Canadian comapny—he’s been a practicing engineer for twenty-five

years. He is married and the father of two college-bound children. He has a couple hobbies: Independent Film Company and Sports Coaching. He picked up an interest in photography and film production during college, and he has apprenticed and honed those skills over the years. Dave also happens to love sports—in fact he's a Canadian national biathlon champion, elite skier and trail runner…and competes professionally today.

At night when he gets home from work his 'real' day begins: Dave and his wife (a two-time Olympian champion—yes, biathlon—and science teacher by day) own and operate XCZone.tv, their brain-and-passion child, which produces "a wide-variety sports specific products for home DVD and broadcast…and is a trusted source for instructional and motivational sports multimedia."

"The Challenge was in my sweet-spot—engineering, athleticism, and cinematography. And now, an opportunity presented itself to combine these disciplines for something very special. We knew NASA was interested in our industry but there's never been a way for me to approach them—we're a boutique shop in Canada!"

"We did it for the prestige, for starters: NASA represents a certain hope and belief around space and exploration. It's a human cause. Just like we'd be interested in water in Africa, or health and fitness for youth; everyone can get behind NASA."

"Was I surprised I won? Well, yes, naturally; but I was even more surprised that it happened so quickly! Governments usually take years not months! That was the real surprise; impressive!"

"The one thing I would have liked would have been a little direct contact with NASA around the Challenge details so I could ask questions of clarification during the formation of the bid. For example, the NASA Challenge said, 3D goggles are available off-the-shelf…No they aren't. But I worked around it."

"Our 'secret sauce' is about combining very disparate skills, interests, and fields into a commercial space where we can be very innovative and help others push their limits in the fields of sports, measurements, and visualization. NASA was looking for that because they are doing very innovative things themselves. Our worlds collided on InnoCentive."

Alex Altshuler, winner of the "Mechanism for a Compact Aerobic and Resistive Exercise Device" and "Simple Microgravity Laundry System" Challenges

Alex Altshuler likes to solve problems. He heard of InnoCentive about 4 years ago and joined right away. He logged in frequently to scan Challenges and get a feel for what was out there. e opened Project Rooms regularly so he could view Challenge details, and he even submitted a winning solution. He continued to scan Challenges over the next few years and then he came across the NASA Challenge, "Mechanism for a Compact Aerobic and Resistive Exercise Device, " and he was hooked all over again.

"The problem," says Alex "was not at all in my area of expertise. I mean—I'm a mechanical engineer, but I work at a company that develops scanners for laser beam scanning technology. I've never worked on exercise devices! I knew nothing about them—I had to look on the web to learn the basics. I didn't want to re-create the wheel!"

Altshuler, who was born in Leningrad and now lives in Massachusetts, believes there is a lot of value to being an outsider: "If you're an outsider, you can suggest new ways of looking at things, you can develop a novel solution. I would rate the difficulty of the Challenge a 3 out of 5. It wasn't such a tough Challenge,

but it was very interesting. I think I used a lot of high school physics and my studies in mechanical engineering. For me the big thing was that the Challenge was so well written, it made me feel like I might be able to solve it! In total, I spent about 45 hours on the Challenge."

"What I've always loved about NASA is their broad approach to developing different technologies, which may have an application in the future. NASA symbolizes a way of progress and there's lots of innovation in what they do.They cover a lot of different directions. NASA encompasses everything. I think it's impressive."

Winning the Challenge impacted his thoughts about submitting another Challenge with NASA. It gave him a lot of confidence to submit his solution for the "Simple microgravity laundry system!"

Addendum: Additional insights from Alex after he won his 2nd NASA Challenge

Winning the "Mechanism for a compact aerobic and resistive exercise device" Challenge gave Alex confidence in the open innovation platform, in NASA's ability to define and evaluate Challenges and solutions, and in his own abilities to spot and work on problems in his comfort zone.

