

The Power of Crowd Based Challenges

NASA's Practical Toolkit for Open Innovation



NASA's Center of Excellence for Collaborative Innovation (CoECI)

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What Is Open Innovation?

open

Accessing people outside your organization up to

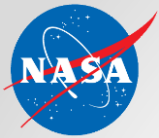
Crowdsourcing

An online, distributed, problem-solving and production model.

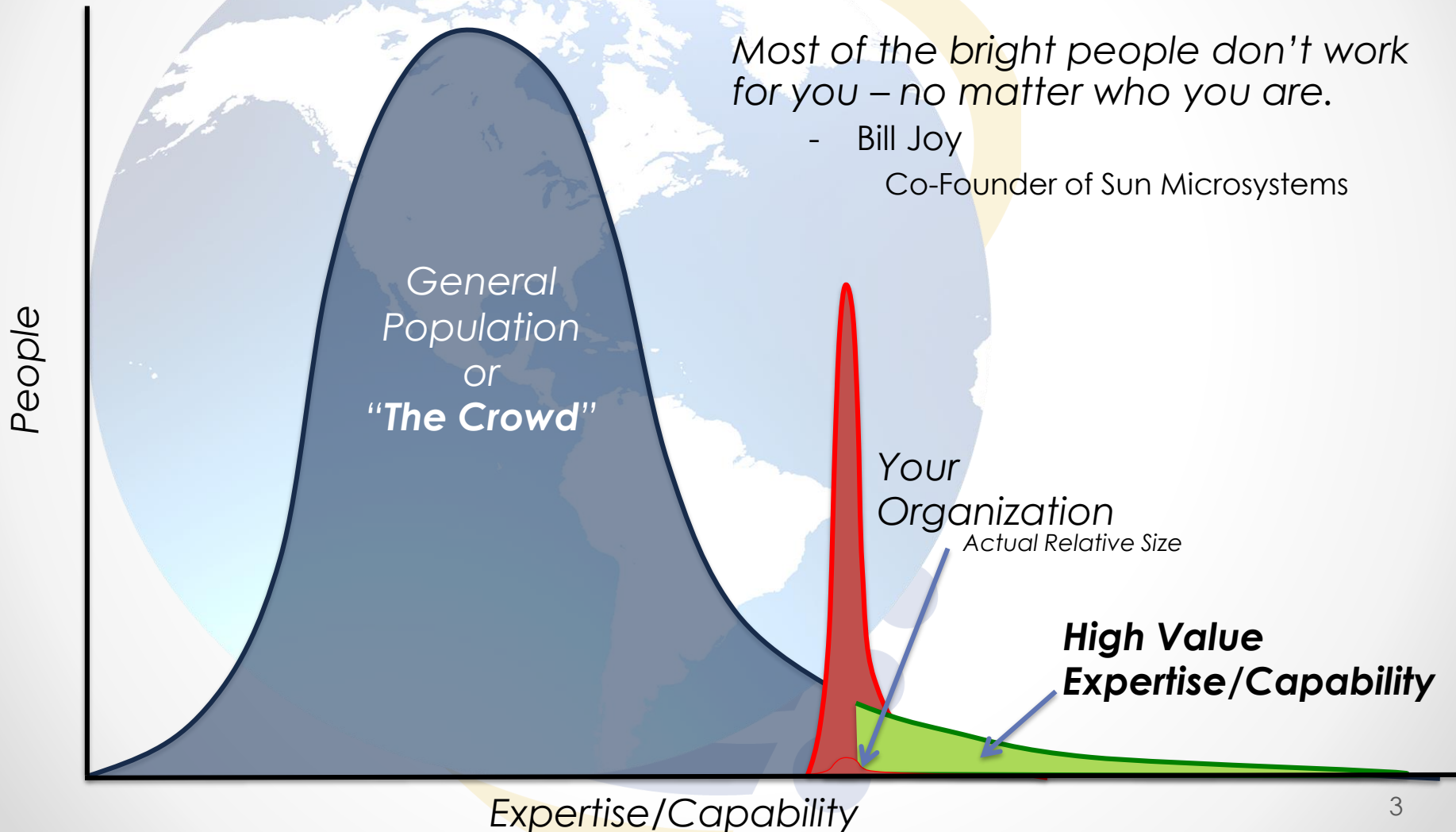
Innovation



ideas, concepts, designs, or solutions that meet a previously unmet need possibly resulting in significant advances in performance.

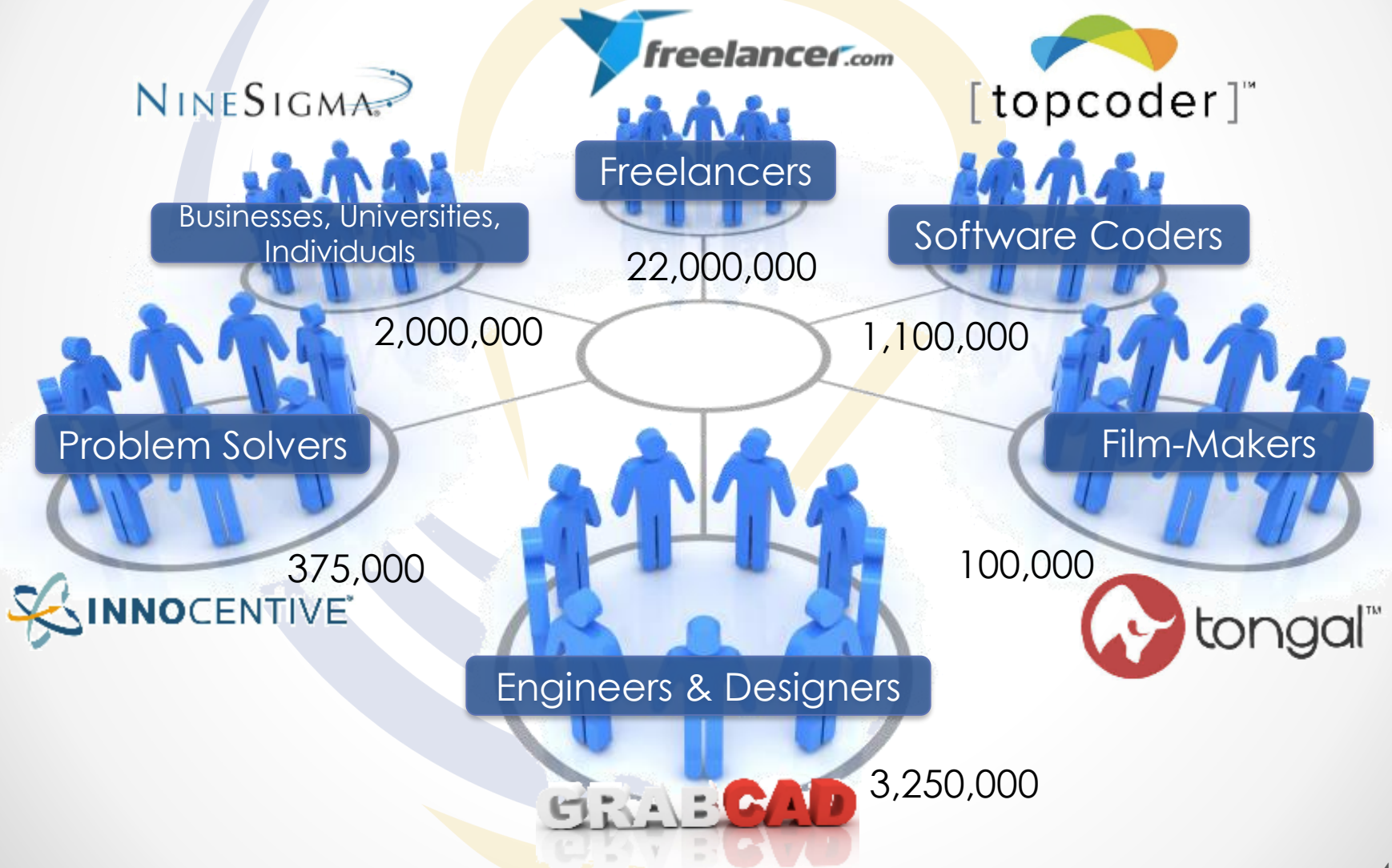


Who Has The Expertise/ Capabilities You Need?



