



Accelerating Innovation: NASA Human Health and Performance

AIAA Innovation Workshop

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Discussion Topics

- Innovation Strategy and Execution
- Human Centered Risk Management
- NASA Open Innovation Efforts
- Solution Mechanism Guide

NASA Human Health and Performance
Exploring space | Enhancing life



NASA Human Health and Performance Directorate

- Space and Clinical Operations
- Biomedical Research and Environmental Sciences
- Human Systems Engineering and Development





Drivers for Strategic Plan

2005: Dramatic reduction in R&TD budget, rapid pace of innovation external to NASA

- loss of some core capabilities through reductions in personnel, contracts and grants
- Continued mandate to address and mitigate the risks involved with human spaceflight for crew

2006: Visioning workshop to chart a course for the future

- A shift from relying on traditional funding strategies to also using partnerships and other collaborative approaches to achieve our goals



Strategic Plan (2007 & 2012)

- Mission
 - Optimize human health and performance throughout all phases of spaceflight
- Key Strategy
 - Develop collaborative business model to advance health innovations and drive human system technology innovations
- Select 2007 Objectives
 - Identify and adopt new collaborative approaches
 - Establish comprehensive risk management process



Executing the Strategy

- Conducted benchmark to inform collaborative strategy execution
- 100% of participants formed partnerships because they had to in order to innovate and meet strategic goals
- Assessed collaborative approaches to technical problems
- Open innovation and cultural changes to advance strategy (Lakhani)
- Portfolio analysis – adopt process to evaluate our R&TD portfolio to determine optimal way to collaborate (Pisano)



Executing the Strategy (cont.)

- Developed risk management process to prioritize and mitigate human health risks involved with spaceflight
- Established virtual centers to facilitate partnering, share best practices, and advance the use of open innovation
- Developed the Solution Mechanism Guide (SMG), a web based interactive tool that enables users to assess and choose the best method for advancing a project



Creating a Culture of Innovation

Two Approaches

...from the top down, through communications initiatives and events

- Workshops for leadership on culture change, open innovation, what collaboration is right for you?
- Organizational briefings, quarterly poster updates, email announcements from director
- Innovation Lecture Series
 - Most recently: April 27 Daniel Kraft:
*Disruptive Innovation in Healthcare—
Current Advances and Future Innovations*





Creating a Culture of Innovation

... AND from the bottom up, by successfully addressing technical challenges through collaborative approaches

