

Cash for answers

By Tim Harford

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In 1737, John Harrison, a self-taught clockmaker from Yorkshire, stunned London's scientific establishment by presenting an idiosyncratic solution to the most important and notorious technological problem of the 18th century. He was hoping to win a then-fabulous prize of £20,000 (about £5m today) for anyone who could devise a way for a ship's navigator to determine its longitude and therefore its position at sea. Harrison's approach was to build a clock that would keep Greenwich time faithfully; by comparing local time (measured using the position of the sun) with the time in London, the navigator would know how far east or west the ship had sailed. The theory was sound, but given the rolling of ships and changing temperature and humidity, the leading scientists of the day – including Sir Isaac Newton – reckoned that a sufficiently accurate clock would be impossible to build. Harrison proved otherwise.

The longitude prize, sponsored by the British government, was not unique. Prizes were also offered in France for a functional water turbine, and for a method of preserving food for Napoleon's armies. The latter prize quickly inspired the tin can, more of a blessing than food snobs might acknowledge.

But such prizes then fell out of fashion. For commercial innovations, we now rely on patents to encourage and protect innovators. Basic research is funded not by prizes but by grants.

And yet two centuries after tinned fish hit the market, the way we look for solutions has come full circle. Governments, private foundations and even corporations are rediscovering the value of offering prizes for good ideas. Rather than paying for scientific and engineering effort as they have done for the past 200 years, idea-hungry patrons are returning to the 18th century, and paying for results.

The most famous innovation prize of this century, the \$10m Ansari X Prize, was designed to promote private space flight. The pot went to Mojave Aerospace Ventures in 2004, after the successful flights of SpaceShipOne. And even the Ansari X Prize is dwarfed by a quasi-prize of up to \$1.5bn that is about to be offered by five national governments and the Gates Foundation to the developers and suppliers of a more effective vaccine against pneumococcal diseases such as pneumonia, meningitis and bronchitis. The prize, called an "advanced market commitment" or "advanced purchase commitment", takes the form of an agreement to subsidise heavily the first big orders of a successful vaccine. Given that the top companies in the UK's powerful pharmaceutical

industry spent little more than £5bn in 2006 on research and development, a \$1.5bn prize should be taken seriously on hard-nosed commercial grounds alone.

And if formidable obstacles to setting the prize conditions can be overcome, the pneumococcal diseases contest could be followed by a malaria vaccine prize twice as big and an Aids vaccine prize that would be bigger still.

Prizes need not have such lofty ambitions. They can simply be a way of turning a solution into a commodity. One company, Innocentive, provides an exchange where “seekers” can offer cash to “solvers”. Both sides are anonymous, which is one of the selling points of innovation prizes: they reward neither connections nor seniority, but solutions alone. Innocentive’s problems read a little like the small ads on the world’s least romantic lonely-hearts website. “A technology is desired that produces a pleasant scent upon stretching of an elastomer film” (\$50,000). “Surface chemistry for optical biosensor with high binding capacity and specificity is required” (\$60,000).

Netflix, a film rental website which offers recommendations based on what you looked at, bought, rented or reviewed in previous visits, has skipped middlemen like Innocentive. In March 2006, the chief executive of Netflix, Reed Hastings, met some colleagues to discuss how they might improve the recommendation system, Cinematch. Hastings, inspired by the story of John Harrison, suggested offering a prize of \$1m to anyone who could do better.

The Netflix prize, announced in October 2006, struck a chord with the Web 2.0 generation. Within days of the prize announcement, some of the best minds in the relevant fields of computer science were on the case. Within a year, the leading entries had reduced Cinematch’s recommendation errors by more than 8 per cent – close to the million-dollar hurdle of 10 per cent. And it has cost Netflix very little to mobilise all this effort. The company has had to pay out a mere \$50,000 progress award, to a team of three AT&T data analysts.

Even Netflix is surprised at how well it’s been going. “We just didn’t think the relevant research community was so big,” says Steve Swasey, vice-president.

More than 2,500 teams from 161 countries and comprising 27,000 competitors have entered the contest. Teams from California, Budapest and Toronto have been battling away at the top. Clearly, the million-dollar prize has mobilised far more than a million dollars worth of research effort.

The Netflix prize has been helped by the ease of transmitting data around the world and the affordability of the computing power necessary to have a go. The fun of the challenge alone is one of the biggest attractions to participants. So, too, is access to Netflix’s huge database of recommendations – a dream for statisticians and computer scientists. And the competition has also been fanned by the fact that all improvements are incremental and the company is able to publish listings of the current leaders, meaning the race is verging on a spectator sport.