Networks & Communities

Curated Communities





Curated Communities

Resources and
Tools for
Members

User Agreements
for Privacy and
Payment

Incentives for
Members to
Participate

Community
Building &
Communication

Mechanism for
Handling IP
Licensing and/or
Transfer

Curated communities are built around enabling people to pursue their passion and create a win-win for the company and its community members.

They provide structure and incentives.

Communities do NOT like to be exploited!



People Most Likely to Provide an Innovative Solution to Your Problem

Mathematicians
 Researchers
 Technicians
 Scientists
 Engineers
 Lawyers
 Artists
 Physicians
 Musicians
 Operators
 Educators
 Entrepreneurs

Applicable Experience

Domain Specific Expertise

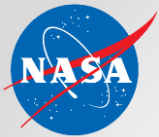
Complementary Expertise or Experience

Passion, Creativity, and/or Curiosity

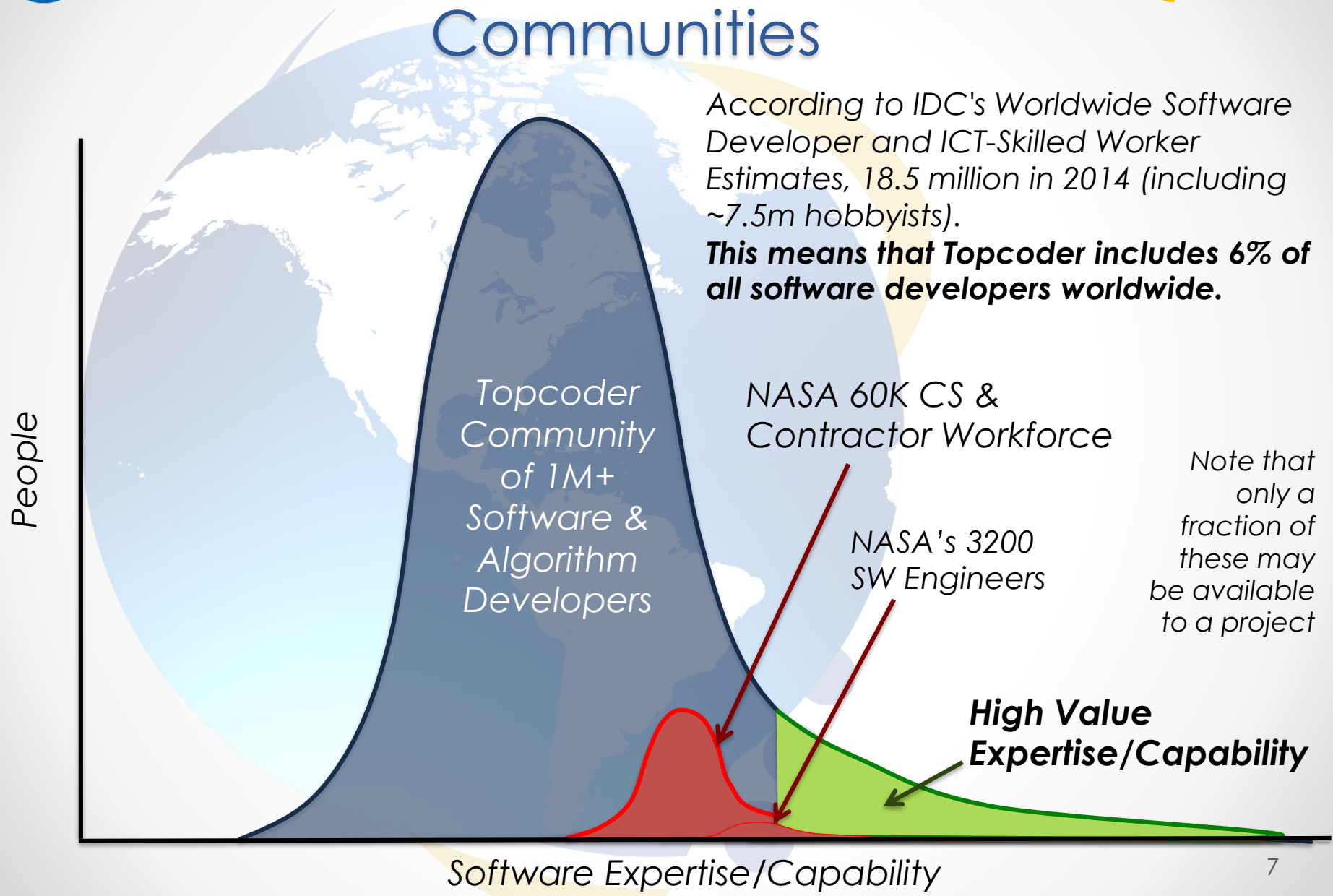
Full-Time Employed
 Part-Time Employed
 Under-Employed
 Freelance
 Retired
 Students
 Hobbyist
 Post-Docs
 Post-Post-Docs (frustrated researchers)
 Teams/Groups
 Startup Companies
 Small Companies



Existing Community Member
 Connected via Targeted Search
 Connected via Challenge Marketing



Specialized Curated Communities



Formulate the Problem Statement

A well formulated problem statement (with good success criteria)

Design the Challenge

A well designed challenge (including setting the right prize amount)

Knowing how to do all of these steps really helps to mitigate the issues associated with this “too many solutions” problem.

Execute the Challenge

Solution Filtering (optional)

Solution filtering mechanisms are offered by some platforms

ALL of these steps can help to minimize the number of solutions you end up needing to evaluate.

Pick the Winner(s)
Evaluating

Get Your Solution
IP licensing and/or transfer



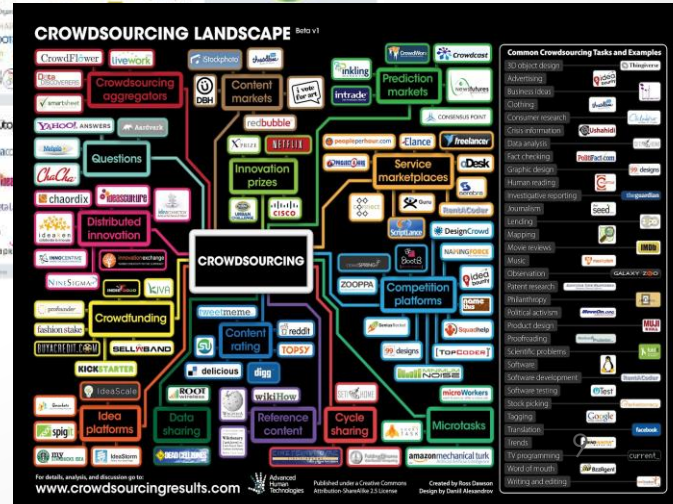
Accessing the Crowd Using Challenges

Crowdsourcing is Mainstream in Industry

While this may seem new, effective crowdsourcing is widely used across industry to access innovative solutions.

Users

Providers



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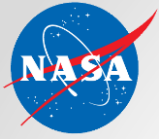


NASA's Center of Excellence for Collaborative Innovation (CoECI)



- The **Center of Excellence for Collaborative Innovation (CoECI)** was officially launched in November of 2011 at the request of the White House Office of Science and Technology Policy (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.



