



Grand Innovation Prizes: A theoretical, normative, and empirical evaluation

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ARTICLE INFO

Article history:

Received 16 May 2011

Received in revised form 7 June 2012

Accepted 17 June 2012

Available online 31 October 2012

Keywords:

Innovation

X PRIZE

Incentive

Energy

Competition

Challenge

ABSTRACT

This paper provides a systematic examination of the use of a Grand Innovation Prize (GIP) in action – the Progressive Automotive Insurance X PRIZE – a \$10 million prize for a highly efficient vehicle. Following a mechanism design approach we define three key dimensions for GIP evaluation: objectives, design, and performance, where prize design includes *ex ante* specifications, *ex ante* incentives, qualification rules, and award governance. Within this framework we compare observations of GIPs from three domains – empirical reality, theory, and policy – to better understand their function as an incentive mechanism for encouraging new solutions to large-scale social challenges. Combining data from direct observation, personal interviews, and surveys, together with analysis of extant theory and policy documents on GIPs, our results highlight three points of divergence: first, over the complexity of defining prize specifications; secondly, over the nature and role of incentives, particularly patents; thirdly, the overlooked challenges associated with prize governance. Our approach identifies a clear roadmap for future theory and policy around GIPs.

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1. Introduction

Solving grand social challenges requires the development of fundamentally new innovations and, possibly, entirely new innovation incentives. Appropriate incentive design must confront at two distinct issues. First, as their name implies, “grand” challenges often involve fundamental breakthroughs that rely on harnessing unusual stakeholders across unexpected bodies of expertise. Second, the social nature of many grand challenges forces policymakers to think beyond existing market incentives to attract the attention of sufficiently diverse and committed a range of innovators to yield solutions. Consequently, traditional incentive mechanisms – procurement and patents – often fail to induce innovators to tackle grand missions: patents do not provide adequate incentives for challenges subject to market failure, and procurement-oriented approaches constrain both the set of possible innovators and the range of approaches they consider.

Given these limitations, the resurgence of interest in an alternative mechanism – prizes – is hardly surprising. Prize mechanisms fall broadly into two types (although a sharp dividing line does not exist). First we define Grand Innovation Prizes (GIPs). These are large

monetary prizes awarded to the xinnovator(s) providing the *best* or *first* solution to a pre-determined set of *significant* new performance goals with no path to success known *ex ante* and believed to require significant commitment and a breakthrough solution (see Kay, 2011). Second, we distinguish GIPs from smaller-scale competitions and challenges for well-defined (albeit difficult) problems that often require only limited time commitment (see Brunt et al., 2008) or involve matching or adapting existing solutions to problems – for example, many of those posted on InnoCentive, TopCoder and elsewhere (see Jeppesen and Lakhani, 2006; Boudreau et al., 2011).

Contemporary interest in GIPs has been particularly intense in the United States. Galvanized by compelling narratives of historical prizes (Sobel, 1995; Siegel, 2009), a community of activists across the public and private sectors increasingly champion GIPs. The X PRIZE Foundation has also led efforts to implement and define GIPs through their X PRIZE initiatives.² In government, the 2010 America COMPETES Reauthorization Act authorized Federal agencies to pursue prizes – both GIPs and smaller competitions – for a range of problems (OSTP, 2009; Zients, 2010; Lane and Bertuzzi, 2011). Several international initiatives have also explored GIPs particularly in global health (Kremer, 1998, 2002; Willetts, 2010).

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² See Diamandis (accessed from <http://www.xprize.org/prize-development> on 14.10.11).

Despite policy directives and private action to deploy this innovation mechanism, systematic analysis of GIPs remains limited (Williams, 2012). Relative to the extensive body of theoretical research considering the design of patents (e.g. Nordhaus, 1969; Merges and Nelson, 1990; Scotchmer, 2004) or procurement contracts (e.g. Laffont and Tirole, 1992) little economic theory explicitly considers the properties of innovation prizes, or how prizes operate in comparison to other incentive mechanisms (see Wright, 1983; Shavell and van Ypersele, 2001; Scotchmer, 2004). The most significant gap is the lack of empirical studies of contemporary GIPs (such as those offered by the X PRIZE Foundation). There exist reasonable accounts of historical cases (e.g. Sobel, 1995). However, the study by Brunt et al. (2008) of prizes and medals offered by the Royal Agricultural Society and Kay's recent detailed analysis of prizes for space innovation including the Northrop Grumman Lunar Lander Challenge (Kay, 2011) provide the only empirical analyses of GIPs to date. While these papers start to detail how GIPs work in practice, the lack of empirics remains worrisome as popular advocacy grows.