The "Simple Microgravity Laundry" Challenge was in his comfort zone in the same way the first Challenge was, which is to say he used his training and expertise in mechanical engineering to develop his views and solutions; however, these Challenges were quite distant from his career work experiences and work products, and he readily revealed he spent several hours researching various aspects of the "Simple Microgravity Laundry" Challenge on the Internet, which gave him a level playing field of information from which to draw.

Alex also indicated the research study provided by NASA in the Challenge details (*Laundry Study for a Lunar Outpost*, by Ewert) was extremely useful background, which gave Alex further guidance around what NASA might have previously considered.

As with the first Challenge he won, Alex reported his main attraction to this Challenge was how well it was defined. "Nothing was impossible to know with this Challenge. It was simply a well-defined problem within my area of expertise."

He rated the "Simple Microgravity Laundry" Challenge a 4 for Difficulty (on a scale of 1 to 5), compared to the 3 he rated the "Mechanism for a compact aerobic and resistive exercise device" Challenge. He also said he worked about 45 hours on this solution—about the same amount of time he spent on the "Mechanism for a compact aerobic and resistive exercise device" Challenge.

Bruce Cragin, winner of the "Data-Driven Forecasting of Solar Events" Challenge

"Data-Driven Forecasting of Solar Events" was a case of right-place-right-time for Bruce Cragin and the NASA Challenge he solved.

Cragin earned his BS in Engineering Physics and his PhD in Applied Physics. He has 15 years experience in space plasma physics basic research and another 13 years of industrial experience as an RF engineer. He's also a licensed PE in Michigan.

The Challenge was "right in the sweet-spot," Cragin said, referring to the fact that the Challenge and solution were within his areas of expertise and skill set. "Though I hadn't worked in the area of solar physics as such, I had thought a lot about the theory of magnetic reconnection. Also, the image analysis

skills I acquired in the 80's, while looking into something called the 'small comet hypothesis,' turned out to be very useful."

Bruce had been an InnoCentive Solver for 3 years, but "I think I saw the Challenge first in the form of a Facebook news update. It's amazing what you can find on Facebook these days!"

"I enjoy building computer models, and knew enough of the relevant plasma physics that I felt I had a better chance of solving it than any of the non-physicist data analysts toward which the Challenge appeared to be targeted. The money was attractive and I thought I had a good chance of winning."

"My graduate work at UCSD was supported by a research assistantship funded by the Air Force Office of Scientific Research, and in my first career as an academic research scientist I was supported by various NASA and NSF contracts and grants. Without that investment by AFOSR and other federal agencies, my solution to this Challenge would probably not have been out there for 'crowd sourcing' to find. The various federal agencies that support basic research in the academic community play a crucial role in insuring our country's future. I fully support the President's efforts to re-invent government, and have no doubt that he will continue to be a strong supporter of basic academic research in addition to exploring these new approaches."

Bruce says he didn't keep track of the amount of time he spent, "but it could well have been 200 – 300 hours."

Winning the Challenge, "motivated me to attend a conference recently, a Space Weather Enterprise Forum held at the National Press Club in June. Space weather is a field that has really come into its own, I think. Many of the pioneers of the field were there, folks who were emphasizing its importance long before it became fashionable. And the breadth and quality of representation from the US and foreign governments and industry really impressed me."

"Another effect was that the NASA Challenge focused my attention on predictive modeling. That led to another Challenge involving Maize Genetics to which I also submitted a solution, and became a finalist. The computational tools acquired in that work are now being applied in two additional Challenges, both genetics-related."

Milan Stengl, winner of the "Medical Consumables Tracking" Challenge

Milan Stengl spent his first thirty years living in his home country of Croatia, "which, in the 1960s, was wedged right in between the East and West and was pretty much frozen during the Cold War."