The X Prize and Netflix prize have managed to generate a tremendous amount of interest. That means more than free publicity for the organisers; it also means that the prize catalyses far more effort than one might expect on cold financial grounds. “One of the goals of the prize is to transform the way people think,” says Bob Weiss, vice-chairman of the X Prize Foundation. “We were trying to create a sea-change.”

Weiss says that the founders of the X Prize foundation wanted to revive their childhood dreams of a day when ordinary people would be able to travel into space – expectations formed in the heady 1950s and 1960s. They may get their wish. To Weiss’s delight, Virgin Galactic claims it will soon be in a position to offer private space flights. It will be using the technology that won the X Prize.

Future X Prizes, each one funded by corporate sponsors and philanthropic donors, aim to kick-start other new industries. The Archon X Prize for genomics will be awarded to the team that can sequence 100 human genomes within 10 days, at a cost of \$10,000 per genome. That is unimaginably quicker and cheaper than the first private genomic sequencing in 2000, which, according to the X Prize foundation, took nine months and cost \$100m for a single human genome. (Craig Venter, the director of that effort, is one of the backers of the new prize.) It is the kind of leap forward that would be necessary to usher in an era of personalised medicine, in which doctors could prescribe drugs and give advice in full knowledge of each patient’s genetic susceptibilities.

Another prize will be awarded to the manufacturer of a popular mass-production car that has a fuel efficiency of 100 miles per gallon. The model is the same each time. The X Prize foundation identifies a goal and finds sponsors; it announces a prize and whips up the maximum possible enthusiasm, with the aim of generating far more investment than the prize itself; the prize achieved, it hands out the award with great fanfare and moves on to set other challenges. The prize winner is left with intellectual property intact, and may capitalise on the commercial value of that intellectual property, if any commercial value exists.

The X Prize foundation claims that the Ansari X Prize directly stimulated \$100m of spending on research and development, 10 times the value of the prize itself. That is clever, and for a handful of sexy challenges it is likely to be a trick that can be repeated.

But the X Prize and the Netflix prize may give too flattering a picture of what might be possible if prizes catch on. Rather, prizes could become humdrum. For the problems listed on Innocentive’s website – “The challenge is to produce a specific citric acid ester in a faster cycle under current specifications” (\$40,000) – the day of the humdrum has already arrived.

In other cases, for example the advanced market commitment for a pneumococcal virus, the sums of money being invested in the research are so huge already that it is hard to imagine the mere glamour of the \$1.5bn “prize” weighing heavily on the minds of scientists and inventors.

For both the uninspiring innovation and the billion-dollar research programme, it is the prize money itself that has to do the talking. If that is not the case, the prizes will not multiply research efforts, as the Ansari X Prize and the Netflix prize have done, but will increasingly need to compete with alternative methods of funding innovation – that is, grants and patents – on a level playing field. To become a significant alternative to grants and patents, prizes will have to become very large indeed – large enough to cover, on average, all of the likely research expenditures of all those hoping to win. Is that desirable?

Champions of prizes see them as a component of a wider system to promote innovation, rather than as an outright replacement either for grants or patents. Instead, the hope is that prizes will help to compensate for the specific weaknesses of those alternatives.

The downside of a patent is fundamental to its design: in order to reward an innovator, the patent confers a monopoly. Economists view this as, at best, a necessary evil since monopolies distort prices. In the hope of raising profits from some customers, they will price others out of a market. The most obvious victims are consumers in poor countries.

In an ideal world, prizes could replace patents. Instead of offering a patent for an innovation, the government could offer a prize. The inventor would pocket the prize but would not be allowed to exploit any monopoly power, so the innovation would be freely available to use in products for poor consumers – cheap drugs for Africa, for instance – and, importantly, in further innovations. But to explain that idea is to see its limitations. How could the government know enough about the costs and benefits – and even the very possibility – of an innovation to put a price tag on it and write the terms of reference for a prize competition? For this reason it is hard to see prizes replacing patents in most cases. But it is not impossible.

The modern heir to 18th-century prizes for canning, water turbines and finding longitude at sea is the advanced market commitment for vaccines for the poor: the goal is clear, the costs and benefits can be guessed at, and the quasi-prize nudges the patent system to one side with a prize contract that respects the patent but, in exchange for a large subsidy, radically constricts the holder's right to exploit it.

