

Surprising results from large crowds using Micro-Purchase Challenges - using contests on freelancing communities to source innovative, impactful and cost-effective solutions.

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(1) Introduction

Our world is more connected than ever before. The new digital economy is empowering platforms and crowds to become a progressively strategic way for organizations to innovate ahead of their competition. Existing research shows the effectiveness and quality of solutions crowdsourcing yields, yet few organizations genuinely understand it nor are leveraging those solutions to unlock the full range of benefits. Moreover, early adopters often face structural and financial barriers towards evangelizing digital platforms at scale within their organizations. NASA is an exception - being an advocate of the field since 2010, it has paved the path for large organizations to follow. An empirical analysis is conducted on NASA's Center of Excellence for Collaborative Innovation (CoECI) micro-purchase challenges on a crowd-based platform to assess the cost-savings, quality of work, time for work turnaround and brand effects of using this problem-solving mechanism. The results proved to provide a tangible impact on all four parameters. As such, micro-purchases could become a compelling entry-point for organizations who are willing to experiment and subsequently build a convincing business case to present to stakeholders. The paper concludes with NASA's learnings, supplemented by literature, on how to redesign business processes, change conventional thinking and create an organization that will transform its future with crowds.

(2) Methodology

2.1 Organizations, Platforms and Crowds

In just under a century, our world has shifted from the industrial revolution to a platform revolution. New technology is once again transforming the laws of our economy. Just as how electricity first disrupted steam-powered manufacturing plants in the 1920s, and the world wide web democratized access to knowledge in the 1990s, (McAfee & Brynjolfsson, 2017) the 2020s will mark a new digital age governed by platforms and assembled by decentralized crowds.

At the turn of the 19th century, electrification proved to deliver extraordinary cost savings and quickened the time to market of production items for factories who adopted this novel technology (Devine Jr., 1983). Within two decades, the plants that went out of business were the ones that fixated on historically proven methods that led them to prior success (McAfee & Brynjolfsson, 2017). In other words, these laggards were stuck in a cycle of 'status quo bias' (Samuelson and Zeckhauser, 1988). History tells us that inspiring mass organizational change is hard because implementing innovative technology is more than just a 'plug and play'. There is "need for organizational and above all for conceptual change in the way tasks and products are defined and structured" (David & Wright, 1999).

Just as Moore's Law governs the exponential growth of computing power, this era of digital economy is bound to accelerate the rate of disruption for organizations (Bondyopadhyay, 1998). Digital flows of data and information now have a higher impact on GDP growth than a centuries-old goods trade (McKinsey, 2016). Moreover, crowdsourcing and freelancing platforms have become more sophisticated, enabling organizations to manage knowledge flows across organizational boundaries and source solutions from distributed workers around the world (Grewal-Carr & Bates, 2016). Billions of freelancers are already using digital platforms to form crowds who are ready to learn, find work and showcase their talents (McKinsey, 2016). At a time when it becomes increasingly difficult for organizations to maintain the exact expertise and skills to support the innovations required to stay ahead, external crowds can provide an on-demand way to access the right talent fast, and with minimum overhead.

2.2 Definitions

Innovation science is still a relatively avant-garde field to the masses. Though there are many academics and startups who have pioneered research or partnered with forward-thinking organizations like NASA to embrace crowd solutions as a viable alternative to existing methods, there are many terms used in this discipline that could be ambiguous. To aid in the context of this paper, the following **definitions** will be used:

Freelancers are independent workers or sole proprietors who are paid by the task (or hour), have the autonomy to accept work based on the fee or desirability of the client and can take as many engagements as they'd like without being restricted to one employer (Boudrea & Lakhani, 2013). They are also called 'users' or 'participants' on platforms.

Freelancing is the act of freelancers who are performing paid services for the party that contracts them for a specific task. They often take on 'gigs' and are the crowds that form the gig economy.

Crowds are made of a group of individuals, many who are freelancers. They are diverse participants with unique interests and varied skills, and are often drawn from around the globe (Boudrea & Lakhani, 2013). A matchmaking algorithm can connect crowds to organizations based on past ratings, skills and expertise. Alternatively a crowd can also be manually filtered or vetted by a curation service provided by digital platforms.

Crowdsourcing, often used interchangeably with open innovation, is engaging crowds for problem-solving, idea generation or task completion through a platform (Araz, 2017).

Platforms are digital, large-scale and efficient marketplaces that facilitate real-time matchmaking between organizations that need a service with freelancers who are willing to provide that service (McKinsey, 2016). Platforms can either be 'contest' or 'projects' based. Freelancer.com is an example that has both platforms.

Contests, otherwise known as challenges or competitions, are tournament-based competitions on crowdsourcing platforms. Completed work is submitted as entries by the crowd and only the winner(s) will be awarded the prize money.

Projects are tasks that freelancers are hired for (either directly or through a bidding process) on freelancing crowd platforms. Independent freelancers can accept the work on an hourly or fixed price basis.

2.2 NASA's Journey to Micro-Purchase Challenges

In 2010, NASA discovered the positive potential for crowdsourcing to accelerate and augment its R&D efforts, leading to the establishment of the Center of Excellence for Collaborative Innovation (CoECI) in November of 2011 at the request of the White House Office of Science and Technology Policy (OSTP). To date, CoECI has run over 300 different challenges across many disciplines and domains through its NASA Tournament Lab (NTL), working with over 13 federal agencies across 17 crowdsourcing communities, in addition to the Laboratory for Innovation Science at Harvard.

Up until 2015, NASA primarily used two methods: NASA@work, an internal crowdsourcing platform, and NASA Open Innovation Services (NOIS) contract vendors. NASA@work includes about 20,000 NASA civil servant employees and contractors. It is primarily used to run "lightweight" challenges and facilitate enterprise knowledge sharing/discovery. The NOIS contract requires more effort, a request for proposal process and often costs between \$60,000-\$150,000 per challenge, sometimes much more. Since procurement finances must be planned and budgeted a year or more before it is spent, it is sometimes difficult to find projects with enough funding available to execute these kind of challenges in the near term.

