Concerning Federally Sponsored Inducement Prizes in Engineering and Science

Report of the Steering Committee for the Workshop to Assess the Potential for Promoting Technological Advance through Government-Sponsored Prizes and Contests, National Academy of Engineering

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Steering Committee

Workshop to Assess the Potential for Promoting Technological Advance through Government-Sponsored Prizes and Contests

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Preface

In response to a request from the National Economic Council, the National Academy of Engineering (NAE) convened a workshop on 30 April 1999 to assess the potential value of federally sponsored prizes and contests in advancing science and technology in the public interest. A five-member steering committee[1] was appointed by NAE President Wm. A. Wulf to organize the workshop and prepare a brief summary report to sponsors. Funding was provided by the National Science Foundation (NSF).

To help prepare participants for the workshop, the steering committee commissioned a background paper on prizes and contests.[2] The 41 participants—from government, industry, and academia[3]—were asked to consider the following questions:

- Is there a case to be made for adding prizes and contests to the federal science and technology policy portfolio?
- What are the potential advantages and disadvantages of prizes and contests relative to other policy instruments?
- What are the most appropriate objectives for such prizes and contests?
- How should such prizes and contests be designed and administered?

At the workshop, discussion was organized around an initial presentation and the prepared remarks of two expert panels.[4] The first panel included prize administrators and prizewinners, and discussed the history, design, administration, and impact of prizes and contests. The second panel included industry and agency leaders, and discussed the potential value of prizes and contests to agency missions and societal objectives, as well as legislative, administrative, and legal issues.

The following report of the steering committee summarizes the workshop discussion, which explored the rationale for federally sponsored science and technology prize contests, potential objectives of such contests, and issues of prize contest design and administration. The report also includes a series of cautions and summary recommendations.

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Executive Summary

The steering committee recommends that Congress encourage federal agencies to experiment more extensively with inducement prize contests in science and technology—competitions designed to foster progress toward or achievement of a specific objective by offering a named prize or award—as a complement to their existing portfolio of science and technology policy instruments.

At present the U.S. federal government makes very little use of inducement prizes in science and technology. However, the recent history of inducement prizes, most privately sponsored, and a growing body of research on contests, grants, procurement contracts, and the optimal design of federal R&D programs, suggest that it may make sense for the federal government to make more extensive use of explicit inducement prizes to advance research, technology development, and technology deployment toward specific societal ends.

The steering committee views inducement prizes as a potential complement to, and not a substitute for, the primary instruments of direct federal support of research and innovation—peer-reviewed grants and procurement contracts. When compared with traditional research grants and procurement contracts, inducement prizes appear to have several comparative strengths which may be advantageous in the pursuit of particular scientific and technological objectives. Specifically these include:

- the ability of prize contests to attract a broader spectrum of ideas and participants by reducing the costs and other bureaucratic barriers to participation by individuals or firms;
- the ability of federal agencies to shift more of the risk for achieving or striving toward a prize objective from the agency proper to the contestants;
- the potential of prize contests for leveraging the financial resources of sponsors; and
- the capacity of prizes for educating, inspiring, and occasionally mobilizing the public with respect to particular scientific, technological, and societal objectives.

Inducement prize contests may be used to pursue many different objectives—scientific, technological and societal. In particular, the steering committee believes they might be used profitably to identify new or unorthodox ideas or approaches to particular challenges, to demonstrate the feasibility or potential of particular technologies, to promote the development and diffusion of specific technologies, to address intractable or neglected societal challenges, or to educate the public about the excitement and usefulness of research and innovation. Moreover, prize contests can be designed to stimulate effort across the spectrum of research and innovation efforts, including basic research, technology development, technology deployment and diffusion, and managerial/organizational innovation.

To encourage agencies to experiment with inducement prize contests, Congress should consider providing explicit statutory authority and, where appropriate, credible funding mechanisms for agencies to sponsor and/or fund such contests. Congress and federal agencies should approach contest structures and administration flexibly, and consider using a variety of

contest models, including contests that are funded and administered by agencies, contests that are initiated and administered by agencies yet privately funded, and contests that are initiated by agencies but privately funded and administered.

The design of any such experiment should include mechanisms for appropriating prize money, for flexibly distributing intellectual property rights, and for reducing political influence. Moreover, prize contest rules should be seen as transparent, simple, fair, and unbiased. Contest rewards should be commensurate with the effort required and goals sought. Finally, if such a policy experiment is initiated, it should be time-limited, and the use of prizes and contests should be evaluated at specified intervals by the agencies involved to determine their effectiveness and impact.

Introduction

Since World War II, the federal government has supported research and innovation in engineering and science under two broad objectives. The first has been to harness science and technology in support of federal agency missions in areas such as national security, public health, and environmental protection. The second has been to advance the nation's economic development and general welfare, proceeding from the premise that the advancement of knowledge, in the form of technological change, is a critical driver of growth in per capita national income and of the well-being of society.

In support of these objectives the federal government relies on a range of policy mechanisms. To meet the needs of federal agency missions, the government directly procures research and technology via contracts. In other areas, where the perceived social value of technological advance is potentially very high yet the market forces are weak, the government either directly funds or fosters private-sector funding of research, innovation, and technology diffusion. Here it relies primarily on peer-reviewed research grants, tax and regulatory incentives, intellectual property rights, and technology diffusion programs.