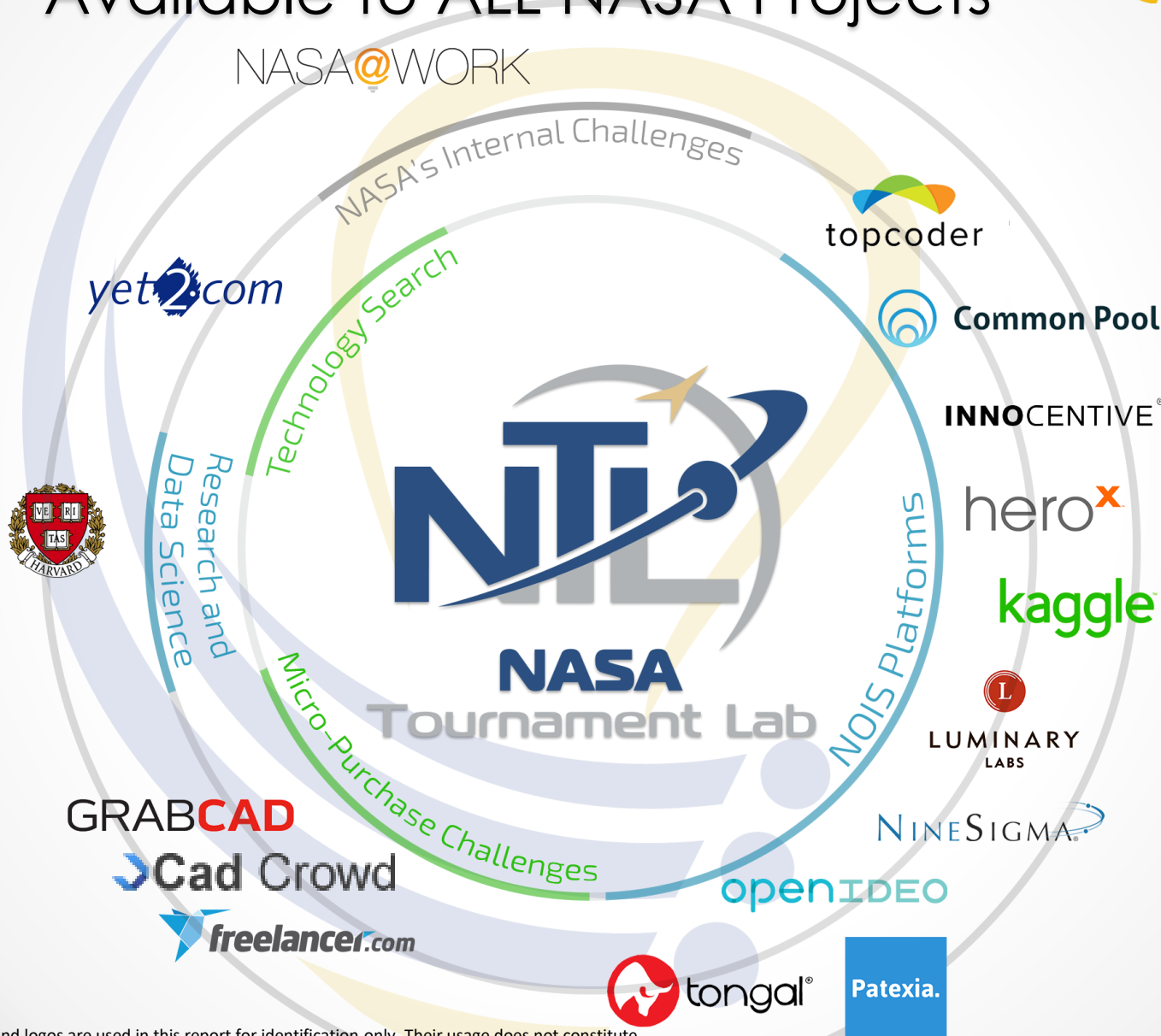


The CoECI Toolkit

Available to ALL NASA Projects



NASA@WORK



yet2.com

topcoder

Common Pool

INNOCENTIVE®

herox

kaggle

LUMINARY LABS

NINESIGMA

openIDEO

Patexia.

tongal®

freelancer.com

Cad Crowd

GRABCAD



Research and Data Science

Technology Search

NASA's Internal Challenges

NOIS Platforms

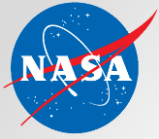
NITL
NASA
Tournament Lab

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Innovation & Problem Solving Challenge Results

Using Challenges with Diverse Communities to
develop unique and innovative approaches
to unsolved problems





NTL Innovation Platforms



- Innovative Problem Solving Communities composed of large diverse communities with a variety of expertise
- Over 5 years of experience with InnoCentive challenges
- New NASA Open Innovation Services (NOIS) Contract added new communities
- A total of 6 communities focused on Innovative Problem Solving Challenges available to NASA



INNOCENTIVE[®]

NINESIGMA[®]



LUMINARY
LABS

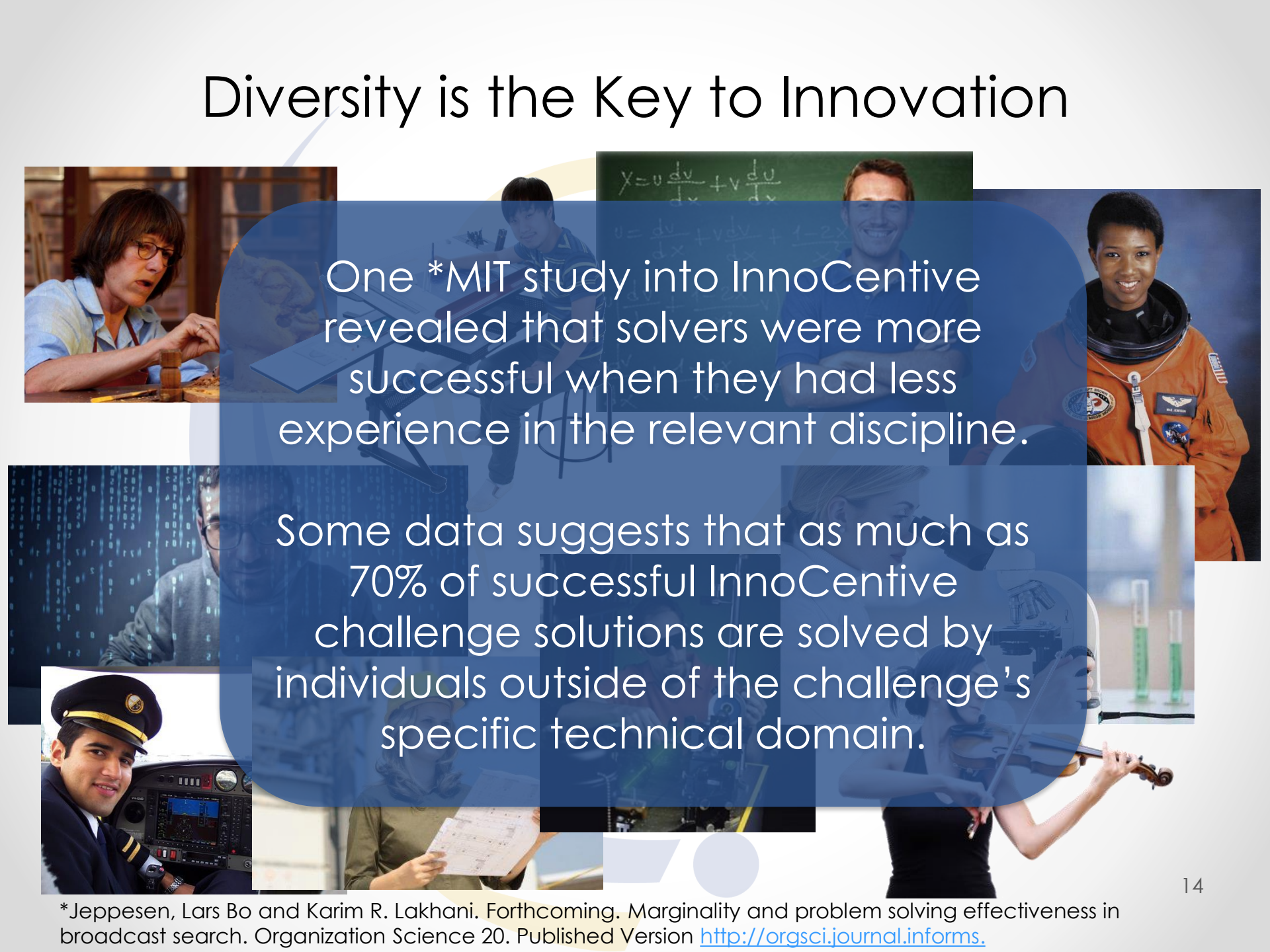
openIDEO

hero^x



Common Pool

Diversity is the Key to Innovation



One *MIT study into InnoCentive revealed that solvers were more successful when they had less experience in the relevant discipline.

