Using Incentive Prizes to Drive Creativity, Innovation and Breakthroughs

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Incentive Prize Overview

This paper discusses the use of incentive prizes to drive creativity, innovations and breakthroughs. Incentive prizes offer a large reward upon completion of a specific objective task. Traditionally they are large cash purses awarded to individuals or teams who build and demonstrate a new system (typically technology based) or accomplish a first time feat.

It is my belief that such prospective prizes that reward innovators for achieving a specific measurable goal have profound economic and psychological levers for accelerating and enabling innovation in areas that might otherwise be stuck for a number of reasons.

While prizes are not a panacea for driving innovation, they do provide an enormous amount of leverage and should be part of every organizations innovation tool box. Unfortunately, prizes are being vastly underutilized at this time. My personal objective is to encourage the notion that 10% of all philanthropic giving and 10% of all research grants should be in the form of incentive prizes which will result in additional capital and talent entering into the innovation marketplace.

Properly structured incentive prizes have a number critical attributes worth considering:

(1) Efficiency: You only pay the winner. The prize stands until the goal is achieved. In one fashion it is fixed cost science or engineering.

(2) Leverage of Resources: Traditionally a well structured prize can drive 10 – 40 fold the amount of the prize purse spent cumulatively by the teams to win. Prizes cause non-traditional funding sources (philanthropic funds, ego money and corporate sponsorship) to enter into a field.

(3) Industry Creation: Rather than back a single approach to a problem which traditionally happens with venture capital funding where you need to "pick the winner" in advance, an incentive prize can support a wide variety of approaches/solutions to come into existence to address a challenge, thereby creating an entire industry

(4) Paradigm Change: A properly structured prize can change what people believe is possible… which is the first step to any innovation… You have to believe it is possible.

As Astronaut Byron Lichtenberg, a close friend and early co-founder of the X PRIZE Foundation once said, "Without a target you'll miss it every time." Incentive prizes offer innovators and doers a target to shoot for and a publically celebrated goal to achieve.

This paper investigates the fundamental drivers that are necessary to inspire exceptional creativity in science and technology and builds the case that incentive prizes have powerful and wide ranging psychological and economic impact on this goal.

Some of the best known incentive prizes (expanded upon in Appendix 1) are:

- Longitude Prize: Over £100,000 in purse money offered by the British Government (Board of Longitude). Won principally by John Harrison for his chronometers between 1737 – 1764.

- Orteig Prize: $25,000 offered by Raymond Orteig for the first non-stop New York – Paris flight. Won by Charles Lindbergh in the Spirit of St. Louis in 1927.

- Kremer Prize: Offered in 1959 by Henry Kremer. The first Kremer prize for £50,000 was won by Dr. Paul MacCready in 1977 in the Gossamer Condor for human powered flight around a figure eight flown between two markers ½ mile apart.

- DARPA Grand Challenge: The DARPA Grand Challenge ($1M) and Urban Challenge ($2M) was a prize competition for driverless cars sponsored by DARPA. The Grand Challenge was the first long distance competition for driverless cars in the world. Over the course of the first two years more than 195 different teams registered to compete.

- Ansari X PRIZE: A $10 million purse offered by the X PRIZE Foundation for the first team to fly a privately built 3-person spaceship to 100 km twice within two weeks. The prize was won by Burt Rutan's SpaceShipOne funded by Paul Allen.

The Drivers of Innovation

True innovations are often a radical departure from accepted theories, modes of business and beliefs. As such, early on, they can be considered nonsensical, impossible or worse yet, heretical before they are ultimately proven and accepted. For this reason, true innovation requires a willingness to take substantial risk.

So what are the fundamental drivers that push individuals, groups and organizations to take risk and innovate?

i. Curiosity: The desire to find out why? To take on a challenge and find the answer is a very important long-standing driver, but unfortunately it is one of the weakest, especially as compared to fear or greed.

ii. Fear/Defense: Nothing focuses one's mind like fear - the fear of harm at the hands of an enemy, the fear of losing in a competition. Extraordinary fear enables extraordinary levels of risk-taking (e.g. "nothing to lose"). An excellent example is the incredible risks taken by the Apollo program in response to Soviet successes with Sputnik and Gagarin.

iii. Wealth Creation/Greed: The desire to create wealth, to multiply one's resources is a fundamental driver in the capitalist society. Best exemplified by the Venture Capital industry that will back 10 ideas hoping for one grand-slam winner. On a smaller level, Paul MacCready's motivation to compete for the Kramer prize was a desire to win the funds to pay off personal debt.

iv. Significance/Fame/Sport: The need for recognition of colleagues; the desire for fame and adoration from the public, or the desire to transition from "success to significance". This is one of the fundamental human drivers. There is a basic desire to compete for sport and pride. We are genetically predisposed to compete, we enjoy it. What causes the wealthy to spend $80 million (on average) to compete for the America's Cup?