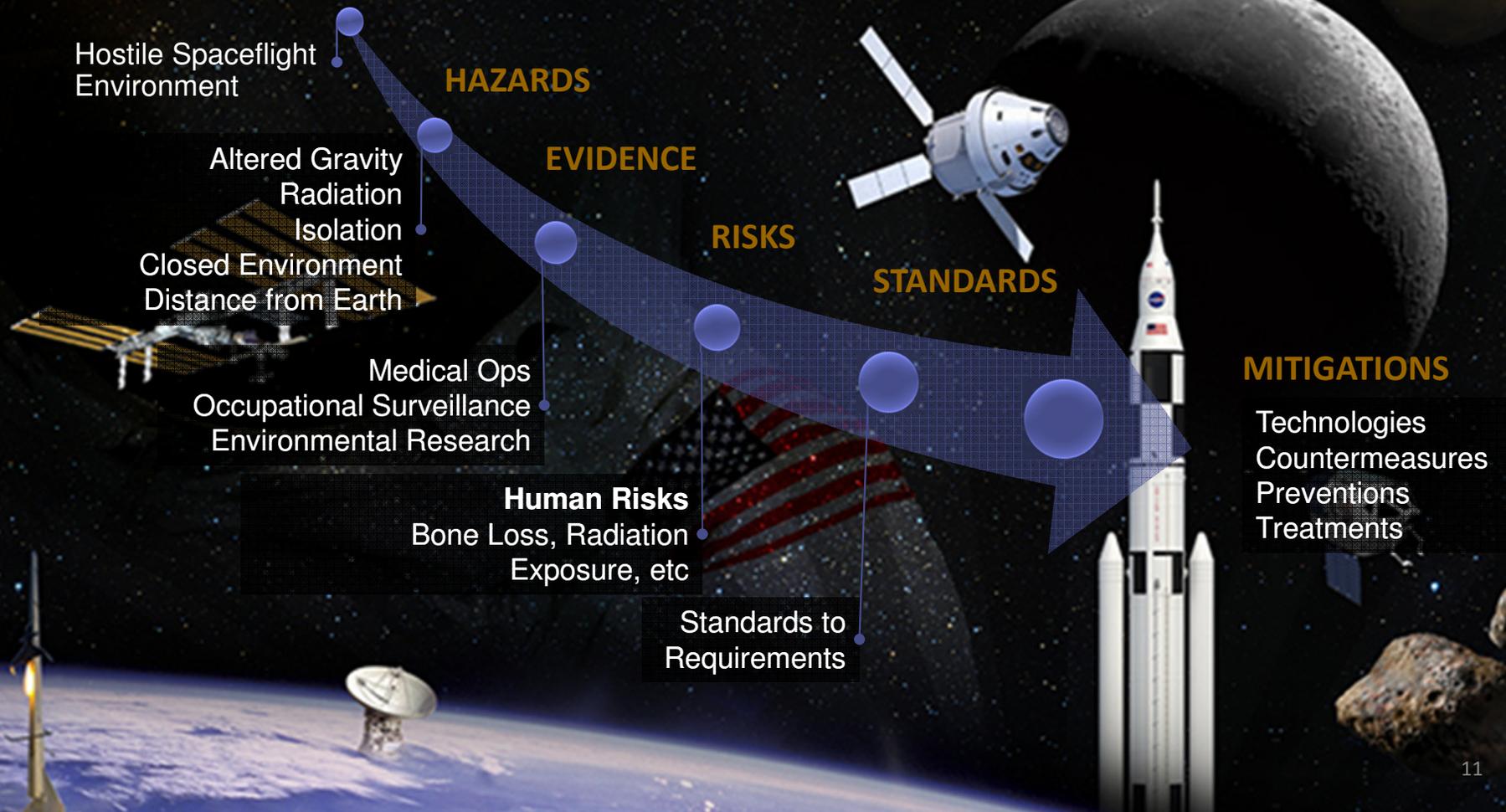
- Open innovation pilot projects
- Established virtual centers
 - NASA Human Health and Performance Center (NHHPC)
 - Center of Excellence for Collaborative Innovation (CoECI)
- Collaborative research and technology development projects





Human Centered Risk Management

Minimizing the Risks of Spaceflight Hazards





30 Human Spaceflight Risks are Grouped by Hazard

Altered Gravity - Physiological Changes

- Balance Disorders
- Fluid Shifts
- Cardiovascular Deconditioning
- Decreased Immune Function
- Muscle Atrophy
- Bone Loss

Hostile/ Closed Environment

- Vehicle Design
- Environmental – CO₂ Levels, Toxic Exposures, Water, Food



Space Radiation

- Acute In-flight effects
- Long term cancer risk

Distance from Earth

- Drives the need for additional “autonomous” medical care capacity
- Cannot come home for treatment