Prize contests that recognize past achievement or induce additional effort by offering a named prize or award have played only a small role in the federal government's science and technology policy portfolio to date. Of these two types of prizes, those that recognize past scientific or technological achievement, such as the Presidential Science and Technology Medals or the Department of Energy's Enrico Fermi Award, have been more prevalent than those that induce technical effort in support of specific goals. Indeed, the Department of Commerce's Malcolm Baldrige National Quality Award contest, which has provided additional incentives to numerous firms to adopt "best practices" in total quality management, is perhaps the only explicit inducement prize contest, i.e., contest for a named prize or award, that is sponsored by the U.S. federal government.[5]

Nevertheless, there is a history of inducement prize contests, most privately sponsored, and a growing body of research on contests, grants, procurement contracts, and the optimal design of federal R&D programs[6] which suggest that it may make sense for the federal government to make more extensive use of explicit inducement prize contests to advance research, technology development, and technology deployment toward specific societal ends. This premise provided the impetus for the 30 April 1999 National Academy of Engineering workshop and the following workshop report, which seeks to open this possibility to discussion by Congress, federal agencies, and the general public.

A Taxonomy of Prize Contests

Before examining the roles inducement prize contests might play in the federal science and technology policy portfolio, it is useful to distinguish clearly between two major types of prize contest, i.e., the *recognition* prize contest, which recognizes past achievement, and the *inducement* prize contest, which induces additional effort by contestants related to specific objectives.

The world's most prestigious prizes in engineering and science—including the Nobel Prizes, the Charles Stark Draper Prize in engineering, and the Albert Lasker Medical Research Awards in medicine[7]—are prizes that are given in recognition of past achievement. Contestants for recognition prizes are usually nominated by others. Winners of these prizes are generally designated in private by criteria that may or may not be announced publicly. In general, recognition prizes do not provide incentives for contestants to invest additional scientific or technical effort or change the focus of their work in order to effect their likelihood of winning the prize.[8]

By contrast, inducement prize contests—the focus of the NAE workshop and this report—require additional effort by contestants, directly related to the achievement of a clearly specified objective, if they hope to win the prize. Notable prize contests of this type have included privately sponsored prizes such as the Orteig Prize won in 1927 by Charles Lindbergh for being the first to fly nonstop from New York to Paris, or the recent contest to circle the world in a balloon sponsored by Anheuser-Busch.[9] Government-sponsored prize contests of this type include the well-chronicled prize offered by the British Parliament in 1714 for the first to invent an instrument for accurately measuring longitude at sea,[10] as well as the aforementioned Malcolm Baldrige National Quality Awards.

Contestants for inducement prizes must actively compete for the prize by investing additional time and resources to meet the objectives of the contest. To attract contestants, inducement prize contests must offer a prize or reward valuable enough, as well as a probability of winning high enough, for contestants to risk the costs of participating in the contest. Such contests may be designed to seek out the best entry within a given period, or the entry that first meets a specific goal. They are generally public and open, and decided on the basis of clearly announced criteria. And as the discussion of prize objectives below makes clear, inducement prize contests can be designed to stimulate innovation across the entire spectrum of research and innovation efforts, including basic research, technology development, and deployment. They can also be set up to serve a diverse range of policy and societal objectives.

Though not discussed in detail in this report, there are also hybrid recognition/inducement prize contests that recognize and reward past achievement yet are also designed to induce additional effort of prizewinners consistent with the prize's objectives *after* they have won the prize. Examples of this type of prize contest include MacArthur Fellowships, Presidential Early Career Awards for Scientists and Engineers, and the National Science Foundation's Alan T. Waterman Award.[11] These contests do not require contestants (who are usually nominated by their peers) to invest additional effort in pursuit of a specified objective to

improve their chances of winning. Rather, the inducement effect of these "genius" awards is expected to occur after the prize is awarded. Specifically, it is assumed that the proceeds of the prize will "induce" the prizewinner to spend less time on the bureaucratic processes of grant applications and reporting, and spend more time on scientific research or innovation in his or her chosen field.

Inducement Prizes and Existing Public Policy Instruments

In an effort to better understand the role inducement prizes might play as an instrument of federal science and technology policy, workshop participants considered the strengths and weaknesses of two primary mechanisms by which the federal government supports research and innovation directly—traditional research grants and procurement contracts—and how prize contests might complement them.

Research grants support most of the long-term, fundamental research in university and government research institutions, as well as a significant share of applied research and a small amount of technology development. These grants are generally awarded through a process of expert peer review. By comparison, procurement contracts support most of the applied research, technology development, and product or service production performed for the federal government by nongovernmental entities. These contracts are arranged between agencies and private firms to support agency missions.

There was general agreement among workshop participants that both the peer-reviewed system of research grants and the federal procurement system have, on balance, served the nation's interests well, and are likely to remain pillars of direct federal support to research and innovation in the future. However, by focusing on several perceived shortcomings of these two principal policy mechanisms, several workshop participants sought to delineate the potential advantages of prize contests and the complementary role they might assume in the federal technology policy portfolio. In particular, participants focused their criticism on the conservative, risk-averse posture of the research grant and procurement systems and at the bureaucratic barriers that have grown up around them.