Some data suggests that as much as 70% of successful InnoCentive challenge solutions are solved by individuals outside of the challenge's specific technical domain.



Swiss company with 80,000 employees, Roche operates in 150 countries and has R&D operations in Europe, North America and Asia-Pacific (\$8B+ in R&D annually)

Diagnostics

Roche is a world leader in medical diagnostics.



Roche ran an InnoCentive challenge:
A \$20,000 prize to develop a better means of measurement in an automated chemical analyzer

“In 60 days, Roche was able to **solve a problem** that it and its partner have been tinkering with and optimizing for the **last 15 years**. The solutions provided actually mirrored the entire history of Roche’s R&D programme. **All of the solutions Roche had tried** came in. “

Julian Birkinshaw, MLabnotes, University of London Business School

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



Total Cost to NASA
\$50,000

Challenge Award
\$25,000

Concept
for Future
Lander
Designs



Results

- Winner: Concept for ionospheric and atmospheric analysis of Mars via tracer element release
- Honorable Mention: Concept to study Mars winds using deployable micro-balloons

STRAIN MEASUREMENT OF KEVLAR AND VECTRAN WEBBING

Challenge - Solve a 3-year-old problem for how to test Kevlar webbing for its durability in the trying conditions in space.



Total Cost to NASA
\$40,000

Challenge Award
\$20,000

72
Submissions
from
19 Countries



Results

3 Awards for similar solutions - winning solutions were quick, simple & easy to test

“So simple, so elegant how could we NOT have thought of this ourselves.”

Tom Jones, Deputy Project Manager, Research Lunar Surface Systems

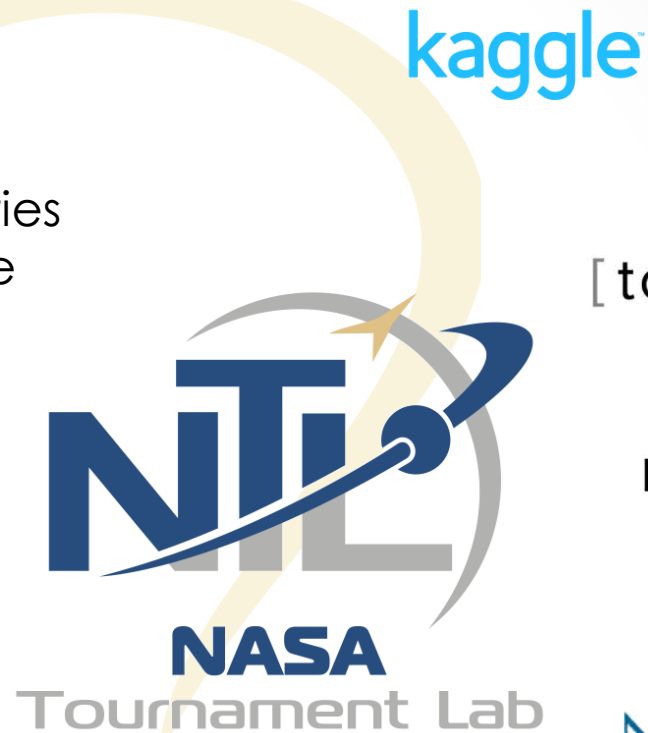
Algorithm & Software Challenge Results

Leverage Competition to Optimize Complex
Algorithmic Problems or Build an App

$$\frac{\partial \log \pi(\xi)}{\partial \theta} = \frac{\partial}{\partial \theta} \int \pi(x) f(x, \theta) dx$$
$$\frac{\partial}{\partial \theta} \log \pi(\xi) = \frac{\partial}{\partial \theta} \left[\log \int \pi(x) f(x, \theta) dx \right]$$
$$\int \pi(x) \cdot \frac{\partial}{\partial \theta} f(x, \theta) dx = M \left(\pi(\xi) \frac{\partial}{\partial \theta} \log f(\xi, \theta) \right)$$
$$\int \pi(x) \cdot \left(\frac{\partial}{\partial \theta} \log f(x, \theta) \right) \cdot f(x, \theta) dx = \int \pi(x) \left[\frac{\partial}{\partial \theta} \log f(x, \theta) \right] f(x, \theta) dx$$
$$\frac{\partial}{\partial \theta} M \pi(\xi) = \frac{\partial}{\partial \theta} \int \pi(x) f(x, \theta) dx = \int \frac{\partial}{\partial \theta} \pi(x) f(x, \theta) dx$$
$$\int \frac{(\xi_i - \theta)^2}{\sigma^2} \frac{\partial}{\partial \theta} \log f(x, \theta) dx$$

NTL Algorithm & Software Platforms

- Data Science and Software Development Communities composed of large communities with both specialized expertise and diversity.
- Over 5 years of experience with Appirio (TopCoder) challenges
- Services available include:
 - Big data/data science algorithm development and machine learning
 - Software Application Development (full life cycle)



kaggle



INNOCENTIVE

NINESIGMA



MEGABLAST

0.72 pts



The Challenge

Improve on NIH MegaBlast algorithm
for nucleotide sequence alignment

4.3 hours\$2M+
Multi-year
Development**47 min.**\$120K
1 year
Development**16 sec.**\$6K Prize
14 Day
Challenge

ASTEROID DATA HUNTER

Challenge -
Create an
algorithm to
detect moving
objects using
Catalina Sky
Survey (CSS)
data



Total Cost to NASA
\$186,980

Challenge Award
\$71,370

15%
Improvement



Results

- 15% improvement over current methods
- Open Source App available for download on any laptop (9000 downloads as of 3/2016)
- Maintained by Planetary Resources, Inc.

ISS ROBONAUT VISION ALGORITHMS

Two challenges to develop vision algorithms to initially detect states of controls (buttons & switches) and later to recognize objects (such as tools) in various lighting conditions.



Total Cost to NASA
\$51,100 (challenge 1)
\$59,500 (challenge 2)

Challenge Prizes
\$21,897 (challenge 1)
\$19,250 (challenge 2)