Isolation & Confinement

- Behavioral aspect of isolation
- Sleep disorders



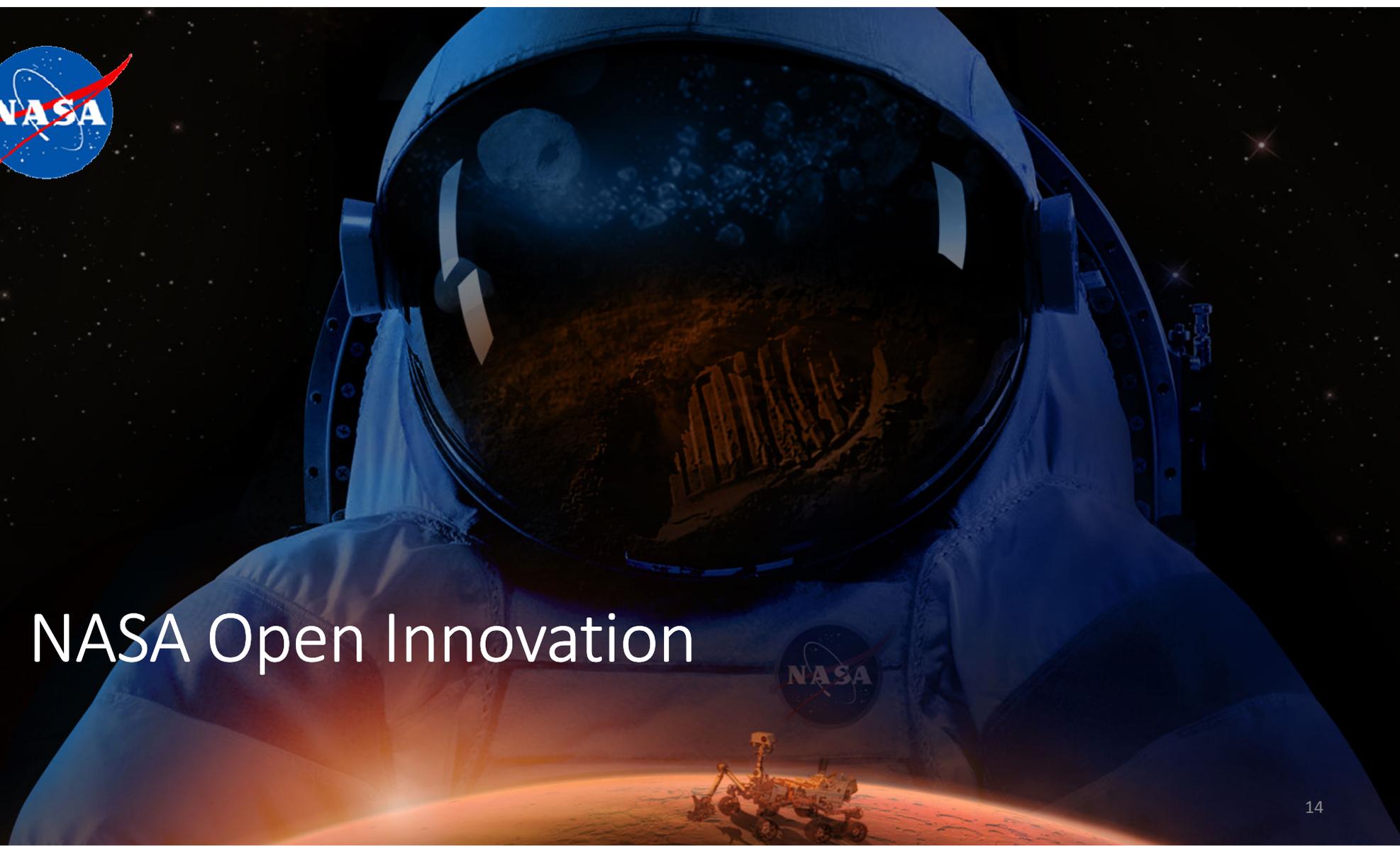
Human Risks are Evaluated Against Design Reference Mission (DRM) Categories



| DRM Categories | Mission Duration | Gravity Environment | Radiation Environment | Earth Return |
|--------------------------------|------------------|---------------------|-----------------------|-----------------|
| Low Earth Orbit | 6 months | Microgravity | LEO - Van Allen | 1 day or less |
| | 1 year | Microgravity | LEO - Van Allen | 1 day or less |
| Deep Space Sortie | 1 month | Microgravity | Deep Space | < 5 days |
| Lunar Visit/Habitation | 1 year | 1/6g | Lunar | 5 Days |
| Deep Space Journey/ Habitation | 1 year | Microgravity | Deep Space | Weeks to Months |
| Planetary Visit/Habitation | 3 years | Fractional | Planetary* | Months |



NASA Open Innovation





Open Innovation

- What is open innovation?
 - “Open innovation is the use of purposive inflows and outflows of knowledge to accelerate internal innovation, and expand the markets for external use of innovation, respectively. [This paradigm] assumes that firms can and should use external ideas as well as internal ideas, and internal and external paths to market, as they look to advance their technology.”
Henry Chesbrough, [*Open Innovation: Researching a New Paradigm*](#) (2006)
- HH&P Approach
 - Crowdsourcing and solution sourcing using open innovation service providers
 - Portfolio analysis to determine which human system risks were best suited for open innovation problem solving



Open Innovation

Why Open Innovation?