Discussing the grant system, some workshop participants argued that the peer review process tends to favor proposals that seem "safe," as opposed to "riskier" proposals that may produce surprising and potentially more innovative results. For example, National Science Foundation (NSF) officials at the workshop said that both experienced grant applicants and reviewers alike are inclined to favor existing lines of inquiry and "nearby" incremental goals that have the best chances of success. These same officials observed, however, that this cautious tendency extends beyond peer review. For example, with the Small Grants for Exploratory Research Program, the NSF has urged program officers to use 5 percent of their budgets for high-potential, high-risk, non-peer-reviewed projects. However, in 1998 less than 1 percent of operating budgets on average was committed to this program.[12]

Likewise, workshop participants criticized the federal procurement system for its intolerance of risk and its bureaucratic and costly demands on private-sector contractors. While

acknowledging that some agencies have improved incentives and reduced the bureaucratic burden for government contractors in recent years, workshop participants noted that the Defense Advanced Research Projects Agency (DARPA) and other agencies continue to experience difficulties in their efforts to identify and contract with innovative companies in fast-paced sectors, or in new fields of technology in which the agency has not previously been active. In response to this challenge, DARPA, which has been a trailblazer in the use of alternative procurement mechanisms, has sought and recently received legislative authority from Congress to offer inducement prizes as a mechanism for attracting and engaging cutting-edge technology companies in support of the agency's mission.[13]

There was general agreement among workshop participants that inducement prize contests were not immune to the challenges that face the grant and procurement systems. Indeed, if prize contests are not designed or administered with care, they may discourage prudent risk taking or unorthodox approaches to particular scientific or technological challenges, or scare away potential contestants with excessive bureaucracy. On the other hand, many participants argued that prize contests—if carefully targeted, designed, and administered—might address some of these challenges in a manner that complements agency missions. Indeed, the workshop discussion and existing research on research tournaments and "prize-like contests" highlight several potential advantages of prize contests relative to traditional research grants or procurement contracts in the pursuit of particular types of objectives.[14]

One perceived strength of inducement prize contests is their potential for reducing the cost and bureaucratic/regulatory obstacles that might prevent federal agencies and innovative researchers and firms from finding each other and working together effectively. In principle, prize contests could lower the cost to federal agencies of identifying capable competitors, selecting among them, and subsequently monitoring and verifying their performance vis-à-vis a predetermined objective. Indeed, if the rewards associated with a given prize contest are adequately calibrated to the level of effort (cost and risk taking) required to compete successfully for it, capable contestants should self-identify. While the costs associated with identifying the highest performing competitors from a large pool of prize contestants can be significant, recent research on the use of auctions and other mechanisms to address this challenge suggests that these selection costs can be significantly reduced for the prize administrator.[15] Moreover, whether the prize is awarded on the basis of objective criteria (e.g., the first to achieve *X*) or the relative performance of contestants, the tasks of identifying a winner and monitoring its performance are made easier because the prize—unlike conventional grants and contracts—is awarded after the prize objective has been achieved. By contrast, the cost and difficulty to federal agencies of assessing the relative capability of competitors and monitoring the performance of grant or contract winners can be quite high in the case of conventional contracts or grants.

Likewise, by relieving would-be prize contestants of the burden of complying with the multitude of government accounting rules, reporting requirements, and other information demands generally associated with federal grants and contracts, inducement prize contests may be more effective at attracting a broader range of participants and approaches to meet particular challenges. This is more likely to be the case if the criteria for winner selection are perceived to be transparent, objective, and fair.

A second potential advantage of prize contests is that, if properly designed, they may help federal agencies to be more tolerant of prudent risk taking than traditional research support mechanisms.[16] Inducement prize contests can effectively shift more of the risk involved in pursuing a particular technical objective from the administering agency to the contestants, who are likely to be in a better position to evaluate the risk associated with different approaches to the contest's objective. With research grants or procurement contracts, federal agencies assume some of the risk of failure of their grantees or contractors. By contrast, with a prize contest, the agency only pays out its reward or prize if the criteria for winning are met—in this case, achieving a specified objective. It should be noted, however, that along with the higher administration costs and risk associated with conventional grants and contracts, federal agencies are likely to receive significantly greater substantive information flows from researchers supported by these instruments than they would receive from prize contestants per se.

A third advantage of prize contests may be their ability to leverage the financial resources of a contest sponsor by inducing contestants to invest their own resources in research and innovation aimed at the prize objective as they compete for the prize's cash and non-cash rewards. In addition to cash awards, prize contests may offer publicity or free advertising generated by the contest itself; the imprimatur of a respected prize sponsor; recognition within a particular community of peers; the potential for follow-on grants, procurement contracts, or venture-capital support; or increased commercial demand for a winning process or technology. That is, non-cash incentives may attract some private-sector participants that value them as much as or more than the monetary value of a prize. In some cases, these collateral benefits will accrue not only to winners but to other contest participants as well. Ultimately, the level of contestant investments induced (or leveraged) by a prize is a function of both the size or value of the prize offered and the probability of winning.

A fourth comparative strength of inducement prize contests (and recognition prize contests for that matter) that received particular emphasis during workshop discussions is the potential of prizes to inspire and educate the public. While seeking to induce the efforts of contestants, inducement prize contests have often incited action by "third parties"—students, policymakers, opinion leaders, et al.—consistent with or complementary to the primary objective(s) of a prize contest. For example, recent space prize contests including the X Prize, which seeks to advance development of reusable, manned, suborbital space craft, and the Cheap Access to Space (CATS) Prize, which seeks to advance the development of inexpensive launch technologies, are focused on achieving specific technical objectives and demonstrating the feasibility and commercial potential of particular technologies.[17] Yet they are also serving to inspire the American public and build popular support for space-related research in general.