I propose that a simplified way to measure the ratio of "curiosity" to "fear" to "greed" as a driver in our society can objectively be measured by the ratio of the government "science budgets" to the "defense budgets" to the "corporate R&D budgets."

On the flip side, what are the drivers that block risk-taking and innovation?

i. Fear: A fear of failure, and therefore a desire to avoid criticism and embarrassment.

ii. Protectionist Attitude: Ultimately, innovation is disruptive and can topple industries and institutions. Large organizations such as government, corporations, and religious organizations desire to maintain the current balance of power in leadership and invested infrastructure.

Ultimately incentive prizes promote and focus the positive drivers of creativity and innovation, and buffer the negative drivers. Properly structured, prizes can enforce drivers such as curiosity, fame, significance, wealth creation and provide the construct that encourages a competitive mindset. On May 18th, 1996 at the X PRIZE Foundation Gala dinner, aeronautics designer Burt Rutan said, "I've never in my life been so creative as I have been going after this god-damn prize! I'm not going to tell you what I've come up with because I want to win this thing!"

Prizes also offer an "off balance sheet" mechanism to deal with fear of failure. An organization wishing to try radical approaches without the recrimination of failure can put up a prize. Failures of the competing teams don't inure to the detriment of the funder, because they back the entire competition not any one specific team or approach.

State of Mind

Your attitude in approaching a problem is perhaps your most important attribute in solving it. A positive, "this is solvable" approach fundamentally affects all those involved. There are three basic 'states of mind' that an individual has when approaching a possible challenge. Each state of mind will affect an individual's creativity, level of risk taking and their ability to marshal the resources to solve the problem.

i. Something is impossible: Someone who believes something is impossible is partially correct… it is impossible *for them.* In order for someone to solve a problem, they first need to be believe that it is solvable. Many "experts" in a field become convinced of existing doctrine that then limits their thinking (e.g. pre-Copernican thinking that the Earth was the center of the Universe). The definition of an expert can sometimes be, an individual who tell you why something can't be done.

ii. Belief that something is possible: An individual (or group) who believes in their heart that something is possible, but cannot yet prove it, can take on an almost religious passion resulting from their faith and their desire to prove themselves right. Also a group racing to achieve a meaningful objective, especially in a race against another team or against the clock can cause the best ideas and individuals to surface to the top. The early days of the Apollo program had this state of mind. The 400,000 individuals who joined NASA on its mission to beat the Soviet Union to the Moon, believed that the goal was possible, but knew the outcome was far from certain.

iii. Knowledge that something is possible, but needs demonstration: This is the situation for an innovator that has seen some convincing expression of a concept and actually wants to invent it, or has seen a technology prototype and wants to reinvent and/or improve on how it is implemented, or is convinced that the curve of improvement of a technology is predictive of what is to come and desires to find the next breakthrough required to implement the improvement. Figure-1 below (Source: Ray Kurzweil) is such an example. People have heard of Moore's law that the price/performance of a computer will double every 18 months. What people fail to understand is that this

curve has been marching on for the past 100+ years at a fairly consistent pace during times of depression, recession and war. Also that we are now in the fifth paradigm of Moores Law (Relays, vacuum tubes, transistors, integrated circuits, etc.). The technologies to continue this curve into the sixth and seventh paradigm still need to be invented, but this provides a strong incentive to inventors to believe that this is possible.