- Joy's Law: "No Matter Who You Are, Most of the Smartest People Work for Someone Else"
 - Bill Joy, Cofounder Sun Microsystems
- "The future is already here — it's just not very evenly distributed"
 - William Gibson, American-Canadian writer who coined the term "cyberspace" in his short story *Burning Chrome*



Starting with Portfolio Analysis

The Four ways to Collaborate:

| | | | |
|---|---|---------------|--------|
| <p>Innovation Mall</p> <p>A place where a company can post a problem, anyone can propose solutions, and the company chooses the solutions it likes best</p> <p>Example: <i>InnoCentive.com website, where companies can post scientific problems</i></p> | <p>Innovation Community</p> <p>A network where anybody can propose problems, offer solutions, and decide which solutions to use</p> <p>Example: <i>Linux open-source software community</i></p> | PARTICIPATION | Open |
| <p>Elite Circle</p> <p>A select group of participants chosen by a company that also defines the problem and picks the solutions</p> <p>Example: <i>Alessi's handpicked group of 200-plus design experts, who develop new concepts for home products</i></p> | <p>Consortium</p> <p>A private group of participants that jointly select problems, decide how to conduct work, and choose solutions</p> <p>Example: <i>IBM's partnerships with select companies to jointly develop semiconductor technologies</i></p> | | Closed |
| GOVERNANCE | | | |
| Hierarchical | Flat | | |

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HH&P Portfolio Analysis

- HH&P Research and Technology Development Portfolio Gaps
 - Food packaging to maintain quality for 5 years
 - Compact (one cubic foot, 20 pound) exercise device for capsules
 - Solar proton event predictive capability for 24 hours
 - Accurate tracking of medical consumables in flight
 - Motivational enhancement for exercise

Pilots conducted on four platforms – NASA Innovation Pavilion (InnoCentive), yet2.com, TopCoder (with Harvard University), and NASA@work (InnoCentive)



NASA Innovation Pavilion



[NASA Pavilion Home](#)

[NASA Challenges](#)



Global Appeal-

2900 solvers
80 Countries





InnoCentive Successes

| Challenge | TRL* | Submissions | Award |
|---|------|-------------|--------------------|
| Data-Driven Forecasting of Solar Events (D. Fry) ➤ Resulting model showed a high percent correct (~85%) but with an equally high false alarm rate. Potential for coupling with other modeling efforts | Low | 11 | \$30,000 |
| Non-invasive Meas of Intracranial Pressure (S. Villarreal) ➤ Resulted in a predictive algorithm from UCLA using available physiologic data. Site visit planned to assess UCLA analysis of NASA data via modification of existing NSBRI study. | Med | 638 | \$15,000 |
| Compact Aerobic Resistive Exercise Device Mech (L. Loerch) ➤ Technology was included in Advanced Exercise Concepts trade space for consideration | Low | 95 | \$20,000 |
| Food Packaging and Protection (M. Perchonok) ➤ Monitoring other packaging team evaluations of flexible graphene material proposed as solution | Med | 22 | \$11,000 (partial) |



Yet2.com Successes

| Technical Need | TRL* | Total Leads | Active Leads |
|---|-------------|--------------------|---------------------|
| Hip Bone Microarchitecture Measurement (J. Sibonga) <ul style="list-style-type: none">➤ Pilot study quantifying changes in sheep bone microarchitecture for preclinical validation expected to be completed by the end of FY13➤ Provides foundation for a research proposal to validate this technology in a population of spinal cord injured subjects | Med | 51 | 5 |
| Water Disinfection and Monitoring (M. Ott) <ul style="list-style-type: none">➤ Provided a status of state-of-the-art water disinfection and monitoring alternatives, which indicated a need for NASA to develop new technologies for our specialized needs during spaceflight | Low | 61 | 8 |
| Food Packaging and Protection (M. Perchonok) <ul style="list-style-type: none">➤ Evaluation of one lead as partner underway | Med | 29 | 5 |