Potential Objectives of Inducement Prize Contests

Workshop participants identified a broad range of objectives—scientific, technological, and societal—that federally sponsored or administered inducement prize contests both have been and might be designed to advance. The following list elaborates several more generic objectives that the workshop steering committee considered particularly worthy of consideration. The first two of these elaborate objectives follow directly from the comparative strengths of prize contests enumerated above—identifying new sources of ideas and innovation, and educating and inspiring the public.

- **Identify and engage nontraditional participants and unorthodox approaches to challenges**. As discussed earlier, by lowering barriers to entry, prize contests may broaden the pool of potential contributors and ideas attracted to a given challenge or area of research. For example, the CATS Prize contest, by setting performance objectives perceived to be within the range of possibility of a significant number of contestants (two-kilogram payload placed 200 kilometers or higher into space by 8 November 2000), and by offering a prize scoped to the anticipated level of investment needed to compete ($250,000) that would allow the winner to earn a profit on their investment, has attracted a number of nontraditional players and approaches to its challenge. One could imagine a prize contest posing a "dual-use" (defense and commercial) technology challenge with a large enough prize to encourage individuals or firms to cross their traditional disciplinary, technology, or industry boundaries to apply new or existing knowledge from one area to challenges in another.

  The field of robotics also offers examples of prize contests that attract a broad range of contestants and competing ideas. The American Association of Artificial Intelligence sponsors contests at its summer meetings; the Institute of Electrical and Electronics Engineers has promoted "micro-mouse" contests for nearly 10 years; and the RoboCup Federation sponsors robotic soccer games each year, which, according to its entry form, are "open to anyone interested in science and technology related to RoboCup."[18]

- **Educate and inspire the public.** While not asserted as a first-order objective of inducement prize contests—which are, by definition, designed to induce effort by contestants aimed at achieving a specific technical or other performance objective—education and inspiration of the public is usually a major secondary objective of all prize contests. As noted earlier, the public is likely to understand the visible aspects of some prize contests better than laboratory-based work funded by grants and contracts. Through publicity and public demonstrations, such as displays of competing aerial robotic systems, inducement prize contests may fire the imaginations of both contest observers and participants. They could also stimulate much-needed communication between the scientific community and nonscientists by inviting public participation. Indeed, by celebrating and publicizing outstanding scientific or technological achievements, big technical or societal challenges, or the triumphs of individuals, inducement and recognition prize contests alike may attract young people to study or pursue careers in engineering or science, and may also inspire support from the public and policymakers for research or technology objectives. As noted above, recent space prizes such as the X

Prize and the CATS Prize have clear goals to educate the public and mobilize public opinion. Similarly, the most prestigious recognition prizes in medicine, the Lasker Awards, were explicitly designed both to publicly celebrate the achievements of outstanding medical researchers, and, by publicizing these achievements, to induce additional support for medical research by private and public agencies.[19]

- **Stimulate nascent or "stalled" technologies.** Prize contests might be used to stimulate the development of potentially useful technologies that lack robust commercial or federal agency sponsorship. Examples could include development of "hummingbird"-style wings for aircraft, or robotic "mice" that could run a maze in a given time. Similarly, NASA has expressed interest in flying a small, low-cost airplane on Mars to celebrate the centenary of the Wright Brothers' first flight.[20] However, there is currently no funding available for a full-scale agency program. A contest endorsed and administered by the space agency might invoke innovative proposals for the Mars airplane and focus public attention on an exciting aspect of space exploration. The winning entry might either be a new technology or a new application of an existing technology. While there may be presently no application "pull" for such technologies (i.e., there is no pressing need for a mouse to run mazes), several workshop participants noted that the "proof of concept" value of prize contests may extend far beyond the finish line.

- **"Stretch" existing technologies by demonstrating their usefulness.** Two such achievements, stimulated by prizes in the 1990s, were nonstop flights around the globe, one in an airplane and one in a balloon. While neither victory depended on new technologies, both provided dramatic demonstrations of advanced technologies and extensive publicity for aerospace as an exciting field to enter or support. In the same way, the aviation prizes of the early twentieth century, including the Oertig prize won by Charles Lindbergh, provided powerful impetus to existing aviation technologies.

- **Foster technology diffusion.** For example, the Super Efficient Refrigerator Prize (SERP), organized by a coalition of electric utility companies to advance refrigeration technologies, promoted the diffusion of the winning technology by awarding the prize money on the basis of units (refrigerators) sold.[21] The winner was Whirlpool Corporation. Ultimately, the market for Whirlpool's super-efficient refrigerator did not materialize and the company was only able to collect a fraction of the prize money. Nevertheless, Whirlpool's achievement allowed the government to set high but realistic new energy efficiency standards for appliances, providing further impetus to the development and diffusion of energy-efficient technologies.