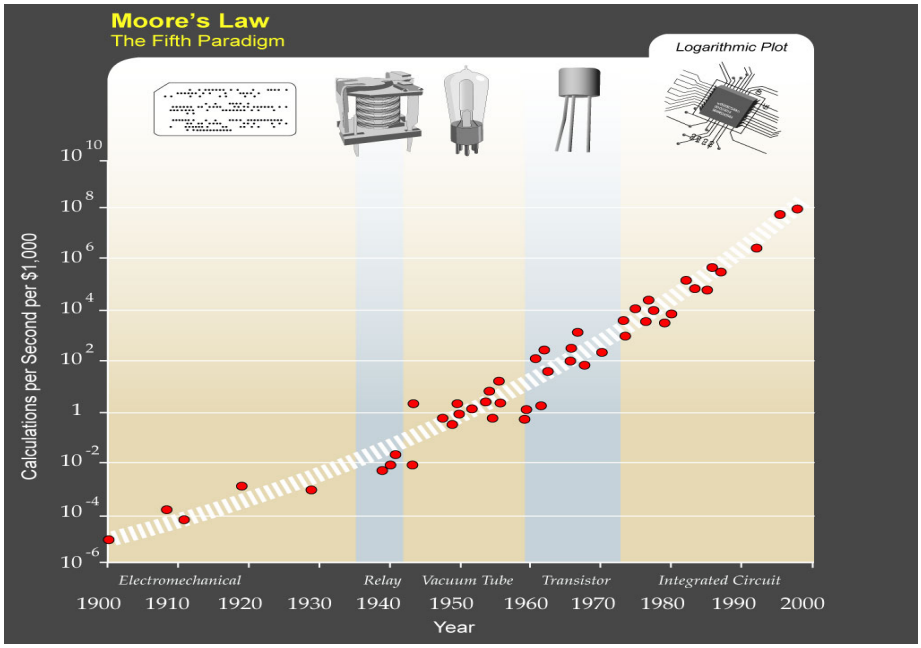

Figure-1

Incentive prizes have a fundamental effect on the innovator's state of mind helping move people from "something is impossible" to "belief that it is possible". Proposing a specific goal in an appropriate fashion, "above the line of super credibility" (Figure-1) can cause people to begin dreaming, wondering, plotting to find a solution, and for capital to begin focusing on the problem at hand.

The concept illustrated in Figure-2 is the notion that "how" you announce an audacious idea is as critical to its success as the idea itself.

An audacious idea that is announced to the public "below the line of credibility" (1) (a subjective measure) is immediately doomed to failure. The meme is not transmitted, and everyone who hears it discounts it immediately. An audacious idea born "above the line of credibility" will either die (2a) or live (2b) depending on early actions taken by the participants of the challenge and the response given by the public and the media. An audacious idea "born above the line of super credibility" (3) is a success from the beginning. In the minds of the media, the public, and the prospective innovators, the challenge is seen as worthwhile and achievable. The idea has a much higher likelihood to attract the creative thinkers and capital required for the challenge. As an example of being born above the line of super-credibility, on May 18th, 1996, the Ansari X PRIZE for spaceflight was announced with tremendous acceptance. On that day, despite there being no money in the purse and no teams competing, the prize was announced under the Arch in St. Louis with twenty astronauts on stage (including co-Founder Byron Lichtenberg and Apollo Astronaut Buzz Aldrin), the NASA Administrator, the Associate Administrator for spaceflight of the FAA, the Lindbergh Family and senior members of the St. Louis community.

The media response was global and positive driving believe that the purse was fundable, the goal laudable and the results achievable.