"My father was a superb Mechanical Engineer, and I admired him. My inclination to science and technology comes from his influence while my love for electronics comes from my uncle. Growing up, our family was very pro-American—the whole nation was—and there were many reasons for this, political and cultural. When I was a child I would go to the American Embassy after school let out. The Embassy had a strong cultural section with the Library and Media rooms where I would pore over my favorite publications, like Popular Mechanics, Popular Science, and Popular Electronics. I first learned of NASA through conversations with my father and uncle, but it was during those after-school sessions in the Embassy when I really got infatuated with the US Space Program and started realizing what a huge impact it had on all of our lives and the science in general."

At the age of 33, Milan moved to the south of France, where he worked as a Network Engineer at Nortel Networks' EMEA operations. It was there he met his wife, a transplanted American from New Jersey. A few

years later, when they had a family of their own, the couple moved to the USA to be closer to the American part of the family.

"The move to the States was inevitable, I suppose," Milan says looking back. "It was like I was finally coming home in a way. During my childhood and as a young adult, thoughts and conversations about America were part of our daily lives. For a boy my age, the US Space Program and NASA's achievements made me want to learn English and all about the US—in addition to the math, physics, and science." Even though very small, Croatia has always been an industrial nation but coming to the US was exciting from professional perspective as well. I was secretly hoping that some day I could participate and give a contribution to that great world of science that existed here. Even the slightest possibility to be involved in anything related to NASA or the Space Program would be a dream comes true.

Milan found the NASA Challenges when he was browsing the Internet: "I was in the process of researching new approaches to consulting, project-based business models, and innovation. Several of the blogs I visited mentioned InnoCentive as a leader in a new approach to innovation, so I decided to check it out."

"And they were right: InnoCentive's model is brilliant! When you put so many people together, you will find the solution to almost anything. Then I found the NASA Challenge and I figured if NASA was running Challenges on InnoCentive, I was interested."

Milan found several projects that interested him, but the "Medical Consumables Tracking" Challenge was too good to pass up because it was at the heart of his passion around bio-medical electronics.

"There is no way I would have found this kind of Challenge working anywhere else. More than money and the award, it was the idea that my solution could help a little in NASA's program—it would be incredible."

"I can tell you precisely what drew me to this Challenge: I loved the description and presentation of the problem! They chose the words well, it was clearly written, and the Challenge web page had a very captivating image. The whole package was superior, really, with clear bullets about what they wanted and expected. It was worded unambiguously, like an exam! Many problems you find on the web are vague, and you feel the Seeker doesn't know what they are looking for. NASA, of course, had a good idea."

"I also received excellent feedback from InnoCentive (I think part of it came from NASA), where it was suggested to combine my three approaches into a single solution and explain it in detail. That made a huge difference."

"All together, the whole process took two weeks (about 50 hours in total). The real work was in the evening after work, five days in a row. They only asked for the idea, but I also presented basic circuits and drawings, what chips I would use, and so on. I gave a kind of a draft of the solution, to show it was not fluff. My wife didn't know exactly what I was working on (I didn't tell her—hoping it would be a crazy surprise if I won) but she was happy to "give me" the time to do it. She could see in my eyes - how happy and excited I was about the Challenge."

V. Value of InnoCentive's Challenge Driven Innovation Platform

The Challenge Owners, Executive Sponsor, and Program Champions describe six major benefits that they received from the use of InnoCentive's Open Innovation Marketplace. In conducting the research and Challenge owner interviews, it was found that NASA achieved:

1. Cost savings associated with new and rapid problem solving techniques
2. More effective use of established resources
3. Increased diversity of thinking through access to an expanded network of experts
4. Efficient process for Intellectual Property transfer
5. The fostering a more innovative culture
6. Improved ability to frame problem statements or research needs

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"Creating a culture of innovation requires the creation of 3 portfolios – a portfolio of Challenges, a portfolio of solutions, and a portfolio of projects. When done properly, these can help make your organizations more nimble."
Dwayne Spradlin, CEO of InnoCentive

Additionally, through the Challenge Owner and Program Team interviews, NASA identified the following benefits of using the InnoCentive's Challenge Driven Innovation Platform. Although, not quantified, the benefits are shown throughout the pilot and may have lasting impact.