- **Address neglected or seemingly intractable societal problems.** Prize contests might be used to attract new, unorthodox, or low-cost technical approaches or solutions to aspects of large societal problems that seem intractable or offer no obvious economic incentive to the private sector. The workshop participants identified several examples of such large, complex challenges as being potentially addressable via prize contests in science and technology, including adult illiteracy, air pollution, hidden explosives and buried mines, solid and nuclear waste disposal, independent living systems for the elderly, and violent crime. A government-backed prize contest with objectives closely linked to such

important yet seemingly intractable challenges might serve to legitimize promising new technological approaches, increase a researcher's or contestant's chances of long-term funding, or serve as an important "signal" to venture capitalists or other sources of private funding. Moreover, prize contests of this type may also serve to attract public attention to neglected societal challenges and generate public support for additional research and policy experimentation related to these challenges.

- **Build "social capital."**[22] Contests can stimulate the capacity of individuals and groups to work together for mutual benefit. Social capital is strengthened through the collaborative aspect of incentive programs—the activity of learning inspired among those who form teams or interdisciplinary groups to compete. A contest, unlike a procurement contract, is likely to lead to the formation of new, ad hoc partnerships whose members determine leadership and direction with specific goals in mind.

  For example, the Royal Aeronautical Society's Kremer Prizes, offered two decades ago, attracted a group of engineers at MIT to form a team and design an entry. Their entry was successful in the latter stages of the competition, and the same team went on to conduct the Daedalus Project, whose human-powered aircraft established virtually all current world range and endurance records, notably a flight of 72+ miles between the Greek islands of Crete and Santorini in 1988. The core of the Daedalus team has evolved into a commercial enterprise, Aurora Space Sciences, whose current mission is to develop affordable robotic aircraft, primarily for high-altitude atmospheric research. Thus the Kremer Prizes focused and advanced the careers of participants in unexpected directions.[23]

In summary, the history of inducement prize contests demonstrates that such contests can serve a broad range of objectives—some highly specified, others very broadly defined. Regardless of their stated primary objectives, many inducement prize contests in science and technology place great emphasis on public education and inspiration as a major goal. Moreover, as the discussion of potential prize objectives makes clear, prize contests can be designed to stimulate effort across the entire spectrum of research and innovation activities, including basic research (Wolfskehl Prize in mathematics),[24] technology development (the longitude prize), technology diffusion (the SERP prize), as well as managerial/organizational innovation (the Baldrige Awards), etc.

Design and Administration of Inducement Prize Contests

Inducement prize contests usually fall into one of two basic categories: best-entry contests, which reward the best solution within a given time period, and defined-objective contests, which may remain open until a specific goal is reached. One example of a best-entry inducement prize contest is the privately funded Loebner Prize, which each year gives a cash award and a medal for the computer that gives the most "human" responses to questions.[25] Another best-entry prize might reward the development of toys that stimulate scientific learning in children, an important educational goal of the nation. Examples of defined-objective contests are aviation prizes such as the aforementioned Oertig and Kremer Prizes.

Recent space prizes such as the X Prize and the CATS Prize also fit this model. Compared with goal-oriented prize contests, best-entry prize contests are likely to require a more complex and subjective judging process to choose the winner.

Case studies of specific prizes presented at the workshop, as well as a growing body of research on contests, grants, procurement contracts, patent races, and the optimal design of federal R&D programs,[26] suggest that the following guidelines may prove helpful in structuring specific best-entry or goal-oriented inducement prize contests:

- **Contest rules should be seen as transparent, simple, fair, and unbiased.** Goal selection must be transparent and credible, the criteria for winning must be clear, and the process for determining winners must be perceived to be fair and unbiased. Clearly this represents much more of a challenge to prize contests targeted at large, complex, societal challenges, than to those that are focused on more readily quantifiable or definable technical objectives.

- **Prizes should be commensurate with the effort required and goals sought.** For example, a prize contest for the design of the best educational toy might offer a modest prize, given the relatively low investment needed to enter. On the other hand, rewards (financial and other) for prize contests with more ambitious objectives—such as the development and marketing of super-efficient refrigerators—must be significantly larger in order to attract qualified contestants.

  At the extremes, if the value of a prize is too small relative to the cost of competing for it, it will attract no contestants. On the other hand, if a prize is much larger than the anticipated cost of competing for it, the contest could draw too many contestants. This would lower the probability of winning the prize for any given entrant, and reduce the expected payoff. This would also raise the cost of administering the prize, i.e., the cost of reviewing and filtering large numbers of prize entries. While there may be ways to reduce the costs associated with singling out the highest performing contestants (e.g., via contestant auctions, entry fees, and other mechanisms),[27] excessively large prizes may affect contestant behavior in ways that reduce the effectiveness of these mechanisms. Furthermore, it might lead to excessive duplication of effort. Indeed, sponsoring a prize that is much larger than the expected cost of competing for it makes sense only if the sponsor believes that there are a large number of very different technical approaches that might work, and so wants to get a large number of contestants participating in the prize competition.

  The closer the objectives of an inducement prize contest lie to perceived market opportunities and the existing capabilities of would-be contestants, the lower the costs of competing for it will be, and the smaller the prize needs to be to attract competitors. Conversely, the further a contest's objectives lie from perceived market opportunities (high-risk challenges far beyond the current technological horizon, or otherwise neglected technologies or societal challenges), the higher the intended inducement effect will be, the higher the cost of competing for it will be, and the larger the prize must be to attract contestants.