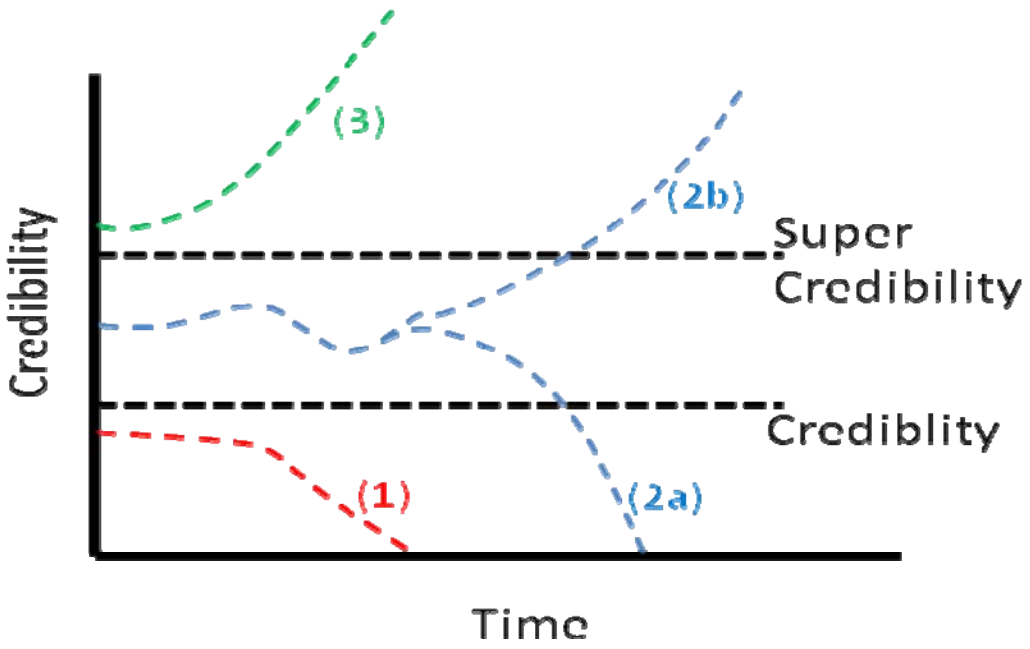

Figure-2

Targeting of Innovation

Once the drivers are place to encourage innovation, the next question is how do creative individuals choose where to focus their creative energy? What provides the targeting information for the innovator? I would propose there are four major mechanisms; each of these is resonant with different drivers:

- Curiosity: First, there is personal curiosity, intuition and free thought. Perhaps this is best exemplified by the nature of Albert Einstein's work on special relativity… day dreaming and asking the question "what if".

- Institutional Direction: Guidance from one's mentor or funding institution.

- Emergent Conditions: The Nazi threat of World-War II leading to the Atomic Bomb and the Soviet launch of Sputnik leading to the Apollo 11 Moon landing. *(Note: both the Atomic Bomb development and the first Moon landing were themselves effectively competitions/races).*

- Grand Challenges: A publicly recognized target of importance, reinforced by a significant cash purse, can provide tremendous targeting inspiration.

Team Composition & Attitudes

What are the dynamics and environment that promote successful creative thinking?

- Team Make-up: The following six attributes of the team make-up promote the maximum creative thinking.
    1. Small groups: Where all the players know and respect each other, where communications and distribution of knowledge is rapid and complete and an organizational bureaucracy is not needed and therefore does not put up roadblocks. Small groups also have the propensity to take higher levels of risk because they have less to lose, and in a winning scenario have more to gain since each individual member stands to get significant recognition, not being lost in a large organization.
    2. Isolated Environment: Isolating a small team away from larger pre-existing organizations was used in a wide range of successful developments from the IBM PC to the Apple iPod. As an isolated population they are free to evolve new practices and approaches without criticism.
    3. New teams: New teams of individuals who are brought together for a specific objective that are not saddled with pre-existing biases that need to be protected. As an example, the NASA of 1961 was a vibrant single-mission-oriented organization with a clearly articulated goal, "get to the moon before the end of the decade" (and, oh by the way… also beat the Soviets there). NASA today is suffocating in the political baggage of its job-centric Field Centers and the bloated risk-adverse contractors.
    4. Diversity of background: One of the most critical elements for creative team dynamic is diversity of background and thought. "Stove pipe mentality" or "group think" will often cause likeminded individuals to discount potentially fertile approaches because peers all share a common bias or blind spot. In addition, traditionally a breakthrough comes from nonsensical, crazy or orthogonal thinking and is best surfaced from brilliant individuals from a different field. Finally, many breakthroughs and new approaches come at the boundaries between fields… This interdisciplinary approach is a critical source of insights (e.g. where information theory intersects biology).
    5. Charismatic leadership: Existence of a strong and charismatic leader who is promoting the attitude "yes we can" such as the work of Werner Von Braun in the Apollo program can make all the difference in keeping a group engaged. Sometimes it is not the first, second or third attempt but the 100th approach that leads to success. As such, keeping a team motivated (or a funding source engaged), with a refusal to give up, is fundamental to success.
    6. Youth: One of the most critical mixes in a team make-up is the addition of youth who are unconstrained in their thinking. In some circumstances, age and experience can be a significant detriment. In 1961 when NASA was given the impossible task of putting an American on the surface of the Moon, the average age of the engineers who developed the propulsion systems, the navigation and guidance, the docking and the structures was in their mid-late twenties. Three decades later, the average age of the engineers who created the dot-com revolution was once again in the mid-twenties. It's critical that innovators don't know what can't be done.

- Team Attitudes: The following four team attitudes promote the maximum creative thinking.
    1. Learn to question and not defend: This was the motto of Burt Rutan's team at Scaled Composites. As soon as people begin to defend their thinking, they begin to back themselves into a corner and shut out the option of discovery.
    2. Non-judgmental attitude that doesn't punish failure, but instead celebrates success: It is critical that individuals who fail not be punished, but instead are allowed to express what was learned from the failed experiment and given the support to try again. In the same manner, success at any level must be celebrated in a strong fashion within the entire team.
    3. Allowing for crazy "nonsensical" ideas: Perhaps most difficult, is how to allow teams to try out crazy ideas in a Darwinian approach that allows those which are valuable to rise to the top.
    4. Persistence: Building a culture that refused to give up on a good idea is critical. The notion that there is "persistence of vision"… or "persistence to the point of success" is best demonstrated by Edison and his light bulb filament experiments.