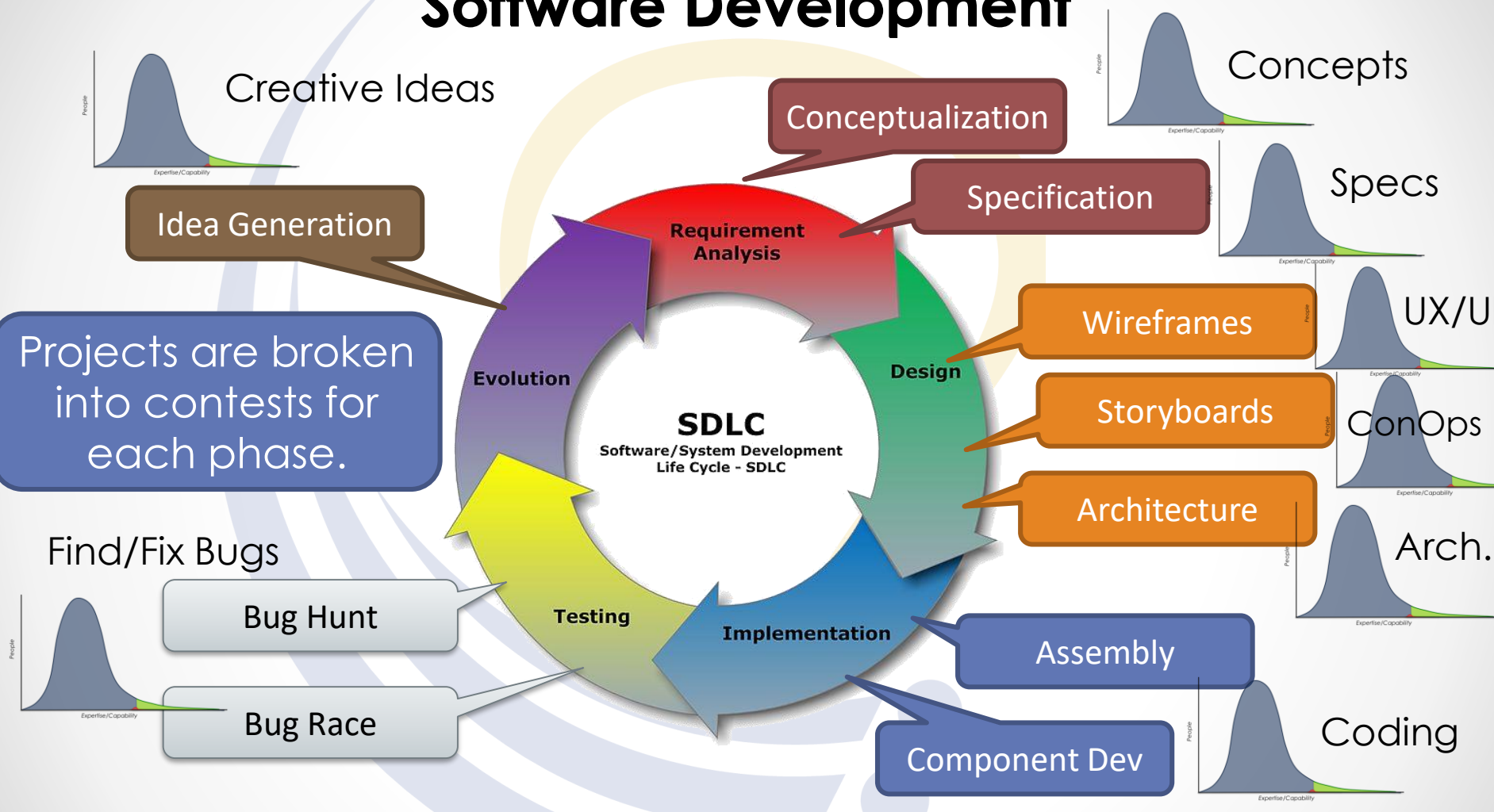
Saved the
project
over
\$500,000



Results

- Initial challenge resulted in 4 quality algorithms each using a different approach that were used to mature their new software architecture.
- Final “Tool Localization” challenge resulted in getting 5 different algorithms that can effectively recognize tools under various difficult lighting conditions.

Using Competitions for Software Development



Projects are broken into contests for each phase.

Each contest taps into the **best** of the portion of the community that has expertise for that phase.

Source:  topcoder

Image Credit: Wikipedia, *Systems development life-cycle*, http://en.wikipedia.org/wiki/Systems_development_life-cycle (as of Mar. 27, 2013, 05:48 GMT).

ISS FOOD INTAKE TRACKER

Challenge -
Create an iPad application for ISS crewmembers to easily enter their dietary intake



Total Cost to NASA
\$144,600

Challenge Award
\$36,288

More
Detailed
Food Log
plus Bar
Code
Scan

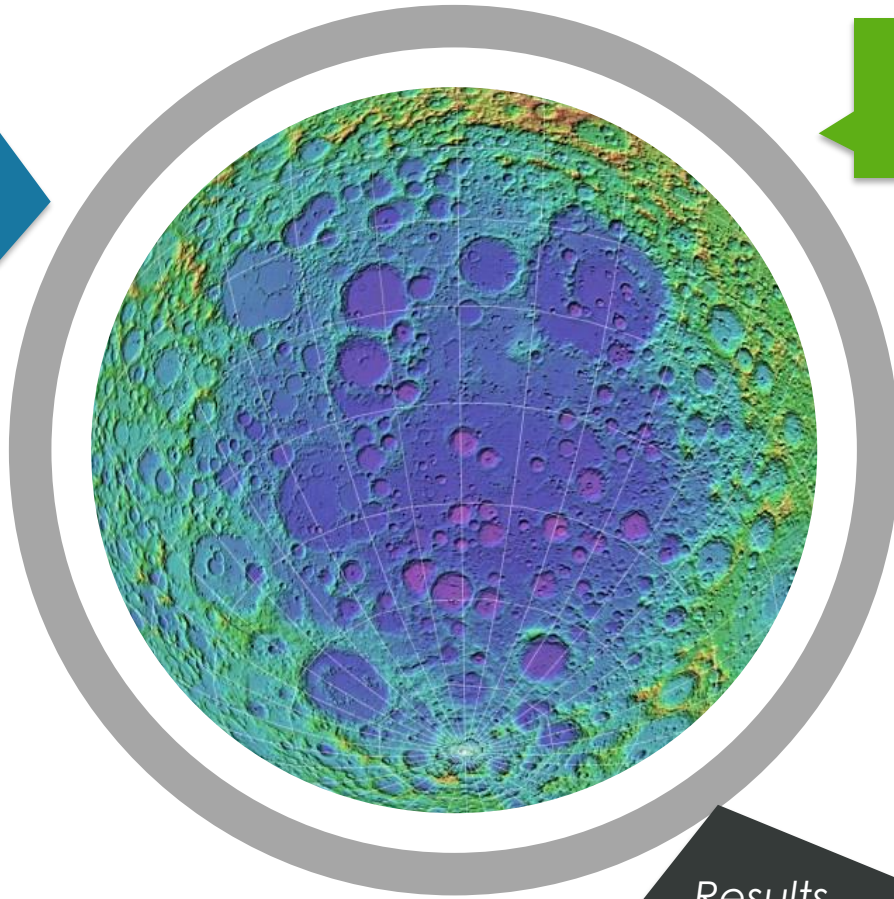


Results

- Will provide NASA scientists a better understanding of nutrition to help mitigate negative physiological effects of spaceflight
- Scheduled for operational use starting in June 2016

LUNAR MAPPING AND MODELING PORTAL

Challenge – develop an application that takes raw images from the Lunar Reconnaissance Orbiter (LRO) and turns them into rich visualization layers



Total Cost to NASA \$81,724

Challenge Award \$12,625

Image processing time reduced from 19 to 3 hours



Results

- Online tool processed LRO images into hi-res geo-referenced mosaic
- Reduced processing time from 19 to 3 hours
- Additional reduction in time by adding additional nodes

Micro-Purchase Design Challenges

Leveraging Low Cost Competition to Access Diverse, Innovative Design Space

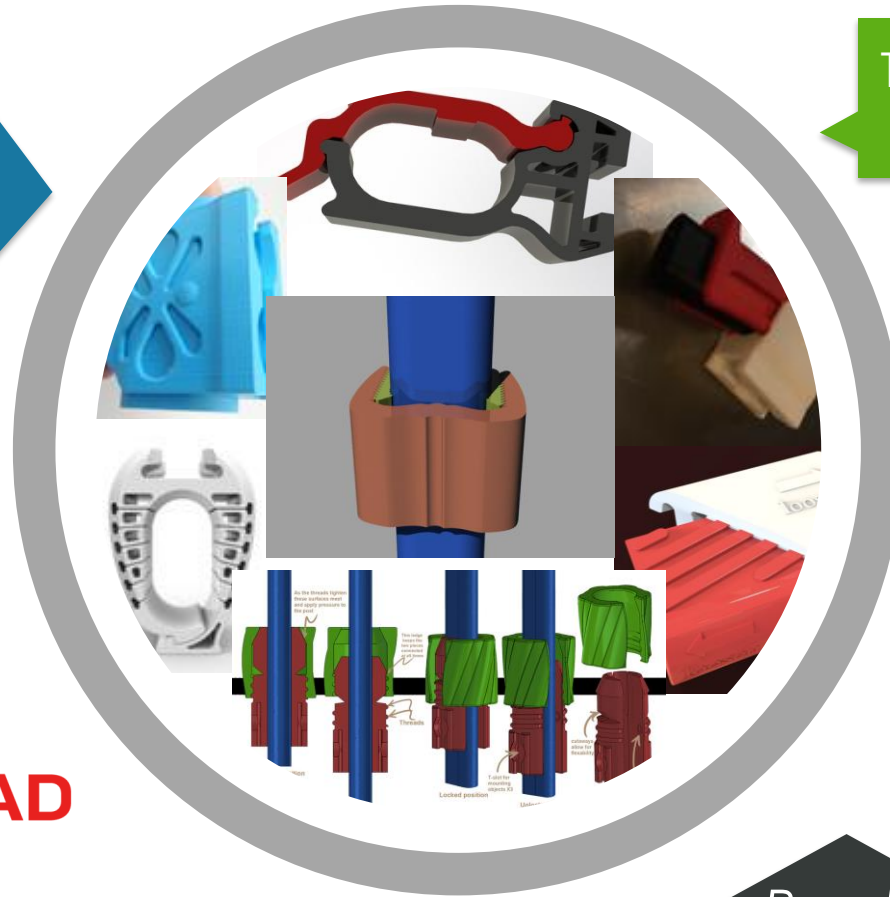


GRABCAD



3D PRINTABLE ISS HANDRAIL CLAMP

Challenge to develop a design for an ISS handrail clamp that could be 3D printed and still withstand the loads and stresses required.