- **Treatment of intellectual property resulting from prize contests should be properly aligned with the objectives and incentive structure of the prize contest.** The issue of awarding intellectual property rights (IPR) must be considered carefully in designing prize contests. No one model or approach will fit all contests. In some cases, contests that invite firms to develop new technologies might be expected to leave the rights with the inventor. In others, intellectual property ownership might be tilted in different directions according to the size of prizes and the intent of contests. In certain cases, the property rights associated with a prize-winning entry might be placed in the public domain, in which case the cash or other non-IPR-related rewards would need to be much larger. In short, the best IPR policy is one that matches the objectives and incentive structures of particular prize contests.

Ultimately, the administering agency or other sponsor should determine the goal of each contest in light of its mission objectives, the overall objective of the research area involved, and the magnitude of the R&D challenge required to win the contest.

While this report is aimed primarily at federal agencies, the same principles of prize contest design and administration can apply to inducement prizes funded or administered by the private sector. In terms of administration, it is logical to expect a range of models for contests, including:

- Agency funding and administration
- Private funding and administration
- Joint agency-private funding and administration
- Private funding, agency administration

For federal agencies to fund inducement prize contests, Congress (congressional committees) would have to develop a mechanism to authorize and appropriate money that might not be spent for several years. At a time of great need, however, unspent federal funds could be difficult for prize-sponsoring agencies to retain. Obviously, even the best-designed prize contests will be futile unless agencies can guarantee access to prize money when the winner steps forward.

Some agencies—depending on the importance of research to their mission objectives—may be able to guarantee prizes autonomously, especially when prize amounts represent a small percentage of the research budget. A more general solution might be an endowment mechanism by which federal prize money could be reserved until claimed.

Prize contests funded by nonfederal sources would not be subject to this uncertainty. The Department of Commerce's Malcolm Baldrige National Quality Awards program is an example of a privately funded, agency-administered model, where a privately created foundation offers stable, long-term support. The use of private-sector judges brings credibility and reduces political influence on the selection process. At the same time, government participation adds prestige and a sense of fairness.

Another form of public-private partnership may be appropriate for agencies whose research holds great immediate interest for the public, such as the National Institutes of Health (NIH). Virtually all of the 1,000 or so diseases under study at NIH have legitimate constituencies. Selecting a fraction of these diseases for federally funded contests would not be politically possible. In such cases, an alternative to federal funding might be to invite nonfederal entities to raise funds and design the contest. The federal agency's role could be to provide administration and validation.

Some Areas for Caution

If federal agencies choose to experiment with named inducement prize contests, there are several other important issues they should consider in addition to those discussed above in reference to contest design and administration. These include fundamental questions such as by whom and by what process should the technologies or societal challenges be selected for which prizes are offered? How can selection processes be designed to minimize undesired political pressures? What kind of accountability is appropriate for participants?

We want to point to a series of questions that deserve special attention when undertaking or designing prize programs and activities:

- Do large prizes create a bandwagon effect, drawing effort to one particular challenge to the neglect of potentially more important or urgent challenges?[28]
- Alternatively, would the creation of many small contests dilute the public's attention and thus render the public education and mobilization role of prizes ineffective?
- Will prizes serve to direct scarce resources away from higher return uses? That is, what are the opportunity costs of prizes in a given area?
- The procurement system is criticized for falling prey to political pressure, complexities of congressional oversight, and the self-protection of agencies. What could prevent prizes and contests from the same shortcomings?
- Would the public accept the use of federal money for contests that carry the risk of failure or the waste of resources on the wrong problem?
- Should international entrants be allowed to compete for federal prizes?
- How should the safety and liability issues associated with prize contests be handled in today's legal climate?
- Under what circumstances will potential negative publicity associated with losing a contest be sufficient to discourage participation?

Conclusions and Recommendations

Conclusions

Named prize contests aimed at inducing contestants to invest effort in pursuit of specific scientific, technological, and societal objectives have seen very little use to date as instruments of federal technology policy. However, discussion at the NAE workshop and findings of related scholarship on the optimal design of federal R&D programs including grants, contracts, patent races, and other "prize-like" mechanisms, suggest that named inducement prizes may have a useful complementary role to play in the federal government's portfolio of policy instruments.

Compared with traditional research grants and procurements, inducement prize contests appear to have several comparative strengths that may offer them an advantage over other traditional contracts and grants in the pursuit of particular scientific and technological objectives. Specifically, these include:

- the ability of prize contests to attract a broader spectrum of ideas and participants by reducing the costs and other bureaucratic barriers to individual or firm participation;
- the ability of federal agencies to shift more of the risk for achieving or striving toward a prize objective from the agency proper to the contestants;
- the potential of prize contests for leveraging the financial resources of sponsors; and
- the capacity of prizes for educating, inspiring, and occasionally mobilizing the public with respect to particular scientific, technological, and societal objectives.

Inducement prize contests may be used to pursue many different objectives—scientific, technological, and societal. In particular, they might be used profitably to identify new or unorthodox ideas or approaches to particular challenges, demonstrating the feasibility or potential of particular technologies, promoting the development and diffusion of specific technologies, addressing intractable or neglected societal challenges, or educating the public about the excitement and usefulness of research and development.

Accordingly, the steering committee believes that by drawing on this limited knowledge base, federal agencies that sponsor research, technology development, and deployment in engineering and science should be encouraged to engage in limited experiments with inducement prize contests.