In 2015, the Federal government paved the way for NOIS to experiment with 'micro-purchase challenges'. The Government Purchase Card (P-Card), which had a limit of \$3000, provided a simplified method to purchase low-cost items without a full government procurement-based contract. The CoECI team initially piloted a mechanical design challenge using GrabCAD.com. Seeing that went well, CoECI searched the internet to see if there were other crowd-based communities that could fulfill this need and discovered Freelancer.com. The team received \$10,000 of funding to run a pilot and proceeded to define 22 contests and one project to run on the Freelancer platform. These included 14 CAD modeling contests, five graphics contests, one technical ideation contest, a smartwatch user interface design, one CAD design contest and a software development project. The pilot concluded that micro-purchase challenges on platforms like Freelancer.com and GrabCAD.com provided an agile and affordable entry point to crowdsource for many of NASA's teams, particularly for initiatives that may not have enough funding for more costly challenges.

(3) Solution

3.1 Crowd-based Platform

In recent years, many other large enterprises have followed NASA's lead and realized the benefits of an on-demand, scalable and highly skilled workforce that can get a job done for a fraction of the cost. Platforms like Gigster, Topcoder or GrabCad either only specialize in freelancing or crowdsourcing. In some cases they are community-based around a single job category or skill like design. Comparatively, on Freelancer.com organizations can interchange between two different platforms: contests and projects. The flexibility to switch between the two is beneficial should the end goal change. For example, contests are often used 1) to find and identify the best freelancers for a job, 2) to cast a wide net for innovative ideas or 3) if the crowd finds the trade-off between effort vs. likelihood of winning is worthwhile. Meanwhile, projects are best for end product if the process is more involved, specific and complex.

Whether it is a contest or a project, these freelancers are matched to the hiring organization based on their past ratings and proven skills or expertise. They can bid for work, be hired directly on a fixed price or hourly basis or compete against one another to win a prize. The type of crowd on Freelancer.com is also global and has scale: 29 million users who collectively span across 228 countries, regions and territories. This number is also proliferating, with over 13,000 freelancers signing up on the platform daily. To date, over \$14 million in jobs has been posted and \$3 billion transacted in the marketplace.

There are usually two main components to most crowd-based platforms: the digital marketplace and a crowd curation service. The technology that fuels the marketplace is comprised of a ranking algorithm, skill evaluation, dispute resolution, payment platform and collaboration tools (milestones tracking, video chat, time-tracking, to name a few). The curation piece is where a human would provide a recruiter-like service to filter the top 3-5 freelancers for each contest or project or vet the top 1% of the platform. Other opt-in features could also include: IP Transfer Agreement, NDA, Private (hide from search engines), 'Feature' (promotes to top users) or 'Sealed' (hides submissions or bids from each other).

The micro-purchase challenge program that has followed the pilot simply started using these contests and projects as a normal way of getting work done for CoECI. In 2018 the P-card limit increased to \$10,000, enabling CoECI to do increasingly complex and larger tasks across +1000 skill categories on the platform over time. Examples include Labviews user interface design and development, structural design using origami concepts, video storyboarding, and CGI development. The program also expanded to include other platforms where a P-Card could be used such as Amazon Mechanical Turk and cOutsource.

(4) Results

4.1 Micro-purchase challenges on the contest platform

Including the pilot, CoECI has completed 40 challenges on Freelancer.com as of 2018, with challenge size ranging from \$75 to \$3500 (USD). Except for one project, NASA chose the contests platform as their primary platform because their focus was on the diversity and quantity of solutions submitted. The winning entries are used across many NASA's centers and directorates, including Engineering, Human Health & Performance and Exploration & Science.

Cost-based

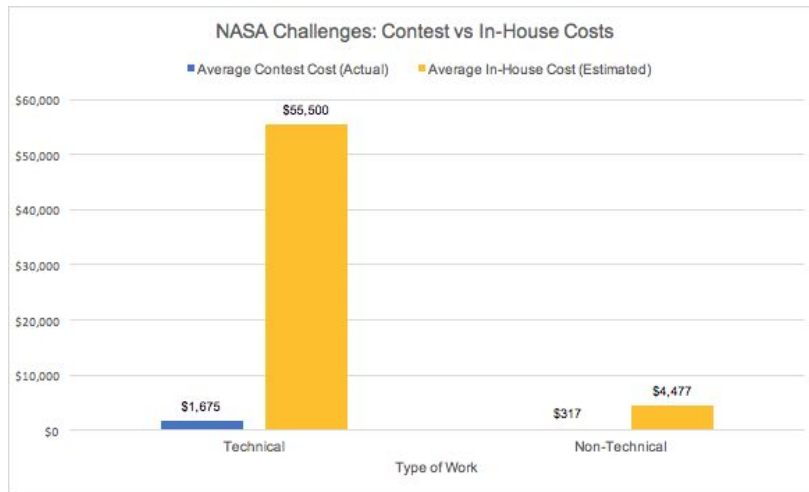
For each of the challenges, CoECI worked with the challenge owners (projects within NASA) to estimate how much the project would have spent if they had used traditional methods instead of crowd-sourced challenges. These estimates were simple, high-level estimates, but reflect the order of magnitude of traditional costs and a reasonable basis for comparison.

Technical Challenges include ideation, software/app or technical solutions like system architecture design while non-technical challenges comprised of graphics or video work. CAD/mech design fell under both categories, with the majority of them being non-technical. The radiation shield challenge was an exception since it was being led by the Engineering directorate. There was also one training course development for DTN ION (Interplanetary Overlay Network Software Distribution) that began as a non-technical challenge but phased into a technical one.