TopCoder Successes

| Challenge | TRL* | Submissions | Award |
|---|------|---|---------------------------------------|
| Open source license for an algorithm to optimize lunar medical kit ➤ Useful algorithm developed and incorporated into NASA model; process deemed more efficient than internal development | High | 2800 solutions submitted by 480 individuals | Small cash prizes (total of \$24,000) |
| ISS FIT app ➤ App developed for an iPad to permit easy, daily recording of dietary intake, facilitate data analysis, and to support nutrition research on the ISS | High | 17 contests, 79 submissions from 20 countries | \$350 to \$5,000 (total of \$36,288) |



NASA@work Successes

| | Display Format Development System for Deep Space Human Spacecraft | Determining Urine Volume in Microgravity |
|--------------------------|---|---|
| Challenge Owners: | JSC | JSC |
| Purpose | Looking for displays for use onboard a deep space human module to be used the crew in combination with Orion spacecraft | Sought to identify an alternate method for real-time in-flight urine volume measurements and maintain the capability to take samples to Earth for additional analysis |
| Submissions | 51 | 60 |
| Solutions Awarded | 2 Awarded | 2 Awarded |
| Next Steps | Incorporate solutions for display format development | Evaluate prototype |





ICP Challenge

- A leading hypothesis for vision impairment during spaceflight is increased intracranial pressure (ICP) resulting from a headward fluid shift
- There is no validated method to quantify intracranial pressure *non-invasively*.
- New innovation tools were employed to search for new technologies.
 - NASA @work searched for ideas within NASA.
 - Innocentive posted our problem seeking responses from solvers.
 - Yet2.com actively searched for potential solutions to our challenge.
- Hundreds of intriguing solutions were offered. Top 3 pursued.
- UCLA's ICP Algorithm was identified by both Innocentive & Yet2 so we knew we were on the right track.
- Uses existing technology on ISS so we can implement quickly.



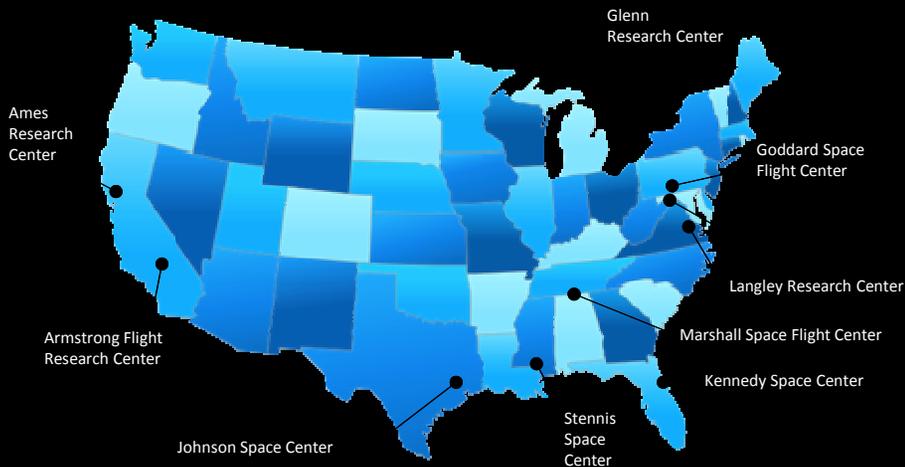
New Partnerships

- ICP algorithm inventor partnered with other investigator teams and won 2 competitively selected Human Research Program NASA research opportunities.
- CASIS, Center for Advancement of Science in Space, that manages ISS National Laboratory, competitively awarded a flight study to the same team to further develop the algorithm.