Recommendations

1. **The steering committee recommends limited experiments in the use of federally sponsored inducement prize contests to stimulate private-sector research, innovation, and technology deployment in service of agency and societal goals.**

   Specifically, the committee recommends that Congress encourage federal agencies to study further the feasibility of inducement prize contests as a potential complement to their existing portfolio of science and technology policy instruments. In addition, Congress should consider providing explicit statutory authority and, where appropriate, credible funding mechanisms for agencies to sponsor and/or fund such contests.

   It is important to note that the purpose of these experiments would be to test the effectiveness of prizes and contests as complements to—not replacements for—traditional R&D grants and procurement contracts.

2. **Both Congress and federal agencies are encouraged to take a flexible approach to the design and administration of inducement prize contests.**

   Prize contests can be agency funded and administered; agency administered and privately funded; agency initiated and privately funded and administered; or joint agency-private sector funded and administered. Prize contest rules must be seen as transparent, simple, fair, and unbiased. Prize rewards must be commensurate with the effort required and goals sought. Moreover, prize contest designs should include mechanisms for appropriating prize money, for flexibly distributing intellectual property rights, and for reducing political influence.

3. **Given its experimental nature, the use of prizes and contests should be accompanied by a mechanism for evaluation and a time limit.**

   The use of inducement prize contests should be evaluated at specified intervals by the agencies involved to determine their effectiveness and impact.

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Notes

[1] See page *iv* for the steering committee roster.

[2] Windham, P. H., "Background Paper: Workshop on the Potential for Promoting Technological Advance through Federally Sponsored Contests and Prizes," prepared for the National Academy of Engineering (March 1999). See excerpted sections of the Windham paper, "A Taxonomy of Technology Prizes and Contests," in Appendix A.

[3] Workshop participants are listed in Appendix B.

[4] The workshop prospectus and agenda are included in Appendix B.

[5] For further information concerning the Malcolm Baldrige National Quality Award, which is administered by the Department of Commerce, see the award's website at http://www.quality.nist.gov/ (date accessed: 14 June 1999). Various design and standards contests sponsored by U.S. government agencies in the areas of defense aerospace technology and communications have been labeled and evaluated as "prize contests" by a small community of scholars—wherein the "prize" may be the profits associated with winning a procurement contract, the temporary but profitable monopoly provided by intellectual property rights, windfalls from having the winning standard, etc. (Farrell and Shapiro, 1992; Rogerson, 1994). Moreover, contests for publicly funded research grants in highly competitive fields of research have also been looked at as "prize contests." This research seeks to explain the incentive structure and dynamic of "prize-like" policy instruments and to assess their effectiveness relative to other policy mechanisms, and as such offers useful insights concerning the design of explicit inducement prize contests. However, the focus of the NAE workshop and this report is on explicit prize contests, i.e., contests for a named prize or award, not on "prize-like" contests.

[6] See, for example, Farrell and Shapiro, 1992; Fullerton and McAfee, 1999; Lazear and Rosen, 1981; McLaughlin, 1988; Nalebluff and Stiglitz, 1983; Noll and Rogerson, 1998; O'Keeffe et al., 1984; Rogerson, 1989, 1994; Rosen, 1986; and Taylor, 1995.

[7] For further information concerning the Nobel Prizes, Draper Prize, and Lasker Awards, see their respective websites: http://www.at.nobel.se/; http://www4.nationalacademies.org/nae/nae.nsf/Awards/; and http://www.laskerfoundation.com/ (accessed 5 November 1999).

[8] Nevertheless, highly prestigious recognition prizes like the Nobel Prizes have been known to induce a certain amount of lobbying activity on behalf of particular prize candidates.

[9] See Appendix A, section 2.1.2.

[10] See Sobel, 1995, and Appendix A, section 2.1.1.

[11] For further information, see Appendix A, section 2.2.2; Knezo, 1999; and the prize websites: http://www.macfdn.org/programs/fel/fel_overview.htm; http://www.nsf.gov/pubs/1998/pecase98/pecase98.htm; and http://www.nsf.gov/nsb/awards/waterman/ (accessed 5 November 1999).

[12] See Knezo, 1999, p. 4.

[13] See the text below, excerpted from section 244 of Public Law 106-65, 106th Congress, 2nd session (5 October 1999), *National Defense Authorization Act for Fiscal Year 2000.*

Sec. 244. DARPA Program for Award of Competitive Prizes to Encourage Development of Advanced Technologies.

(a) AUTHORITY.—Chapter 139 of title 10, United States Code, is amended by inserting after section 2374 the following new section:

"S 2374a. Prizes for advanced technology achievements

"(a) AUTHORITY.—The Secretary of Defense, acting through the Director of the Defense Advanced Research Projects Agency, may carry out a program to award cash prizes in recognition of outstanding achievements in basic, advanced, and applied research, technology development, and prototype development that have the potential for application to the performance of the military missions of the Department of Defense.

"(b) COMPETITION REQUIREMENTS.—The program under subsection (a) shall use a competitive process for the selection of recipients of cash prizes. The process shall include the widely-advertised solicitation of submissions of research results, technology developments, and prototypes.