Access to Capital & Resources

One of the most difficult ingredients for creativity and innovation is access to capital. Frequently the leading thinker or innovator of the group is forced to spend 80% of their time raising capital to cover salaries and access to resources rather than thinking and/or leading. Worse yet, those ideas which have the highest probability of producing true breakthroughs are the most novel and therefore the most difficult to prove and therefore fund.

Incentive prizes provide an environment which attracts a new "flavor" of money that has different objectives. Again the Ansari X PRIZE offers an excellent example. Before announcing the $10M purse, any team wishing to fund a private sub-orbital spaceship would need to approach an angel investor or venture fund for capital. Any sophisticated investor would immediately say "no" given the inherent risks, specifically: no proven market, regulatory risks (the laws to allow private human spaceflight did not exist), technology risk and risk of very visible public failure. As such, few investment funds flowed towards this technology development arena, and those who did invest lost significant amounts. It was space community expressed this thought with the following joke: "what is the best way to become a millionaire in the space business? Start as a billionaire!"

After the Ansari X PRIZE was announced, teams found it much easier to raise the capital and support. Rather than seek investment funds, these same teams were able to viably pursue to alternative sources of capital: sponsorship and private benefactor money.

- Sponsorship funding which typically is in the $20 billion - $30 billion per year in the U.S. is looking for highly visible, unique opportunities. As the sporting work continues to be cluttered, incentive prizes offer a unique alternative. As Sergey Brin, co-Founder and President of Google said in a video address at the announcement of the Google Lunar X PRIZE, "I knew we never wanted to do something so conventional at Google, I thought if we were ever to sponsor something it should be something ambitious. Having seen the success of the Ansari X PRIZE, the fact of having many different entrepreneurs all competing to accomplish a goal is first more exciting, second more likely to actually achieve the goal and third probably less expensive overall."

- Private Benefactor money, which is sometimes called “ego money” is the same pot of funds that an individual uses to put their name on the side of a building, or to personally fund an America’s Cup team. It is money that gives them personal gratification or helps build a family legacy. A large audacious prize can help wealthy individuals transition from “Success to Significance. These levels of funding can run in the tens to hundreds of millions of dollars. The properly constructed prize can entice and attract funds to back a team. As Paul Allen, the vision backer of SpaceShipOne said at the Ansari X PRIZE post-flight press conference in October 2004, “A few years ago I was just browsing the internet and I came across this thing on the X PRIZE and I thought this is kind of interesting, who are the crazy guys trying to do this kind of thing…”

Designing Incentive Prizes

X PRIZEs have been designed to offer significant economic and psychological levers for accelerating and enabling innovation in areas that might otherwise be stuck for a number of reasons. Following are the most important guiding principles in the design of these incentive prizes:

1. **Simple, Clear and Objective Rules**: When creating an X PRIZE we strive to create simple, clear and objective rules that can be easily understood by the public. An objective and clear finish line makes the winning of the prize obvious to the observing public. In the case of the Orteig Prize the rules were “fly non-stop between New York and Paris.” In the case of the Ansari X PRIZE the simple rules could be expressed as “Fly the same 3-person spaceship, twice to 100 kilometers altitude, twice in two weeks.”

2. **Defining the Problem and Not the Solution**: The prize rules should define a problem to be solved, not a specific solution to be implemented. For example, the Ansari X PRIZE did not speak about the type of propulsion or the mechanism of launch or even the location of the launch, only the objective of getting 3 people to 100 km twice in two weeks. As such the competition saw the design of over a dozen uniquely different approaches.

3. **Addressing Market Failures**: X PRIZEs are needed to jumpstart a stuck industry and demonstrate a market as well as drive distribution to get critical mass. Prizes should address problems where a market failure prevents solutions due to a blockage such as:
   - Industry or other societal constraints that prevent change
   - People believe a problem is not solvable
   - Industry, institutional and public misperception or perceptions
   - Capital is not available to an important problem

4. **The Proper Balance of Audacity and Achievability**: The prize needs to be audacious enough that it is inspirational and heroic in its pursuit, but not so difficult that it can’t be achieved. While many thought that the Ansari X PRIZE should be focused on orbital human flight, this is 50-fold harder from an energy standpoint than sub-orbital flight. Had this been the objective, the Ansari X PRIZE might never have been won. We recognized that we didn’t need to go to orbit in order to stimulate the type of paradigm change we desired to affect.