Enhanced ability to define and frame research Challenges for outside solution finding.

NASA Challenge owners were assigned an InnoCentive Innovation Program Manager (IPM) to learn best practices for Open Innovation, Challenge Development, and the process for finding solutions in the global innovation marketplace. Through the workshops, professional development and training, and one on one consulting, InnoCentive helped NASA with their approach and ability to frame research problems outside of the traditional "NASA way."

An example of the enhanced ability and importance of properly defining and framing research Challenges can be highlighted from an awarded Solver interview. The new Solver noted that his interest in answering (and ultimately winning) the NASA Challenge peaked when he saw how clearly defined and well written the Challenge statement was, a consistent theme among all winning Solvers. The Solver noted that the description, requirements, and success criteria were very well articulated and it included areas to steer clear. As a participant in Challenges on other

open platforms he had been frustrated by the unclear requirements and vague description of the prize; this does not provide inspiration or confidence that the Seeker knows what they want.

Efficient IP Transfer Process

InnoCentive worked with NASA upfront regarding Solver community agreements for confidentiality and transfer of Intellectual Property. NASA resources are then no longer required to spend the time and effort on the legal processes and regulating and transferring IP rights for a solution.

Culture of Innovation

The NASA community and Challenge Owners as a whole agreed that, through this process, innovation is a priority. The foundation for creating a repeatable and predicable innovation mindset comes through a structured methodology. The NASA Open Innovation initiative is supported by enthusiastic individual team members that are creating an environment that promotes involvement and inspires. Ultimately, the system of innovation is built on the ability to proactively surface, prioritize, and frame Challenges. Once this cultural mindset is established, NASA will be able to leverage every means of finding powerful solutions through open innovation.

VI. Lessons Learned During Pilot

Lessons Learned:

1. ***Clear Solver agreements and communication regarding NASA contractor or related civil servant participation is required.***

   During the Phase 1 Challenges and specifically the Compact Aerobic Exercise Device Challenge, clear communication / delineation of eligibility requirement with NASA contractor personnel was identified as a concern. It was felt that the language in the Challenge statements to address eligibility was not robust; thus resulting in potential conflict of interest and ownership disputes. To address this concern more clearly in the Phase 2 Challenges, the following language was created by NASA legal and inserted into each Challenge description:

   NASA Employees are prohibited by Federal statutes and regulations from receiving an award under this Challenge. NASA Employees are still encouraged to submit a solution. If you are a NASA Employee and wish to submit a solution please contact InnoCentive who will connect you with the NASA Challenge owner. If your solution meets the requirements of the Challenge, any attributable information will be removed from your submission and your solution will be evaluated with other solutions found to meet the Challenge criteria. Based on your solution, you may be eligible for an award under the NASA Awards and Recognition Program or other Government Award and Recognition Program if you meet the criteria of both this Challenge and the applicable Awards and Recognition Program. If you are an Employee of another Federal Agency, contact your Agency's Office of General Counsel regarding your ability to participate in this Challenge.

   If you are a Government contractor or are employed by one, your participation in this Challenge may also be restricted. If you or your employer receiving Government funding for similar projects, you or your employer are not eligible for award under this Challenge. Additionally, the U.S. Government may have Intellectual Property Rights in your solution if your solution was made under a Government Contract, Grant or Cooperative Agreement. Under such conditions, you may not be eligible for award.

   If you work for a Government Contractor and this solution was made either under Government Contract, Grant or Cooperative Agreement or while performing work for the employer, you should seek legal advice from your employer's General Counsel on your conditions of employment which may affect your ability to submit a solution to this Challenge and/or to accept award.