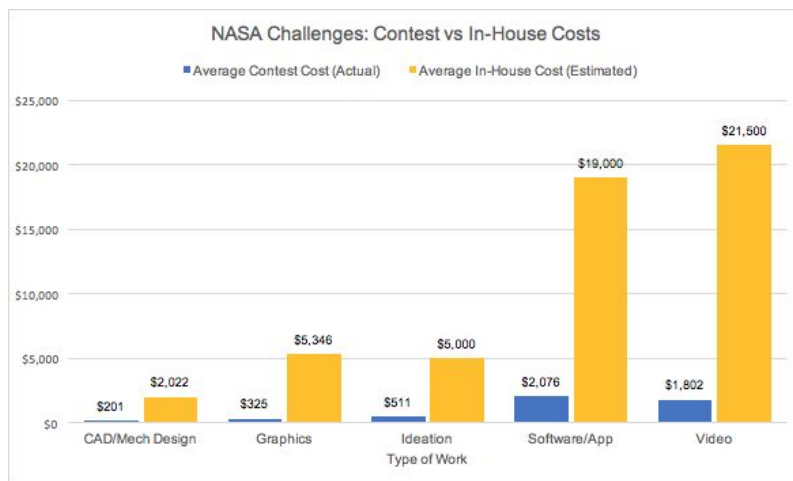
Total savings across all challenges were estimated in excess of \$322,033 (USD) when compared to traditional methods. As expected, the average price of technical work both in-house and on the platform (\$55,500 vs. \$1675) was higher than non-technical

contests (\$4477 vs. \$317). Average cost savings per challenge for both were significant but technical work (97%) realized slightly higher savings than non-technical work (93%). This could be nominal over time since the sample size was only comprised of 40 contests.

Note: These costs do not include the NASA labour hours required by the challenge technical owners (Robonaut team, DTN teams, etc.) and pilot management (set up, collecting data, monitoring progress, coordinating budgets and scheduling). Though, these efforts are similar to those required if teams were completing the projects in-house.



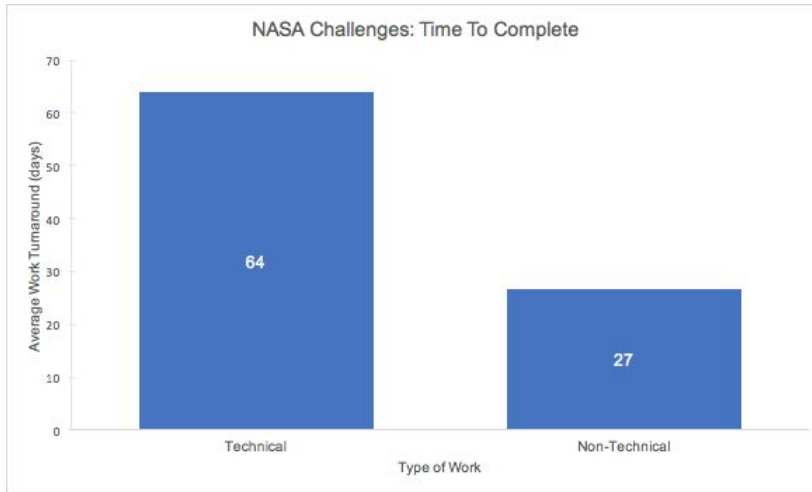
Across all categories of work, whether technical or non-technical, CoECI on average would have paid ten times the price if it used other methods to source a similar solution. The highest savings by category was Graphics (94%), followed by Video (92%), CAD/Mech Design (90%), Ideation (90%) and Software (89%).



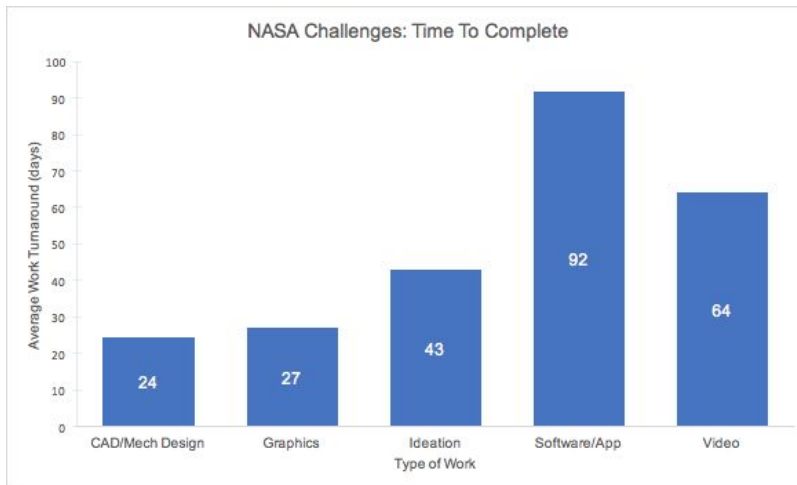
Time-based

Technical challenges were executed in about two months, while non-technical could be done on average in under a month on the platform. There is also evidence that some challenges can run in as little as two days. Also, there was one instance where a well-defined challenge was requested and it was launched in just five hours, with completed entries coming in just a few hours after that. This compares to an average standard work turnaround of two to three months for NASA's existing NOIS contract vendors.

On the Freelancer.com platform, the contest holder has the liberty to decide how long or short to open the contest entry period for, with 62% of contests receiving a completed entry in an hour. The length of time a contest runs is positively correlated to the number of entries it receives until it reaches a tipping point of decreasing marginal returns.

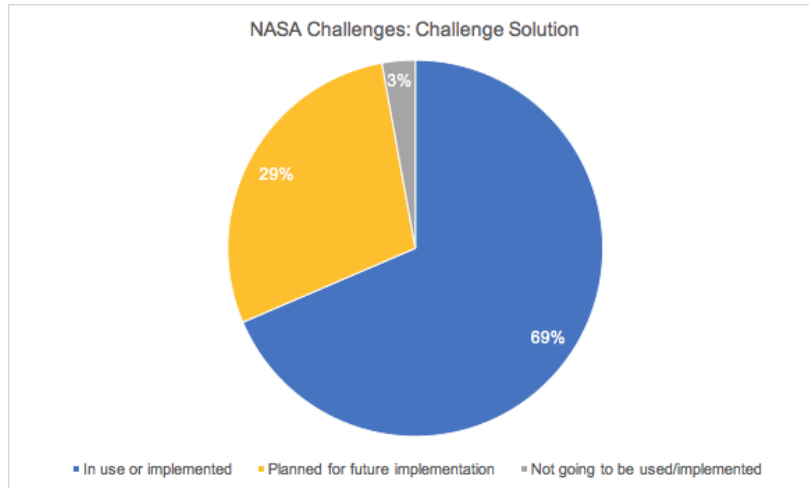


Linear with pricing, challenges that cost more on average (like Software/App and Video) took longer to complete on the platform given the increased complexity and size.