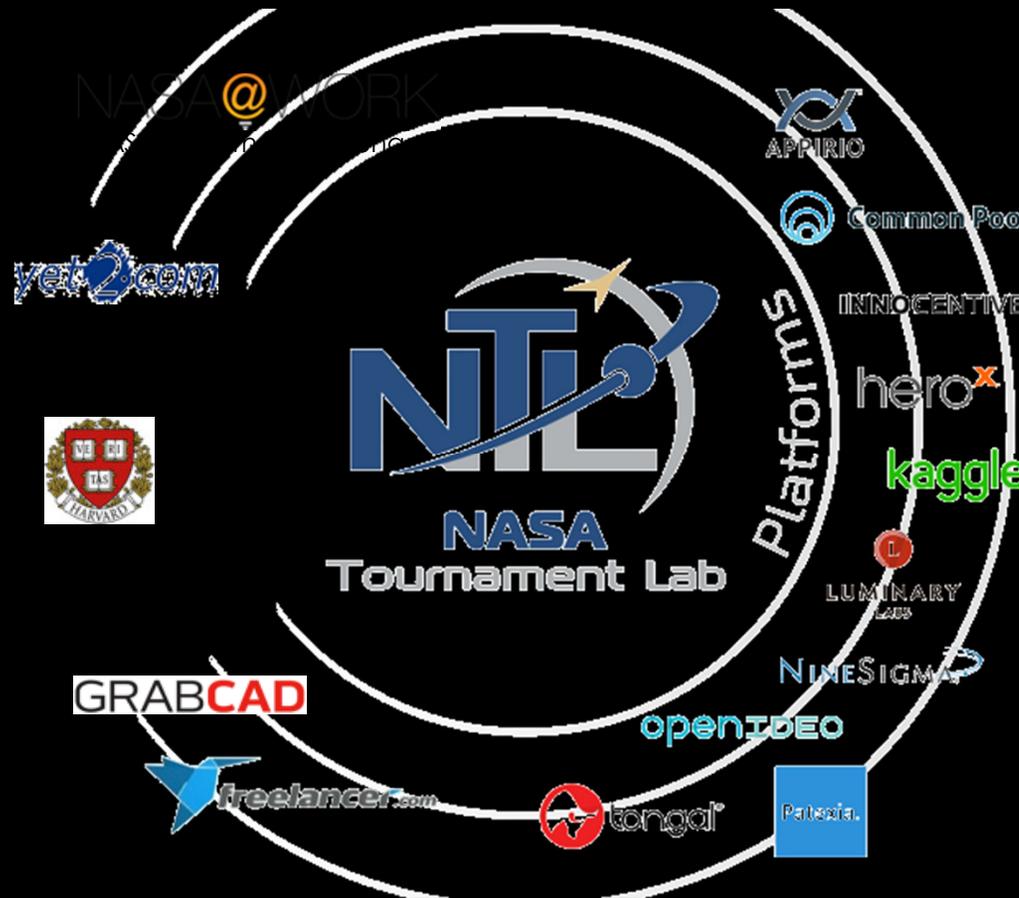
NASA's Center of Excellence for Collaborative Innovation

- Officially launched in November of 2011 at the request of the White House OSTP
- **CoECI** works across all of NASA and with other federal agencies to infuse crowdsourcing methods as a set of available tools to create innovative, efficient, and optimal solutions to real world problems





The CoECI Toolkit





Ex: Mars Balance Mass

Challenge -
Ideas to find dual
purpose for
balance mass that
is jettisoned from
Mars landers to
balance the
aircraft during
entry and landing