2. ***Additional evaluation process training and support was required for Challenge Owners. An Evaluation Workshop was conducted for all Challenge Owners approximately 2 weeks prior to the Phase 1 and Phase 2 Challenge posting deadlines.***

   The InnoCentive ONRAMP professional development and training covering the Challenge process was provided to NASA and the Challenge Owners in November 2009. It was found by the NASA Pilot Program team that additional / refresher training was necessary to educate and remind the Challenge Owners of the expectations, timeline, and process requirements for evaluating submissions and making awards. The InnoCentive team worked closely with the NASA Pilot Program team to develop material consistent with the process requirements established for NASA. The training included best practices for making awards, presentation of the evaluation worksheet, and training on the use of the InnoCentive platform for the

management of submissions. These events, held via WebEx, were found to be very effective and valued by the Challenge Owners and their evaluation team.

3. ***Scheduling difficulty between the Challenge Owner and InnoCentive's Client Services (IPM's) to coordinate the initial scope of Challenge.***

   The timing and schedules for Challenge Owners and IPMs proved difficult at times during tight deadlines and schedules. Additionally, certain Challenge Owners provided more detail and pre-Challenge definition than others causing delay in coordinating the launch of Challenges in parallel. Better up front planning and communication of timelines was incorporated to help alleviate this issue.

4. ***Process standards for approval to notify Solvers of NASA Challenge Awards.***

   InnoCentive provides a convenient on-line communication and tracking tool for Challenge Owners to document their rejections and awards made to the submissions received. InnoCentive's standard process is to notify awarded and rejected Solvers once completed by the Challenge Owners in the password protected system. The NASA Pilot Program team has established an effective Review Panel as a process gate for the Challenge Owners to receive final approval on their awards and rejections made. hese Review Panels were scheduled anywhere from 1-2 weeks following the Challenge Owners' decisions after evaluation. InnoCentive sent notification of awards to Solvers prior to the completion of the NASA Review Panel based on the completion of rejections and awards on the website. Immediately following the discovery of this issue, InnoCentive instituted a final confirmation for notifying awarded Solvers to come centrally through Cynthia Rando to ensure the proper steps had taken place. Further, the importance of the NASA Review Panel was emphasized with the Challenge Owners during the Evaluations and Best Practices training prior to the submission review period. No further issues surfaced after these measures were put in place.

5. ***Challenges can compete for Solvers and awareness for Challenge awards.***

   The Data-Driven Forecasting of Solar Events Challenge was initially felt to be negatively affected by the posting of a similar "competitive" Challenge on the InnoCentive Marketplace. This was hypothesized due to the high engagement of Solver project rooms (570), yet low solutions submitted (4). The similar Challenge would draw the type of Solver NASA was targeting, but benefit from their time due to the $100,000 award versus the $30,000 for the NASA Challenge. Although this factor should be considered when selecting an award level, it was found that NASA holds a unique advantage over other Challenges in attracting quality Solvers. NASA's brand and the advantage of having solutions reviewed by a NASA scientist and contributing to the exploration of space was expressed by the Solver community, through the post Challenge survey, to be a larger motivator than the award alone. In the end, with just 4

submissions, the Forecasting of Solar Events Challenge has been by far the most successful solution found to date in this report.

6. Tools to support efficient reviews in the NASA process.

InnoCentive provides an evaluation scorecard worksheet to the Challenge Owners as a tool to aid in the review and selection of submissions during the evaluation period. The concept of this worksheet was highly favored by the Challenge Owners but a customized NASA document focused on the needs of the NASA review environment would be an improvement to consider as the program progresses.

Secondly, the submission quality and disparity between InnoCentive's 1-5 star ranking of solutions in most cases did not seem to align with the Challenge Owners' rankings. A suggested program improvement would be jointly defined definition of star ratings between the Challenge Owners and InnoCentive's Client Services team to be developed prior to the deadline of a Challenge. It is felt that the lower quality submissions will be more easily identified and eliminated, thereby saving review time for the Challenge Owners.