Quality-based

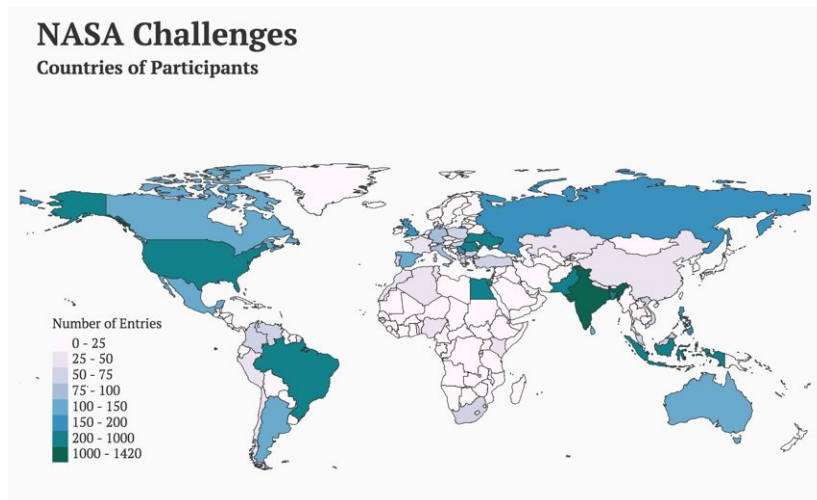
Overall, NASA rated that 97% of all challenges would be implemented by NASA; 69% are already in use and 29% will be planned for future implementation. Advanced Mission Operations, CoECl, NASA Centre for Climate Simulation, In-Space Manufacturing, Logistics Reduction and Disruption Tolerant Networking were among the projects within NASA that have already implemented and are currently using the solution developed on the platform. The REALM Animated Video is an example of a sourced solution that is already in use while the NASA's Astrobeer Robotic Arm Architecture Challenge is one planned for implementation in the coming months.



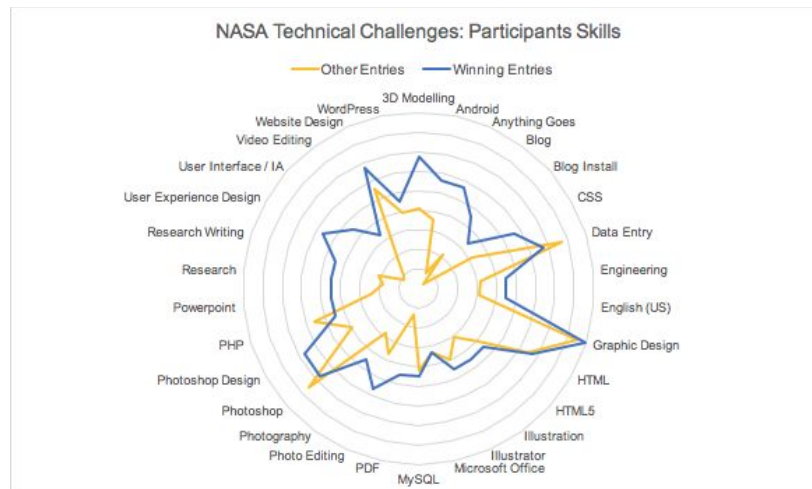
Brand Effects and the Crowd

The NASA brand has been a considerable lever for incentivizing the crowd size and engagement, as evident from the first pilot challenge on the platform. The first 3D modelling contest for \$50 resulted in 451 members on Freelancer.com expressing interest and 92 submissions; the second contest had 130 users registering intent and 51 submissions. This decaying trend continued over time - this indicates for some categories, the novelty of the NASA brand could subside over time. However, it is interesting to note that based off of NASA's feedback (though the overall number of entries decreased) the quality of submissions remained quite high so that the overall quality of entries was steady.

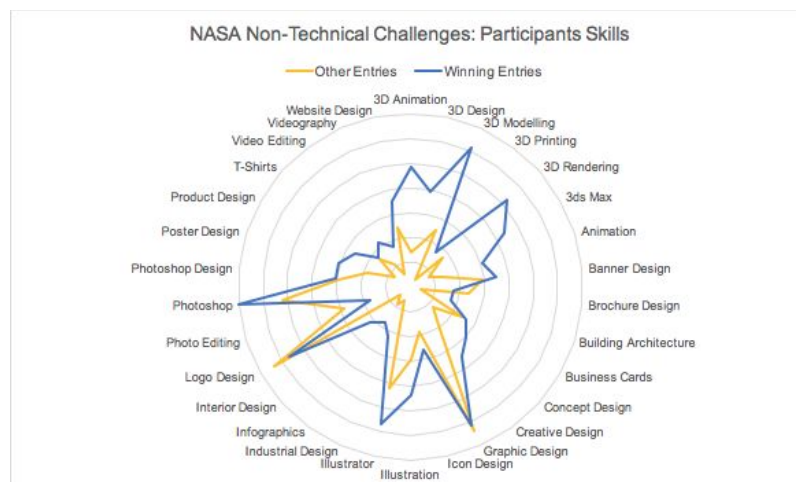
To date, there have been 4534 freelancers from 126 countries who have submitted 7820 entries for CoECI challenges. The most involved countries and regions include India, the United States, Brazil, the UK, Eastern Europe and Southeast Asia, followed by Russia, Canada, Mexico, Argentina, Spain and Central Europe.



For technical challenges, winning freelancers had more Android, 3D Modelling, Website Design and UX Design skills when compared to all other participants.



Winners for non-technical challenges interestingly also had more 3D Modelling skills, in addition to 3D Animation, 3D Rendering, Poster Design and Illustrator skills than the other participants.



NASA's brand had the ability to both increase participation from Freelancer.com's existing user base, as well as acquire new members of the public to sign-up specifically to participate in one challenge. During the two month pilot period alone, Freelancer.com measured 110,000 hits to the NASA Landing page. Having an official landing page (<https://www.freelancer.com/contest/nasa>) to link as part of the contest descriptions also added credibility, convincing freelancers that it was the legitimate NASA team running these competitions instead of users pretending otherwise. The response from the crowd community from both participants and winners alike were exceptionally positive:

"Thank You nasacoeci for the great opportunity to work with you! Your contests were really a great start for a recent college graduate like me."

- Winner of the Robonaut Dumbell Stand Model Challenge; Tarun Kalia, Mechanical Design Engineer from Gurgaon, India.