Total Cost to NASA
\$3,000

Challenge Prize
\$2,000

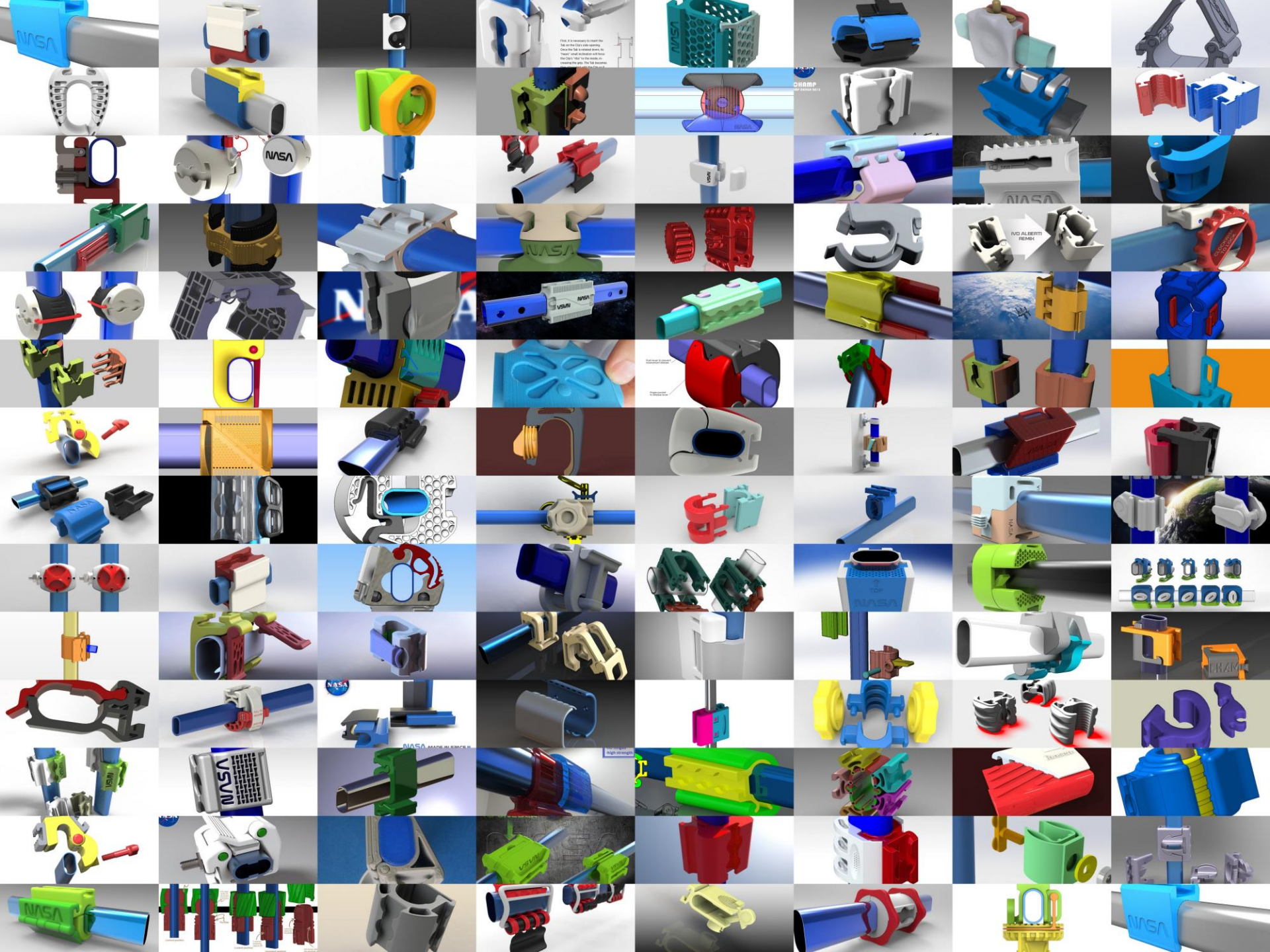
492
submissions
in 30 days



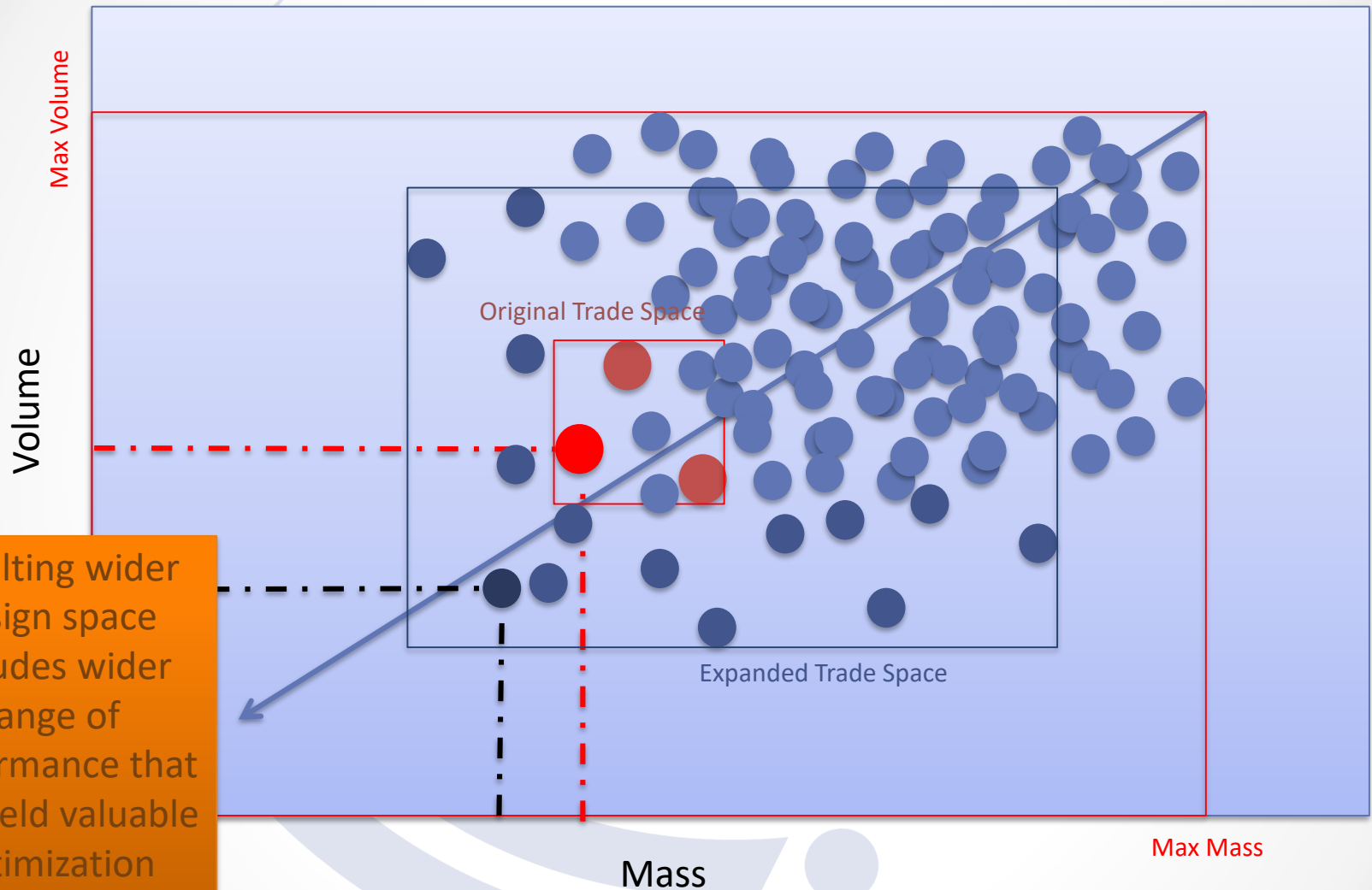
GRABCAD

Results

- Selected 5 winning designs from 492 diverse and innovative mechanical designs demonstrating a wide range of approaches.
- Winning designs evaluated for best approaches for in-space printing.