Prizes can also, in principle, supplement grants for basic research, paying scientists for results as well as for effort. There is, for example, an “Mprize” for creating long-lived mice. The eventual aim is to lengthen human life spans. And the Clay Mathematics Institute, a non-profit body set up 10 years ago by a Boston businessman, is offering million-dollar prizes for the solution of seven “Millennium” problems in mathematics.

These prizes are exceptions; but prizes were once the standard way of encouraging basic research. According to Robin Hanson, an economist at George Mason University, more than twice as many 18th-century scientific societies paid for results using prizes or medals than paid for effort with grants. As that changed, scientific societies sometimes ignored the wishes of donors, or even had the wills of deceased donors voided, in order to hand out grants rather than the prizes specified.

The standard historian's explanation of this trend is that once science became a profession rather than the province of rich amateurs, prizes were no longer a suitable way of funding innovation. Hanson is not convinced. "Most academics who study the issue of prizes have focused on what a prize does to the behaviour of researchers, versus a grant," he says. "But there's another aspect: what does the person giving the prize or the grant get out of it?"

He argues that grants are more appealing than prizes to bureaucracies for many reasons, not all admirable: "With grants, there's all sorts of possible patronage and corruption." Even leaving aside outright graft, there is plenty of opportunity for cosiness and cliques. Then there is the mundane fact that grants are easier to account for in an annual budget than a multi-million prize that could be paid tomorrow, in a year, or never. For Hanson, it was for these reasons, rather than any intrinsic merits, that grants elbowed aside prizes in the 19th century.

Prizes may be making a comeback because of all the money now available from private foundations – which demand results. Not only the X Prizes and the Millennium problems prize, but even the pneumococcal vaccine prize is part-funded by private money. Yet governments are getting in on the act. The US space and defence research agencies Nasa and Darpa both use innovation prizes, and other government agencies look likely to follow with, for example, an "H prize" for advances in hydrogen fuel technology.

If Hanson is right, this new trend is a welcome swing of the pendulum towards a modest use of prizes. But not everyone is convinced that prizes will live up to the hype.

"The literature has pushed them as a silver bullet; more recently there's been a bit more sobriety in the debate," warns Andrew Farlow, an expert in the economics of vaccines at Oxford University. "How much genuine risk-taking can it pull along?"

The problem is not the principle, he argues, but the details. A vaccine for HIV is a distant and costly prospect, and might require a \$10bn or \$20bn prize. Inevitably, companies and their shareholders will question whether the prize would be honoured in full. The triggers for releasing some of the prize money are difficult to define: early vaccines would probably be expensive, fallible and risky, but better than nothing. Donors would not want all the money to go to those efforts and leave none to encourage superior successors. Try framing "good enough" in legalese, when billions are at stake.

Donors might pay a lot more than they needed to for a substandard product, or the prize might be too restrictive and too small to generate any interest at all. That would drain attention, enthusiasm and political will. "It all sounds like good economics, but whether you could ever set a prize big enough or correct enough to work in those cases is doubtful," Farlow concludes.

But the proponents of advanced market commitments (AMCs) believe the problems can be overcome. "There's no question that there's going to be a way to deal with these challenges in a sensible, analytically based way," argues Ruth Levine, vice-president of

the Center for Global Development, a think-tank based in Washington, DC, which has been a leading force in evaluating and advocating AMCs. “By that I mean that a proposal or contract will be written that makes sense and is based on good empirical work.”

The pilot is the pneumococcal vaccine pledge, made in principle back in February 2007, and now being hammered out. It is a big deal – a lot of money is on the table, with the potential to save many millions of lives at a low cost. Yet compared with other possible AMCs, the pneumococcal problem is relatively simple: two credible vaccines are in the late stages of development. Levine acknowledges that this example is as close to a procurement contract as to a pure innovation prize, but believes there is much to be learned from the exercise about whether donors can make a commitment together and handle the legal and accounting challenges. “What this won’t be is a pure test of whether putting a market-like offer out a long distance into the future will give firms an incentive to do early-stage R&D,” she says.

That is the dream of AMC proponents, but the true test – a malaria or HIV prize – is some way off yet. Only then will we see whether private companies will take the bait, and the public purse will get value for money. We can be sure that big Pharma will be checking the small print: John Harrison, master clockmaker, was eventually rewarded for his brilliant, accurate maritime clock only by appealing direct to King George III. Neither he nor anyone else was ever judged to have satisfied the conditions necessary to receive the longitude prize.