"To many of us working for NASA in any shape or form is a dream, a dream that could never come true. This was as close as it was ever going to get for me and it was a great experience. Thank you NASA!"

- Winner of the NASA@WORK 3D Award; Steven Brewis, designer from Johannesburg, South Africa.

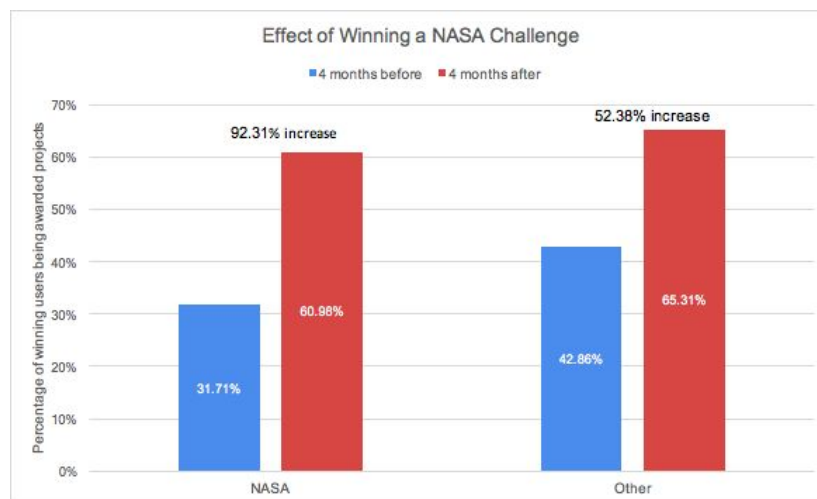
"It was a pleasure to work with NASA and a very big honor for us. We hope that we can work together in the future."

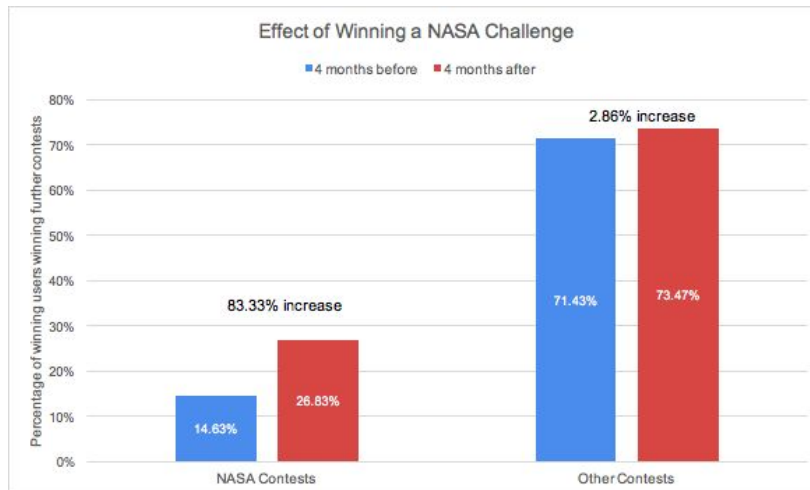
- Winner of the Robonaut RFID Scanner Challenge; Gergo Szatmari with Black Riddles Designs from Göd, Hungary.

Many freelancers were incentivized by NASA's mission as an organization and ability to showcase their portfolio with NASA's work, as opposed to prize money alone. Using the 14 Robonaut 3D Modelling Challenge Series as an example, only five of the winning participants earned a profit when benchmarked against those freelancers' usual hourly rates (as listed on their profiles ~\$25-\$60USD). The other nine winning participants invested time above and beyond their hourly rates - equating to an additional 38.3 man-hours. This indicates that the non-monetary benefits of the challenge outweighed the prize money on offer. While this may not appear a lot for this small group, if we assume the cost to participant averaged 6 man-hours x 186 total participants then it would equate to 1,116 man-hours in effect being donated by participants.

Challenge	Hours	Member Rate (per hr)	Time Cost	Challenge Prize	Member Profit
EVA Handrail	6	\$25	\$150	\$50	-\$100
Manila Envelope	0.25	\$10	\$2.50	\$50	\$48
Flashlight	6	\$13	\$78	\$50	-\$28
Scopemeter	10	\$25	\$250	\$50	-\$200
EVA Grapple Hook	6	\$18	\$108	\$50	-\$58
RFID Scanner	3	\$15	\$45	\$75	\$30
Scopemeter Soft Goods Case	8	\$20	\$160	\$75	-\$85
Small Soft Goods Box	8	\$20	\$160	\$75	-\$85
Sheathed Hose	3	\$50	\$150	\$75	-\$75
Soft Goods Task Panel	5	\$10	\$50	\$75	\$25
Drill with/without Battery	15	\$10 (assumed)	\$150	\$100	-\$50
Drill Battery with/without Charger	10	\$25	\$250	\$100	-\$150
Blanket Stand	9	\$10	\$90	\$150	\$60
Dumbbell Stand	7	\$10	\$70	\$100	\$30

Participants likely saw this as an opportunity to build their own brand as a freelancer and invest in NASA now to increase their likelihood of future success. Winning a contest on Freelancer.com indeed becomes a predictor for future success: across all challenges on Freelancer.com, the likelihood of being awarded a future project increases by 52.28% and a contest by 2.86%. This number is even more staggering if the data was extrapolated only for NASA contests winners. These freelancer's ability to win future work on the platform: increases substantially: a remarkable 92.31% for projects and 83.33% for contests!





4.2 Challenge Case Studies

Robonaut 3D Modeling Series

The NASA Robonaut project sought to virtualize much of its Robonaut vision and grasp testing. Therefore they required a set of 3D models of objects used in real-life testing but did not have the time nor resources to create these models. They decided to run 14 challenges on Freelancer.com, each of which ran for ten days.

Overall, NASA found “the results of these challenges to be quite remarkable.” The price and quality of the 3D models developed demonstrated significant value potential for NASA. They saved an estimated 86% (\$11,680) compared to traditional CAD model development costs and spent a total of \$1910 for all 14 contests. Based on the Robonaut 3D modeling series, NASA’s recommendation for its internal department was to use Freelancer.com when 3D modeling resources are unavailable/over-loaded or not affordable.