Typical Hardware Design Space (Performance Box)

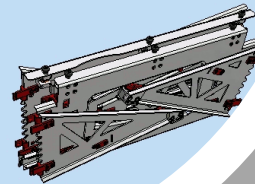
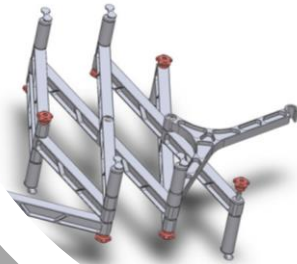
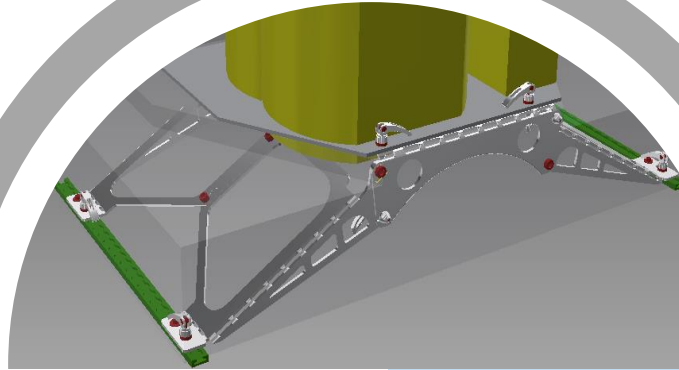


Resulting wider design space includes wider range of performance that can yield valuable optimization options

- Internal Team Solution Options
- Crowdsourced Solution Options

EXPERIMENT ATTACHMENT SYSTEM

Challenge to develop a structure to attach an experiment to an ISS rack with structural, stowage, and crew assembly constraints.



Total Cost to NASA \$3,500

Challenge Prize \$3,000

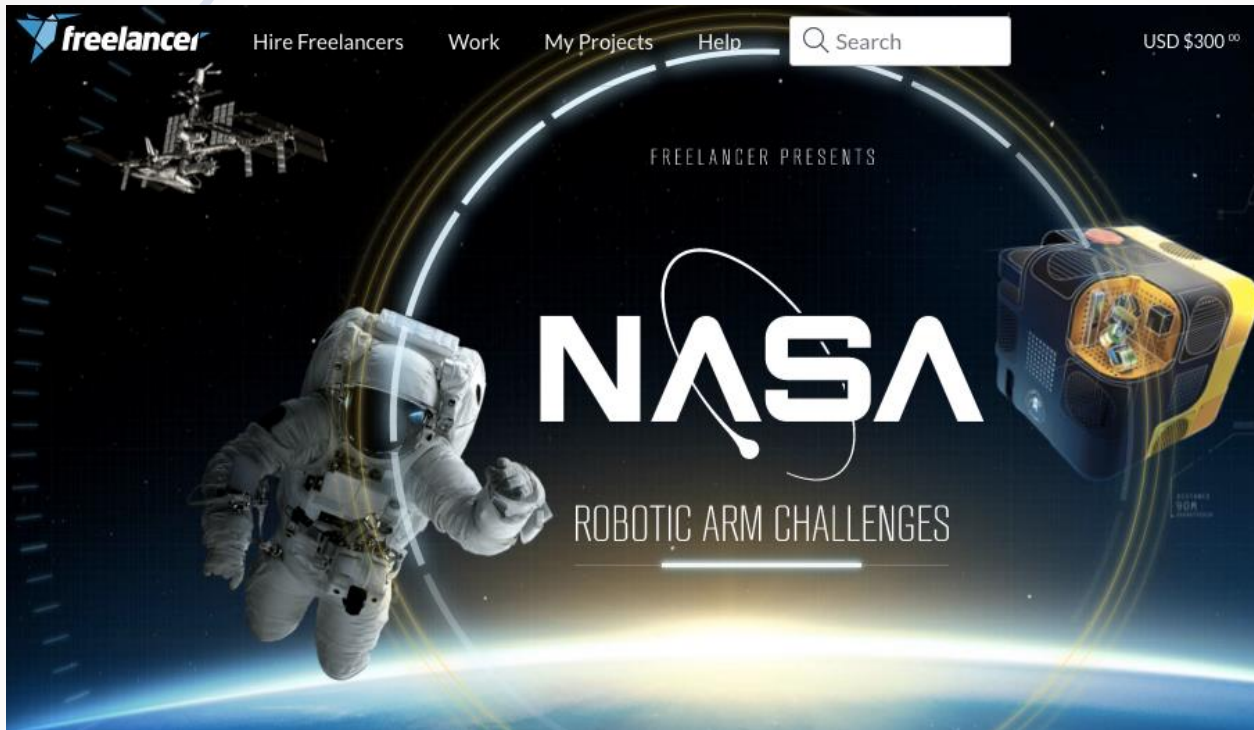
50 submissions in 30 days from 23 countries



GRABCAD

Results

- Selected 5 winning designs from 50 diverse and innovative mechanical designs demonstrating a wide range of approaches.
- Designs included manufacturing considerations and stress analysis.
- Winning designs will be used to inform final ISS design.



- Freelancer.com is a community of over 20M members who do a variety of freelancer work.
- Challenges provide them a way to build their portfolio.
- They charge very little overhead (2.3%) for contest.
- CoECI ran a set of pilot challenges to see if there was value in these challenges (\$10K for the pilot challenges) using a Gov't P-Card.

ROBONAUT SIM TOOLS 3D MODELING

Challenge to develop 3D CAD models of 14 different Robonaut testing tools (from photos) to be used in a testing simulation.



Total Cost to NASA \$1,100

Challenge Prizes 5x\$50, 5x\$75, 3x\$100, 1x\$150

Almost 300 submissions across 14 10 day challenges



Results

- Most challenges resulted in an acceptable submission by day 3.
- Demonstrated the power of the NASA brand and the desire of skilled people from around the world to contribute to NASA projects.
- In-house development estimated to be 3-10 times more expensive.

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PROJECT GRAPHICS/PATCHES

Challenge to develop graphics and patch designs for various projects that reflect the project based on information provided about the project.



Total Cost to NASA
\$1127

Challenge Prizes
1x\$100, 2x\$150,
2x\$200, 1x\$300

Over 1900
submissions
across 6
challenges



Results

- Evaluation showed \$200 prize optimal for around 200 submissions.
- Showed how individual submissions can be customized via feedback to freelancers.
- Demonstrated NASA brand power and the desire of skilled people from around the world to contribute in a meaningful way to NASA projects.

ASTRONAUT SMARTWATCH UI CONCEPT

Challenge to develop a UI concept for a smartwatch app that integrated ISS crew tools from the crew timeline, communications status, C&W, and timers.



Total Cost to NASA \$1535

Challenge Prize \$1500

245 submissions received over 30 day challenge

Results

- Winning Concept was from two User Interface experts from Canada.
- Challenge got significant worldwide news coverage (CNET, Time, Wired, Bloomberg, Forbes, etc (over 50 news outlets)).
- Winning concept was used as the starting point for demo software dev.



ASTRONAUT SMARTWATCH APP

A task on Freelancer.com where the recruited freelancer bid \$3000 to build the smartwatch app based on the UX concept contest.



Total Cost to NASA \$3,029

Task Schedule
5 months

Fully
functioning
prototype
app on a
Gov't
P-Card



Results

- Fully functional implementation of crew timeline, caution & warning messages, communications status, and timers.
- Included a web based data emulator in the delivery.
- Hardware (Samsung Gear2) required custom OS programming.