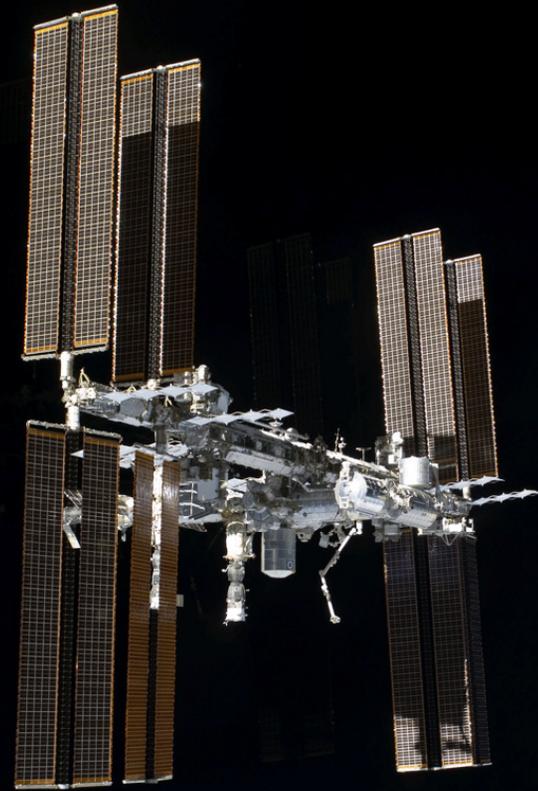
Challenge Budget
\$50,000

Challenge Award
\$25,000

Concept for
future lander
designs



Partnerships and Development





NASA Collaborations

- NASA Human Health and Performance Center - [NHHPC](#)
 - Established October 2010, now >150 members from government, industry, academia, non-profits
 - Several cross-sector projects in development
 - Engagement portal on the NHHPC website
- Rapid Reaction Technology Office (RRTO) Workshop
 - 12 companies identified and now followed
- Rice Business Plan Competition
 - Annual life sciences earth/space benefits prize
 - 6 start-ups followed
- Pumps & Pipes – annual conference between energy, medicine and aerospace



Workforce
Engagement:

The Solution Mechanism Guide





Inter-Agency Agreement

Workshop

Procurement Contract

TopCoder

Grant

InnoCentive

Space Act Agreement

Cooperative Agreement

Inter-Personal Agreement

NASA@work

Purchase Card

yet2





The Solution Mechanism Guide (SMG)

- A web-based, interactive guide that:
 - Leverages existing and innovative problem solving methods (e.g. SBIRs, contracts and challenge competitions)
 - Presents this information in a unique user experience so that users are empowered to make the best decision about which problem solving tool best meet their needs.



Home Help Topics Examples Feedback Contact Us F.A.Q.

Solution Mechanism Guide

Tell Me More →

How It Works:

Make Your Selections Review Mechanism Information Make Your Decision

? Knowledge Maturity Level (KMLs)
 Gather Synthesize Validate Apply

? Monetary Cost of the Solution Mechanism
 \$0 >\$0; < \$5K >\$5K; < \$20K >\$20K; < \$50K
 >\$50K; < \$100K > \$100K; <\$500K > \$500K; <\$1M
 > \$1M

? Time to Execute Solution Mechanism
 < 3 months > 3 months; < 6 months >6 months; < 1 year
 > 1 year; <2 years > 2 years

? Deliverable Type
 Knowledge Countermeasures/Controls Technology
 Standards/Requirements

To use the Solution Mechanism Guide, please answer the questions on the left. Then click on 'Identify Solutions' to see what solution mechanisms best fit your needs!

Identify Solutions





The SMG Challenge (TopCoder)

Challenge - Create an online tool that allows users to answer a series of questions to pinpoint solution mechanisms to best fit their project needs.



Challenge Budget
\$56,500

Challenge Award
\$37,474

- User and administrative interfaces based on tailorable content
- Delivered as OpenSource software
- Currently internally deployed on NASA's network and deployed in the Human Health and Performance Directorate

- 23 contests
- 359 registrants from 13 countries
- 99 submissions
- Iterative development with customer



Next Steps

- June 30th – “go live” with SMG within Human Health and Performance (HH&P). Potential to educate all employees about novel problem solving tools.
- TBD - roll-out SMG for Johnson Space Center, possibly NASA HQ
- Build upon September 2015 HH&P retreat to develop a framework for problem solving
 - integrate the use of all problem solving tools
 - apportion portfolio into strategic innovation areas
 - permit customization by work groups





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