5. **Purse Size:** We define X PRIZEs as purses that are $10 million or more in size. The $10 million figure is used to break through the media clutter, raise the visibility of a problem and attract non-traditional players. The size of the purse is a function of many things including

an understanding of the incentive needed, the value of the back-end marketplace, the minimum amount needed to attempt the feat (i.e. degree of difficulty, a purse might be sized to be the minimum expected that a team might spend), the perceived importance of the problem, and the sponsors' desire for branding (e.g. the "biggest ever"). Teams are typically willing to invest more than the amount of the purse when the properly designed X PRIZE has a back-end business model that allows teams and their backers to capture a return on investment. While the largest X PRIZE at this moment is $30 million (Google Lunar), in the future we may see prizes rise to a $100 million or more.

6. **Persistent Media Exposure over Time for Prize Competition:** A properly designed X PRIZE will have a competition structure that allows teams to have repeated exposure in the media. The persistence of exposure to the public helps drive the paradigm change. In the case of the Ansari X PRIZE, the competition required two flights over two weeks which prolonged all media exposure compared to if it had been just for one day.

7. **Captivating, Telegenic and Clearly Measureable Demonstrations:** X PRIZEs must engage the general public in a fashion which gives everyone the opportunity to root for their favorite team and celebrate the victory. X PRIZEs should be designed to generate popular interest throughout the prize lifecycle, from initial competitor enrollment, to the start of the competition, to the many telegenic attempts at the purse (both successful and unsuccessful) and following the completion of a competition. The winning of the prize should be objective and clearly measureable to ensure that there is no question or debate. In addition, it is important people clearly understand why the prize is being conducted, namely, what is the radical benefit to humanity being created when the prize is successfully won.

8. **Multiple Purses and Bonuses:** Using a second place purse and "Bonus" purses can increase the number of teams competing and the variety of approaches that they pursue. Second place purses keep teams competing after 1st place is awarded. It can keep teams engaged if there is a strong front runner. It can also lengthen the amount of time that the competition is in the public mind, thereby increasing its ability to achieve the desired paradigm change.

9. **Launching Above the Line of "Super Credibility":** The initial announcement of an X PRIZE should be done in a very visible fashion with the maximum amount of media exposure. The prize launch should publicize the prize, its sponsors and the challenge to the world's press. This is to ensure that the competition is taken seriously from the start. Properly done, the prize launch changes the perception of the public from, "Can it be done?" to, "When will it happen and who will win?" At the launch event, it is important to have the participation of gold-plated endorsers (who share their reputational equity) and even a number of teams ready to compete.

10. **Global Participation/Open to All:** X PRIZEs are global in nature, allowing teams from around the world to register to compete. We seek the broadest range of qualified teams. Any team from any nation is able to register, and the results from the competition are to benefit all of humanity. X PRIZEs are open to all participants independent of age, education, and experience.

11. **Targeting a 3 – 8 Year Prize Timeframe**: The "Degree of Difficulty" of X PRIZEs are designed so that they are nominally won in a 3 to 8 year time period. If a prize is won in less than 3 years, it was probably too easy; if it takes longer than 8 years to win, most people will lose their interest.

12. **Using Deadlines to Drive Intelligent Risk-taking**: X PRIZEs may utilize a posted deadline, or a stepped down reduction in prize purse to drive teams to make attempts earlier in the competition. Such deadlines can always be extended by the prize purse benefactor.

13. **Ownership of Intellectual Property & Media Rights:** In a typical X PRIZE, the teams retain IP and the XPF retains media rights. However prizes can vary and in some cases they may require that the IP is made available to the public, or in some cases that a portion of the IP is owned by, or licensed to the prize sponsor.

14. **Designed with a Backend Business Model:** The ideal X PRIZE is designed so that there is a backend business opportunity for the teams to exploit, and enter into revenue business once the prize is won. It was for this reason, for example, that the Ansari X PRIZE required a 3-person spaceship rather than a one-person ship. The back-end business model makes it easier for teams to raise funding for their teams. It is also the case that the publicity resulting from the winning of the prize will drive capital investment, innovation deployment and market acceptance.

Benefits of an Incentive Prize

Ultimately, these are a dozen key benefits that derive from an X PRIZE Competition worth noting for competing teams and prize benefactors.