Shown Above: Winning 3D Models for Robonaut Simulation

DTN Application Ideation

This challenge asked the community to come up with an idea for a software application that uses the Delay/Disruption Tolerant Networking (DTN) Protocol. It required the crowd community to learn about the DTN protocol suite (a difficult task), then creatively come up with a terrestrial application the public could use on a mobile device.

A similar challenge was planned for \$28,000 on a competing platform. On Freelancer.com the challenge ran for 30 days with a \$500 prize. The results were 67 submissions from 43 members. There were several ideas that intrigued the DTN team, but the winning submission was from a physicist from Chicago who had seen this challenge on Challenge.gov and joined Freelancer.com to participate. The DTN built an application conceptualizing the winning submission.

This challenge saved NASA just over \$27,500 (99%) compared to the other platform and proved that Freelancer.com had a vast pool of talent to solve ideation challenges where creativity and innovation skills are essential. NASA states it was “unlikely that the other platform would have attracted the same physicist from Chicago with a good idea”.

Astronaut Smartwatch App

Two young engineers at JSC pitched the idea of using a smartwatch for the ISS crew at the Innovation Charge Accounts (ICA) elevator pitch competition. Though they were not selected for the ICA funding, CoECI approached them to see if they would be interested in bringing their idea to life using Freelancer.com. They agreed and proceeded to define a challenge to develop a user interface concept for a smartwatch app that integrated ISS crew tool features from the crew timeline, communications status, caution and warning, and timers.

NASA posted this as a \$1500 challenge and chose to run it for 30 days, which resulted in 245 submissions by 154 members. Two engineers from Canada, who signed up on Freelancer.com after reading a news article about the challenge on CNET, developed the winning entry.

A similar conceptualization challenge on an alternative platform costs \$32,459. Estimates show that this challenge was likely a bit less complex and may have cost as little as \$25,000 on that platform. At \$1500, this resulted in \$23,500 in savings (or 94% savings).

The actual coding of a demonstration application that implements the user interface concepts was completed as a Freelancer.com project for a flat \$3000. Contests are best used for open-ended, ideation, design or small-scale technical tasks to test the skillsets of a large crowd of freelancers. For specific tasks that have an expected output and complex in nature, projects are the ideal method. The Astronaut Smartwatch App turned out to be an interesting experiment where the contest and project platform are used together to take an idea from prototype to finished product.



Landing page linking to other (not all) NASA challenges

Though not comprehensive, <https://www.freelancer.com/contest/nasa> features some of NASA's past work on the platform and planned challenges for the future.

(5) Implications for the Future

5.1 NASA's Learnings on the Contest Platform

For CoECI, open innovation has proved successful for the following areas: solving difficult problems, enterprise knowledge sharing, data science, software development, technology search, mechanical design, and creative/multimedia design. During the micro-purchase challenge program since 2015, NASA has tested various strategies to optimize output from the crowd. The learnings from that journey, along with literary references are used to discuss how internal team structure, challenge design and crowd incentive can jumpstart a micro-purchase challenge program.

Actionable Insights for Organizations

Internal Team Structure. Organizational structures and business processes have to be redesigned in order to optimize the benefits of crowd-based work. Nominate a Project Manager who will be the designated owner of this initiative. For example, CoECI's Deputy Manager was the main person that coordinates requests from NASA's internal teams, manages the micro-purchase challenges (contest design, timeline, milestones) and engages with the crowd. Collaborating with a virtual workforce is much like working with an offline team - effective management and feedback yields better results. "Collaborative communities work best when participants can accumulate and recombine ideas, sharing information freely" (Boudreau & Lakhani, 2013). By increasing interaction with the freelancers throughout the challenge duration, CoECI could steer their final output closer to NASA's vision; participants will also comment and provide feedback on each other's entries.

To discover if open innovation is the right choice for the organization, workshops are required to start a dialogue with internal teams. CoECI's Deputy Manager, who effectively became the in-house 'crowdsourcing evangelist', educated internal teams at NASA and farmed out problems to decompose them into component pieces that were solvable with crowdsourcing. Having a quality approval process also enabled CoECI to align its stakeholders and have full control over the winner selection, payment and IP

handover. Contest entries should be reviewed and evaluated by a panel with the relevant skills and be able to do the evaluation quickly (Bhandari et al., 2018).

Challenge Design. Identify the objective and well-defined problem in which a solution is required. The problem must be “extracted” from the organization - translated or generalized to be immediately understandable to many outside solvers then abstracted to avoid revealing organization-specific details if confidentiality is essential (Boudreau & Lakhani, 2013). CoECI often broke up larger tasks into multiple smaller ones that were under the micro-purchase limit. This sort of modular design enables the organization to slot in different elements as they are developed and refined (Bhandari et al., 2018).

Writing a detailed, accurate and clear contest brief that is free from jargon is essential for communicating needs to the crowd. Creating judging criteria and scoring systems also aids in the evaluation process. After, it is vital to establish the parameters of the challenge: its duration, evaluation criteria and budget (Deloitte, 2014). Customize the parameters of the challenge with upgrades based on needs, whether that is time-sensitive or confidentiality. Depending on the success metric(s), should it be speed, quality, diversity of ideas or cost, the challenge could be structured differently. For example, time could be traded for higher quantity and diversity of submissions if a contest duration was extended. The best challenges are designed to yield solutions that an organization can feasibly implement after (Boudreau & Lakhani, 2013).

A contest can also be designed with the intent of ‘screening’ freelancers for large, complex tasks later. For example, through a code review challenge, the top 5-10 engineers can be filtered based on a small sample of work they have already submitted as the contest entry. These freelancers can then be filtered and hired via the projects platform for a fixed price or an hourly task. Using this method could be a great way to curate the crowd and control for quality.

Crowd Incentive Experiments. Crowd-based platforms are an open market economy for services; sending different signals to the crowd will incentivize them accordingly. Create the first 3-5 micro-purchase challenges with the intent of testing how the challenge design could affect crowd participation and output. Various incentives can be used such as financial payment, community-related motivations, crowd size and public reviews or ratings (Antikainen et al., 2010).