To bridge this gap, this paper draws on an in-depth study of the \$10 million Progressive Insurance Automotive X PRIZE (PIAXP). We leverage detailed information from the teams, organizers and judges involved in the prize to test theoretical and normative claims against the facts on the ground. To enrich our analysis, we explicitly compare theoretical arguments regarding GIPs, positions taken by GIP advocates, and the empirical reality of the PIAXP. To do so, we develop a simple framework that defines three dimensions over which to evaluate prizes: objectives, design, and performance. Rather than an exhaustive assessment of the entire GIP landscape, our evaluation offers a window into how the claims made by prize theorists and advocates compare with a Grand Innovation Prize in practice. We have five key findings:

- GIPs are used to meet more complex and multi-faceted goals than anticipated in theoretical or policy analysis. Education, attention and community building can be as important as the technical solutions themselves.
- While theorists design prizes with the object of producing efficient levels of effort towards a goal, advocates and practitioners aim to maximize effort.
- The design of the *ex ante* technical specification for GIPs is complex and specifications that ensure “appropriate” solutions are hard to predict *ex ante*.
- *Ex ante* incentives are more nuanced than recognized by theorists or prize advocates. Retained IP ownership is often a complement not a substitute to the award.
- Prize governance is of critical importance: “thin” institutional arrangements leave prize organizers vulnerable to disputes over the structure or fairness of GIP awards.

These findings have received little attention in the theoretical literature and are often assumed away by prize advocates. They suggest important divergences that have policy implications particularly as the government moves forward with prize implementation. Moreover, they suggest several paths for future empirical analysis.

Our paper proceeds as follows. Section 2 provides a brief history of the use of GIPs in incentivizing solutions to mission-oriented problems. In Section 3, we outline our framework as a context within which to evaluate the objectives, design, and performance of prizes. Section 4 describes the methodology for our comparative theory, policy and empirical analysis, focusing on the empirical methods used in the study of the PIAXP. Section 5 structures our findings around the evaluative framework comparing theory, policy-advocacy and the empirical reality of PIAXP. A final section briefly concludes.

2. A short history of Grand Innovation Prizes

As this special issue highlights, society confronts a range of daunting challenges; public health to food security, energy, and defense. These are simultaneously extremely costly when they go unsolved and yet remain highly intractable. In many cases, the solution of these grand challenges depends on the development of macro innovations for which the solution (as well as the solution path) is difficult to establish *ex ante*. The very nature of these grand challenges and their solutions implies that traditional innovation mechanisms likely fall short (Mokyr, 1999). On the one hand, procurement contracts limit the scope of experimentation and are rarely able to induce the macro innovations required. At the same time, many grand challenges are the consequence of significant market failure; market-based incentive mechanisms thus have limited value. Alternative approaches are required to encourage innovations to address grand social challenges. The question is therefore: what mechanisms can ensure that significant effort, creativity and experimentation are plausibly focused on the challenges at hand? Faced with this question, it is perhaps not surprising that policymakers have gone “back to the future” and turned their attention towards prizes and challenges of all types but most centrally on Grand Innovation Prizes – prizes for innovations that met significant challenges.

2.1. Historical perspectives

As early as the thirteenth century, governments established incentive systems to encourage innovations to address their most pressing needs. In this context, GIPs have a storied history as a tool of innovation policy to induce solutions to national challenges (see the detailed catalogue in Knowledge Ecology International, 2008). By the sixteenth century, governments and private actors provided inventors with significant *ex post* monetary rewards for breakthrough innovations; the British Parliament rewarded Jenner for his vaccine inoculation and Gatehead for the lifeboat (MacLeod, 2007). The eighteenth century saw the more systematic use of *ex ante* Grand Innovation Prizes. Following unsuccessful longitude prizes in Spain (1567) and the Netherlands (1627), the British promulgated the Longitude Act – a monetary reward of £20,000 (equivalent to \$12 M today) for a method to calculate longitude at sea – with the objective of solving one of its most significant problems, navigation.³

While longitude is certainly the most storied GIP, it was not the only attempt to use a large innovation prize to focus inventive activity. The French were particularly assiduous in offering grand prizes for national challenges (as well as a range of smaller prizes) throughout the 18th and 19th century. Via royal decree or the French Academy of Sciences, GIPs were instituted in areas from Food preservation (1795) to Agricultural pests (Davis and Davis, 2004; Knowledge Ecology International, 2008; Wright, 1983). And from 1839 the (British) Royal Agricultural Society sponsored (smaller) prizes and medals for a range of innovations in agricultural instruments used in tillage, harvesting and crop preparation (Brunt et al., 2008).

Despite these initiatives, Grand Innovation Prizes gradually fell out of favour during the 19th century to be replaced by mechanisms such as patents, procurement, or market-based rewards based on first mover advantages and complementary asset control (Teeco, 1986; Chandler, 1990; Murmann, 2003). While the decline of prizes has not been fully explained, one impetus was presaged

³ The Longitude Act noted that “The Discovery of the Longitude is of such Consequence to Great Britain for the safety of the Navy and Merchant Ships as well as for the improvement of Trade. ...”

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