1. **Attracting New Capital to a Problem:** X PRIZEs drive non-traditional financial resources toward funding innovation. These funds include a portion of the $20 billion sponsorship market that typically funds sporting, arts and entertainment platforms, and events and a portion of the $300 billion dollar philanthropic market.

2. **Attracting and Motivating Doers:** X PRIZEs attract and motivate non-traditional players to attack a problem as well as the world's best and brightest minds to work harder, faster or in entirely new ways. It is the objective of an X PRIZE to turn these teams and their leaders into heroes by shining the media spotlight on them and their stories. Prizes give individuals "permission to turn their dreams into reality" as well as help them raise further capital investment because of the increased visibility.

3. **Crowd-sourcing Genius:** Properly structured X PRIZEs attract genius from around the world independent of age, race and gender. They allow brilliant individuals who do not necessarily function well in traditional "programs". High visibility incentive prizes capture people's imagination and discretionary cycles.

4. **Increasing Public Awareness/Raising the Visibility of a Problem:** Publicity around an X PRIZE educates the public and focuses them on the importance of the problem. This publicity motivates teams to work harder and increases leverage of the prize purse. This global media attention motivates innovators seeking to tackle a challenge of significance to humanity.

5. **Overcoming Existing Constraints**: X PRIZEs reconfigure what is possible by transcending path-dependent limitations such as societal constraints, legal/regulatory hurdles and policy regimes. Prizes overcome resignation and cynicism because they drive the elimination of the excuse that "everyone" believes that the problem is not solvable.

6. **Changing the Paradigm:** A principal focus of an X PRIZE is to challenge and then "change the paradigm" of what the public believes is now possible. This takes place by having the prize won in a dramatic fashion, with extended media exposure that allows the message to break through the clutter. In ideal circumstances, prizes can also drive behavioral changes.

7. **Launching an Industry, with Lasting Benefit and Impact**: An X PRIZE should be designed so that after the purse is awarded, it is not the end, but the beginning of a new industry. Innovation alone is not sufficient. To drive true breakthroughs and benefits to humanity, these innovations need to be marketable and deployed. Ultimately the goal is to solve the problem and create commercial companies through an entrepreneurial process.

8. **Providing Financial Leverage:** An X PRIZE must generate outside investment in competitors at an order of magnitude greater than the purse size. A prize needs to motivate donors, sponsors and investors, such that teams receive greater access to funding. Prizes work because they generate much greater interest and investment than the net value of the purse offered. Innovators and investors are typically willing to invest more than the amount of the purse for two reasons. First, many are typically optimists, and initially believe that they can solve it for less than the purse amount, and then incrementally rationalize larger investments over time; and second, the properly designed X PRIZE has a back-end business model that allows teams to capture a return on investment.

9. **Innovation and Real-world Deployment:** X PRIZEs ideally create both technological innovation as well as successful "real world" deployment. A properly constructed X PRIZE either demonstrates a capability in such a fashion that market demand and capital step in to finance the continued development and deployment (e.g. Virgin Galactic) or reward a real world deployment through advanced market commitments.

10. **Attracting Cross-disciplinary Solutions:** True breakthroughs often come from outside the normal field of experts (e.g. when a physicist looks at a biological problem). X PRIZEs should raise a problem to a level of visibility that attracts multidisciplinary innovators that would otherwise be unlikely to tackle the problems that the prize is designed to address. Prizes drive interdisciplinary collaboration amongst unlikely partners.

11. **Driving Regulatory Reform:** A properly designed X PRIZE will help to clarify the regulatory issues relevant to the competition. Sufficient publicity surrounding the prize coupled with a large number of teams can provide sufficient pressure to allow regulations to be created and/or modified allowing for the competition to be won.

12. **Inspiration, Hope and Intelligent Risk-taking:** X PRIZEs are about creating inspiration and hope in a field which has been stuck for a number of reasons. These prizes encourage non-traditional teams to take intelligent levels of risk that can allow for breakthroughs in a sector that is otherwise stuck or dominated by risk-adverse incumbents.

APPENDIX-1
(Notes from Wikipedia)

The Longitude Prize: The **Longitude Prize** was a reward offered by the British government through an Act of Parliament in 1714 for a simple and practical method for the precise determination of a ship's longitude. The prize was administered by the Board of Longitude.The measurement of longitude was a problem that came into sharp focus as people began making transoceanic voyages. Determining latitude was relatively easy in that it could be found from the altitude of the sun at noon with the aid of a table giving the sun's declination for the day. For longitude, early ocean navigators had to rely on dead reckoning. This was inaccurate on long voyages out of sight of land and these voyages sometimes ended in tragedy.