Pricing is interesting to test. For example, all of CoECI’s micro-purchase challenges resulted in high-quality products, with the exception of when the prize was intentionally set too low (\$50 for a CAD challenge). On the other hand, setting a price too high (from \$250-\$300 for a graphics contest) increased the entries from ~100 to an overwhelming 1600 entries. Keep in mind NASA’s brand had a particularly strong effect on this variable.

Crowd motivation is also influenced by the type of community and platform. There is a distinction between running a contest on a dual freelancing/crowdsourcing platform (Freelancer.com) vs. a specialized challenge-only platform (Topcoder or Tongal). In the first type, freelancers are competitive because they depend on the platform as a source of income, thus carefully considering their tradeoff between time and money for work. However this factor is often offset by the sheer size of the Freelancer.com community - out of 29 million users there is a statistically large number of passionate and talented people who would participate in a contest despite the risk of not winning (and making money). Meanwhile specialized platforms have many skilled members who are smaller in numbers but work more like a community to obtain good results. They also have an intermediary agent that provide an end-to-end service on behalf of the organization (which is where the extra cost comes in) whereas Freelancer.com is a ‘high-touch’ affair that enables the contest owner to interact directly with the crowd for a lower price-point.

The size of the crowd is also a consideration. Adding more competitors increases the overall performance for highly-uncertain problems but can have a negative effect if the nature of the problem is straightforward (Boudreau et al. 2011). In the latter, it would work best to hire a freelancer via the projects platform. Given that freelancers like to outcompete each other, prizes and opportunities that could increase the reputation of freelancers among peers is also a way to draw skilled participants (Boudreau & Lakhani, 2013).

Independent freelancers on the platform want to do well because their future income depends heavily on their current performance and skills ratings. Freelancers have to continually provide a credible quality signal, most apparent in the ranking algorithm that reflects relative performance (Boudreau et al., 2016) and build a portfolio to showcase themselves to increase their rehire rate going forward. In this sense, crowd-based platforms arguably creates more transparency than the average in-house performance reviews because the ratings are public. However, no single combination of motivational drivers are generally applicable to all crowds - offering a range of motivational drivers and varying the implementation details over time can enable the organization to gain insights particular to its situation (Ghosh & McAfee, 2011).

5.2 Conclusion

Micro-purchase challenges on contest platforms provide a low barrier of entry for organizations that are at early stages of exploring open innovation as a problem-solving mechanism but have limited or restrictions to funding. Successful low-cost challenges could build a great business case to win management buy-in and open the door for larger, more complex crowdsourcing and freelancing tasks later. Over a period of three years from 2015 -2018, NASA demonstrated this micro-purchase approach on almost 50 contests using 4 different platforms. Its first contest was \$75 and by 2018 CoECI launched the \$25,000 Astrobee Robotic Arm contest series (<https://www.freelancer.com/contest/nasa/astrobee>). Because of the success of this program, CoECI now includes these types of challenges as part of its core open innovation toolkit. Additionally, CoECI continues to seek ways to engage vendors like Freelancer.com, GrabCAD and Amazon Mechanical Turk in new and expanded roles beyond just micro-purchase challenges.

CoECI's innovative, streamlined process with the P-Card enabled quality and fast work turnaround with extraordinary cost-savings (80% - 99%) when compared to traditional methods. Furthermore, NASA implemented a majority of the solutions (97%) across a wide range of its federal space programs. By matchmaking needs with skills on-demand in areas where NASA teams did not have the expertise nor resources available, crowds delivered high quality and creative work. Not to mention, challenges have become a vehicle for NASA to engage with the public and vice versa.

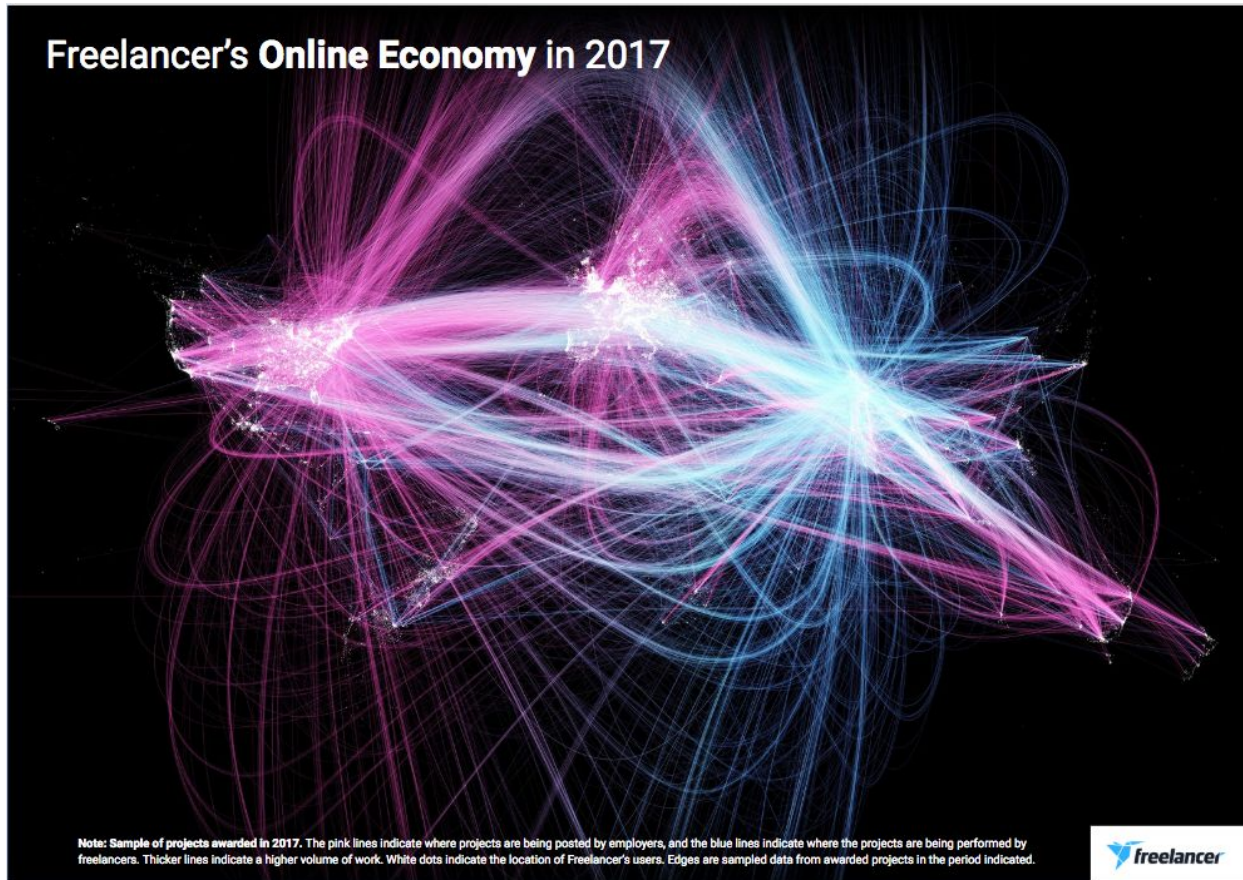
Following NASA's lead can enable organisations to redesign their business processes, challenge conventional wisdom and adopt new problem solving instruments as a strategic play. Crowdsourcing is a phenomenon that will radically change our digital economy, offering the convergence of organizations, platforms and crowds. Now is the opportune time for organizations to start experimenting and rethink how it can embrace the inevitable future of crowds.