Thirdly, review periods are set by the Challenge type. The time it takes to review the submissions is also a factor of the number of solutions received and difficulty of material to review. An evaluation period extension is offered by InnoCentive to lengthen the evaluation period by 30 days for an additional fee. The offering of this service should be included in subsequent contracts and offered early on in the Challenge lifecycle.

Lastly, it was felt by some Challenge Owners an anxiety to award at certain award amounts. The need for a defined rational or guidelines as to why certain Challenges should be worth certain values should be developed and provided to Challenge Owners as part of their getting started packet.

VII. Conclusions and Recommendations

1. Is a Crowdsourced Innovation viable for NASA?

The full and partial awarding of seven out of seven Pilot Challenges clearly demonstrates that InnoCentive is a viable platform for finding quality solutions to research and technology gaps of NASA. As demonstrated in this report, the value of the solutions and the speed at which they can be found reveals the benefits InnoCentive's Challenge Driven Innovation approarch has for NASA.

The use of InnoCentive's CDI platform allows NASA Challenge Owners to be aware of diverse thinking and thus increases the chances that new solutions will become successful outcomes for NASA. This flow of external and tacit knowledge into the organization is being clearly supported by NASA and the US government. The support Challenge Owners are shown through the NASA Review Panel and an established innovation team, working synergistically with InnoCentive's Client Services team, ensures that they receive the best practice insights needed to thrive using an Challenge Driven Innovation.

NASA's SLSD focused on strategic planning and identification of high priority technical needs. This pre-planning and continuous monitoring of the SLSD strategic planning process provided clear direction and focus. It is recommended that this model be benchmarked as a best practice for NASA Centers and Directorates planning an open innovation initiative.

2. Will NASA Challenge Owners who used the InnoCentive CDI platform use it again?

"Yes!" All of the Challenge Owners who were interviewed and who had posted Challenges and received solutions through the InnoCentive platform said that they would use the platform again and will recommend it to their NASA colleagues.

It is recommended that as NASA continues to use the InnoCentive's CDI platform that we jointly develop certain NASA specific tools and processes to address the needs of NASA and its Challenge Owners. Challenge Owners recognize the value of the evaluation scorecard and yet a revision should be developed to help the Challenge Owners meet the needs of the NASA environment.

Further, a NASA defined Challenge process requires development to aid in clearly communicating expectations and time requirements of the Challenge Owners as well as their options moving forward:

a. Clear communication regarding NASA and InnoCentive processes that must be adhered to (e.g., the InnoCentive timeline, requirements for documented submission feedback to Solvers, and JSC Review Panel prior to award communications to Solvers through the InnoCentive website).

b. Challenge posting and award protocol

3. What is the potential for broad adoption of the InnoCentive platform by NASA?

Through the discovery of this report, the framework for broad adoption of the Global Solver Marketplace is established and shows that Challenge Driven Innovation is an effective innovation enabler for NASA in the future.

The seven Challenges chosen for this Pilot Program were in various stages and technical development. The effectiveness of the InnoCentive Marketplace showed results in all stages and higher value in others. In particular, large and difficult problems that could benefit from fresh thinking did very well as described by the Challenge Owners, as did the Langley Research Center's Challenge that was in the early stages of development.

As the broad adoption continues, a recommendation made by Challenge Owners was to consider Challenges in Pre-Phase A as a means of broadly collecting diverse insights and technical viewpoints. It was generally felt that the InnoCentive Marketplace delivers wide-ranging solutions more quickly and thoroughly than by other means.

Further recommendations include the use of more tools available from InnoCentive to support broader adoption. Leveraging the InnoCentive Marketplace for follow on Challenge Solver Consulting services and exploring the use of eRFP Challenges to find partners to develop technology. InnoCentive's CDI model can also be used to commercialize or distribute unused or for the public good Intellectual Property base of NASA.

A robust framework and process requirement for the management of external communication is recommended to uniformly communicate with other government agencies and the public on the results of the InnoCentive program. This framework developed would support the flow of information and how it is presented.