Many persons benefited from the awards offered by the Board. In total, over £100,000 was given in the form of encouragements and awards. Significant among these are John Harrison who won £14,315in several payments. £4,315 was awarded during his work on his chronometers from 1737 to 1764 with the remaining £10,000 provided in 1765.

The Orteig Prize: The **Orteig Prize** was a $25,000 reward offered on May 19, 1919, by New York hotel owner Raymond Orteig to the first allied aviator(s) to fly non-stop from New York City to Paris or vice-versa. Several famous aviators made unsuccessful attempts at transatlantic flights before relatively-unknown Charles Lindbergh won the prize in 1927 in his aircraft *Spirit of St. Louis*. His flight was followed by the "Lindbergh boom", as public interest in air travel bloomed and aviation stocks skyrocketed.

Although advancing public interest and aviation technology, the Prize occasioned expenses many times the value of the prize and cost 6 men their lives in three separate crashes. Another three men were injured in a fourth crash. During the spring and summer of 1927, 40 pilots would attempt various long-distance over-ocean flights, leading to 21 deaths. In August 1927 alone, the Orteig Prize-inspired $25,000 Dole Air Race to fly from San Francisco to Hawaii would cost ten lives before it was over.

The Kremer prizes: The **Kremer prizes** were a series of monetary awards, established in 1959 by Henry Kremer, that were given to pioneers of human-powered flight. The first Kremer prize of £50,000 was won on August 23, 1977 by Dr. Paul MacCready when his Gossamer Condor was the first human-powered aircraft to fly a figure eight around two markers one half mile apart. The second Kremer prize of £100,000 was won on June 12, 1979, again by Paul MacCready, when Bryan Allen flew MacCready's Gossamer Albatross from England to France.

A Kremer prize of £20,000 for speed was won in 1983 by a design team of the Massachusetts Institute of Technology for flying their MIT Monarch B craft on a triangular 1.5 km (0.93 mi) course in under three minutes (for an average speed of 32 km/h (20 mph)).

DARPA Grand Challenge/Urban Challenge: The **DARPA Grand Challenge** is a prize competition for driverless cars, sponsored by the Defense Advanced Research Projects Agency (DARPA), the most prominent research organization of the United States Department of

Defense. Congress has authorized DARPA to award cash prizes to further DARPA's mission to sponsor revolutionary, high-payoff research that bridges the gap between fundamental discoveries and their use for national security. DARPA has technologies needed to create the first fully autonomous ground vehicles capable of completing a substantial off-road course within a limited time. The third event, The DARPA Urban Challenge, which took place on November 3, 2007 and was broadcast via webcast,[1] further advanced vehicle requirements to include autonomous operation in a mock urban environment.

The Grand Challenge was the first long distance competition for driverless cars in the world; other research efforts in the field of driverless cars take a more traditional commercial or academic approach. The U.S. Congress authorized DARPA to offer prize money ($1 million) for the first Grand Challenge to facilitate robotic development, with the ultimate goal of making one-third of ground military forces autonomous by 2015. Following the 2004 event, Dr. Tony Tether, the director of DARPA, announced that the prize money had been increased to $2 million for the next event, which was claimed on October 9, 2005. The first, second and third places in the 2007 Urban Challenge received $2 million, $1 million, and $500,000, respectively.

The competition was open to teams and organizations from around the world, as long as there were at least one U.S. citizen on the roster. Teams have participated from high schools, universities, businesses and other organizations. More than 100 teams registered in the first year, bringing a wide variety of technological skills to the race. In the second year, 195 teams from 36 US states and 4 foreign countries entered the race.

The Ansari X PRIZE: The **Ansari X PRIZE** was a space competition in which the X PRIZE Foundation offered a US$10,000,000 prize for the first non-government organization to launch a reusable manned spacecraft into space twice within two weeks. It was modeled after early 20th-century aviation prizes, and aimed to spur development of low-cost spaceflight. The prize was won on October 4, 2004, the 47th anniversary of the Sputnik 1 launch, by the Tier One project designed by Burt Rutan and financed by Microsoft co-founder Paul Allen, using the experimental spaceplane SpaceShipOne. $10 million was awarded to the winner, but more than $100 million was invested in new technologies in pursuit of the prize.

In total 26 teams from 7 nations registered to compete. The competition generated a wide variety of approaches including solid, hybrid and liquid-engines and vertical and horizontal launch approaches.

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