Exhibits

1. Freelancer.com's Online Economy in 2017

Pink lines indicate where the work is posted from and the blue lines indicate where work is being performed by freelancers. There are 29 million freelancers across 228 countries, regions and territories. 13,000 new freelancers sign up on the platform daily.

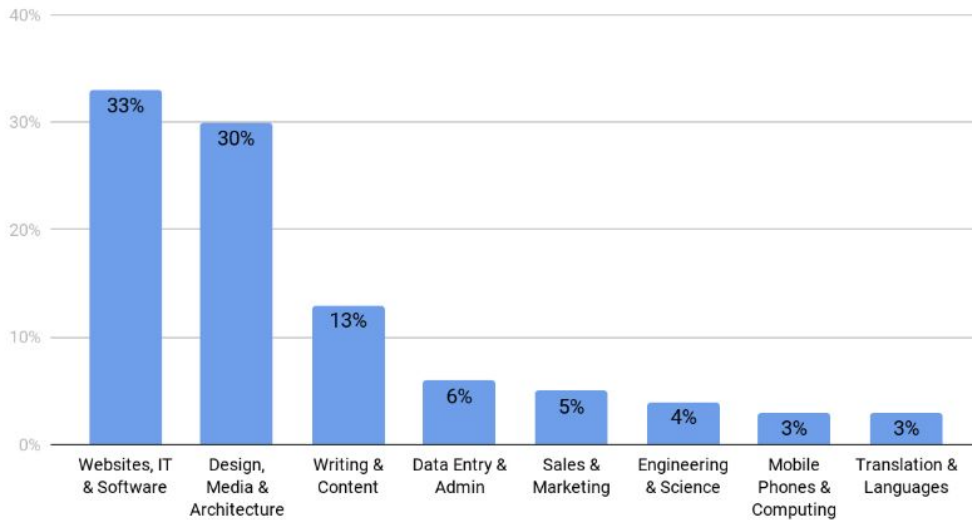
This number is also proliferating, with over 13,000 freelancers signing up on the platform daily. To date, over \$14 million in jobs has been posted and \$3 billion transacted in the marketplace.



2. Top Categories by completed projects in 2017

The most popular category of work done on Freelancer.com include 1. Website, IT & Software (33%), 2. Design, Media & Architecture (30%) and 3. Writing & Content (13%).

Top categories by completed projects FY17 (%)



3. NASA's Micro-purchase challenges

The four visuals below represent the work done by NASA on Freelancer.com

freelancer


We push the boundaries of human innovation

The NASA Tournament Lab and Freelancer have teamed up to help crowdsource solutions to the most complex problems being faced by astronauts on the cutting edge of space exploration.

4. Users on Freelancer.com

The freelancers 'Charis' and 'GregoryBair' were hired via a the project platform on Freelancer.com to aid in collecting academic research for this paper.






FREELANCER / BUSINESS / CHARIS





Our Rate


\$34 AUD/hr


I'm Offline



 Woodbridge, On, Canada

 It's Currently 2:41am Here

 Member since November 9, 2015

 17 Recommendations

Report User

Charis

Professional Writing, Editing, Legal Docs

FEATURED REVIEW

"Best professional freelancer I ever worked with. Dedicated and created all text from scratch. Was not an easy job at all and she did an eye opening job. Worth all my respect and will definitely work with again." — bara3212

4.9

★★★★★

127 reviews

6.8

\$

★★★★★

100% Jobs Completed

98% On Time

98% On Budget

17% Repeat Hire Rate


Bad writing costs you money. Let me write high-quality, high-impact content that will translate into better online visibility and growth for your business or career.

I write materials for businesses, academia, non-profits and the general public. My areas of specialty are:

- Website Content
- White Papers
- Policies and Procedures
- Handbooks
- Manuals
- Other Technical documents

Read more






FREELANCER / BUSINESS / GREGORY BAIR, MBA





Our Rate


\$61 AUD/hr


Replies within a few hours



 Kansas City, United States

 It's Currently 8:29pm Here

 Member since February 13, 2010

 83 Recommendations

Report User

Gregory Bair, MBA

High Level Business, Finance and Marketing

FEATURED REVIEW

"Very professional services. I was very impressed with his high quality of work, all done in such a remarkably limited amount of time. I would definitely use his services again and I highly recommend him." — tfermand

4.8

★★★★★

876 reviews

9.8

\$

★★★★★

89% Jobs Completed

91% On Time

98% On Budget

7% Repeat Hire Rate

Greetings! I provide professional business, finance and marketing consulting and focus primarily on business planning, marketing strategy (online and traditional) and have additionally developed dozens of websites. I hold a Bachelor of Business Administration degree in Management and a Master of Business Administration degree in Finance.

I have created over 1000 business plans and Investor Memorandums in the past 10 years. Additionally, I have raised debt and equity totaling \$240+ million to fund these ventures. My goal is to create dynamic narrative content combined with compelling financial data for you.

I spend considerable time analyzing current marketing efforts and creating marketing strategy that works. SEO, SMM, SEM for both inbound and outbound efforts.

Read more

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