NASA@WORK

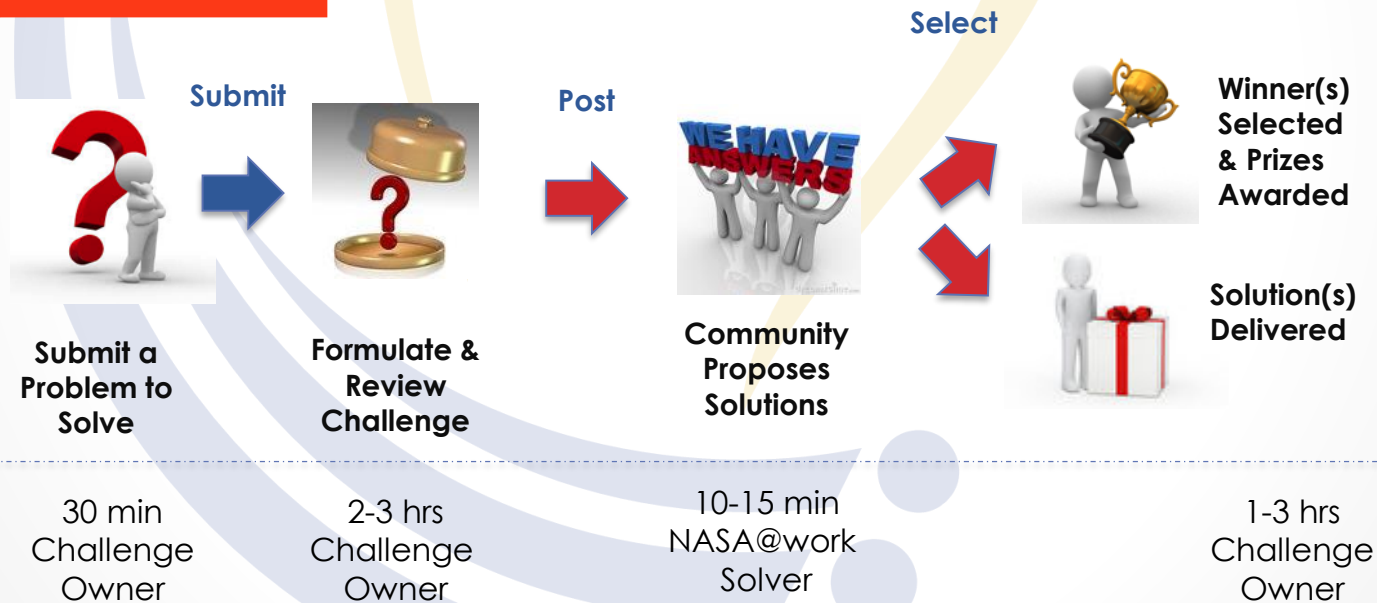
Tap into our most innovative community: NASA



What Is NASA@work?

- A NASA-wide platform for employees to find technical solutions, new ideas, or expertise using prize-based challenges (crowdsourcing).

How Does It Work?

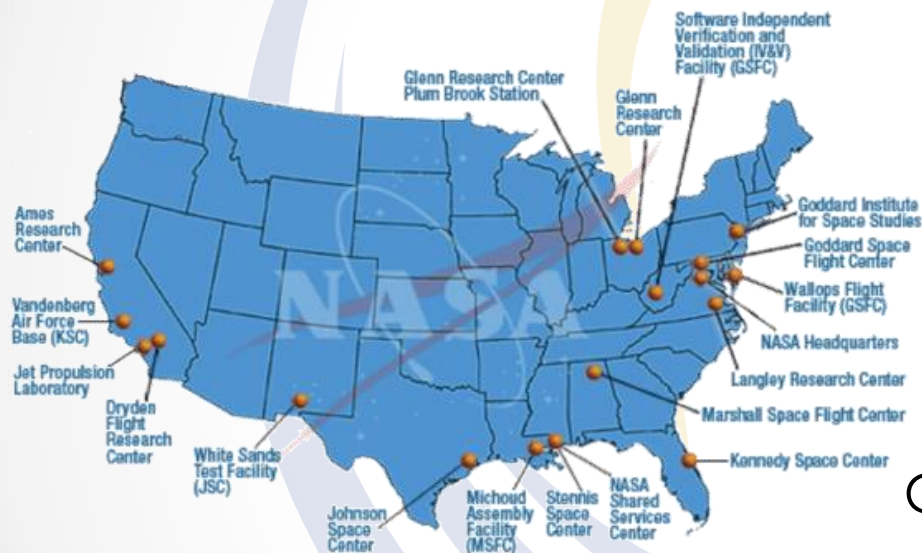


NASA@WORK

People that work at NASA want to make a difference!

Over 19,000 Registered Members

(+32% of NASA's 60,000 CS & Contractor Workforce)



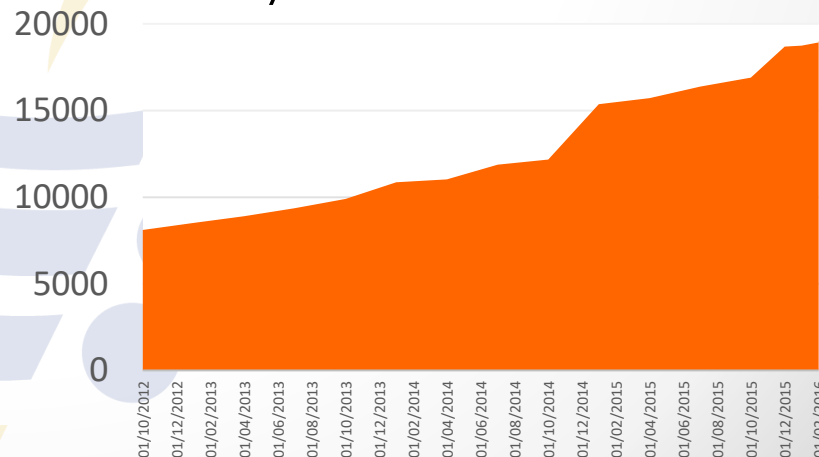
18-20 Challenges per Year

2-4 Active challenges posted at any one time

Growth of the NASA@work Community since October 2012

113 Challenges Posted

~80% Success Rate



Determining Urine Volume in Microgravity

Challenge – 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



60 Submissions

2 Solutions Awarded

Saved an estimated \$1.3 M; 3-5 years



NASA@WORK

Results

- Microgravity Capillary Graduated Cylinder (working prototype) and Calorimetry
- Unknown collaboration was identified within a sister organization

Use of Thorium Instead of Uranium

Challenge –
This challenge sought to identify any research that NASA has conducted into the use of Thorium instead of Uranium to generate nuclear power



17 Submissions

1 Solution
Awarded

Also
discovered
Apollo-era
research
results



NASA@WORK

Results

Winning submission was “instrumental in helping KSC understand the research NASA has funded in this area” Michael Lester– Challenge Owner.

CoECI's Crowdsourcing Experience

266 Challenges Total Completed or in Progress (with 18 more in formulation)



21 Innovation:
7 Ideation*
13 Theoretical
1 Reduction to Practice

1 Video
*3 USAID



3 Innovation
1 Consultation Task



4 Innovation
1 Video
*1 NIST



18 Algorithms*

23 Software** ***

3 Ideation

6 Graphics/Design

*USPTO, USAID, 2 EPA
**2 CMS, OPM, DOE

 APPLAUSE



1 Algorithm
*1 DHS



18 Tech Surveys*

*1 EPA, 5 NIST



130 Challenges



Common Pool

1 Innovation
*1 NASA/RWJF



5 Videos



2 Eng. Design



3 Ideation

15 CAD Modeling

11 Graphics

Plus 1 SW dev task
and 30 Architecture tasks

How NASA Teams Leverage the Power of the Crowd?

NASA@WORK

Register

Participate in a Challenge

Launch a Challenge

Free - Weeks

Run an Innovative Problem Solving Challenge

\$40-80K, 3-6 mo.



Run a Software or Algorithm Challenge

Cost & Duration Depend on the Challenge

yet2.com

Run a Tech Search

\$20K, 4-6 mo.

freelancer.com

GRABCAD

Run a Micro Challenge

<\$3.5K, 2 mo.
Gov't Purchase Card

<http://www.nasa.gov/coeci>

The NASA Tournament Lab



www.nasa.gov/coeci