"(c) LIMITATIONS.—(1) The total amount made available for award of cash prizes in a fiscal year may not exceed $10,000,000. "(2) No prize competition may result in the award of more than $1,000,000 in cash prizes without the approval of the Under Secretary of Defense for Acquisition, Technology, and Logistics.
"(d) RELATIONSHIP TO OTHER AUTHORITY.—The program under subsection (a) may be carried out in conjunction with or in addition to the exercise of any other authority of the Director to acquire, support, or stimulate basic, advanced and applied research, technology development, or prototype projects.
"(e) ANNUAL REPORT.—Promptly after the end of each fiscal year, the Secretary shall submit to the Committees on Armed Services of the Senate and the House of Representatives a report on the administration of the program for that fiscal year. The report shall include the following: "(1) The military applications of the research, technology, or prototypes for which prizes were awarded. "(2) The total amount of the prizes awarded. "(3) The methods used for solicitation and evaluation of submissions, together with an assessment of the effectiveness of those methods.
"(f) PERIOD OF AUTHORITY.—The authority to award prizes under subsection (a) shall terminate at the end of September 30, 2003."

[14] See, for example, Farrell and Shapiro, 1992; Fullerton and McAfee, 1999; McLaughlin, 1988; Rogerson, 1989, 1994; Taylor, 1995.

[15] See Fullerton and McAfee, 1999.

[16] Clearly, prize contests can be structured to be highly risk-averse in the selection of goals and the criteria for competing and winning. Indeed, there is both documented and anecdotal evidence of contest administrators who were sufficiently risk-averse to prevent or delay the award of prizes to winners who had met the contest criteria. See, for example, the history of the chronometer's invention in Sobel, 1995.

[17] For further information concerning the X Prize and the CATS Prize, see Appendix A, sections 2.1.6 and 2.1.7, or their websites: http://www.xprize.org and http://www.space-frontier.org/EVENTS/CATSPRIZE_1 (accessed 5 November 1999).

[18] Contestants in the RoboCup include high school students, graduate students, postdocs, faculty as well as researchers based in other not-for-profit as well as for-profit organizations. For further information regarding the "micro-mouse" contests and the RoboCup, see the website for the International Micro Robot Maze Contest at http://www.mein.nagoya-u.ac.jp/maze and the Robot World Cup Initiative at http://www.robocup.org (accessed 5 November 1999).

[19] This point was made by Neen Hunt, executive director of The Albert and Mary Lasker Foundation, in her prepared remarks to workshop participants on 30 April 1999. See also the conclusions of Zuckerman, 1992, regarding the educational/inspirational role of prizes.

[20] See, for example, Colozza, 1990.

[21] However, increasing the requirements of a contest in this way can shrink the pool of potential contestants. In the refrigerator contest, only large companies with distribution outlets in place could hope to compete. For further information concerning the SERP, see Appendix A, section 2.1.4, and also Langreth, 1994.

[22] See Fountain, 1998. Fountain writes, "This form of capital, as powerful and physical as human capital, is the 'stock' that is created when a group of organizations develops the ability to work together for mutual productive gain."

[23] Personal correspondence of 2 May 1999 from John S. Langford, President, Aurora Flight Sciences Corporation, to Proctor Reid, Associate Director, Program Office, National Academy of Engineering.

[24] The Wolfskehl Prize was created in 1908 to reward whoever could prove Fermat's Last Theorem, i.e., that the equation $x^n + y^n = z^n$ has no whole number solutions for *n* greater than 2. The prize was won by Princeton professor Andrew Wiles in 1997. For further information concerning the Wolfskehl Prize, see Appendix A, section 2.1.13.

[25] For further information concerning the Loebner Prize, see Appendix A, section 2.1.9. How much additional effort the Loebner Prize induces from prize contestants above and beyond what they would have done without the inducement of the prize is difficult to determine.

[26] See note 6 above.

[27] See, for example, Fullerton and McAfee, 1999.

[28] For further discussion of "bandwagon effects" see Zuckerman, 1992, p. 228–229.

Appendix A
A Taxonomy of Technology Prizes and Contests

Excerpted from
"Background Paper: Workshop on the Potential for Promoting Technological Advance through Federally Sponsored Contests and Prizes"

Prepared for the National Academy of Engineering
by Patrick H. Windham

A Taxonomy of Technology Prizes and Contests

Patrick H. Windham

1.0 Types of Prizes and Contests

This addendum has two parts. This first section introduces major types of technology prizes and contests and the objectives they can help meet. A second part provides some examples of inducement and recognition prizes.

1.1 Prizes

There are two types of prizes: inducement awards and recognition awards.

1.1.1 Inducement Prizes

Inducement prizes—or incentive prizes—are offered to individuals or groups who provide the best entry in a contest or who first meet some specified technical goal. These prizes are prospective, intended to induce people to do something better than others or to do something that has not been done before. Technology prizes encourage people to "stretch" the state of the art in technology. The award may or may not include a cash component.

Historical examples include a 1714 prize offered by the British government for the first practical method to determine longitude at sea and a large set of aviation prizes offered in the early 20th century, including the prize for the first nonstop flight from New York to Paris. More recent inducement prizes include a private prize for super-efficient refrigerators, a prize-like program at the Federal Communications Commission in the early 1990s, two new private prizes for innovative space launch vehicles, and several prizes offered for achievements in computing. Another set of inducement prizes serve primarily educational purposes, encouraging young people to enter engineering contests and awarding the prizes to the best entries.

1.1.2 Recognition Prizes

Recognition prizes are awards offered after an accomplishment, to recognize past achievement. The Nobel Prizes in science are the most famous examples. The Draper Prize is the NAE's similar award to recognize significant accomplishment in engineering. As with inducement awards, these prizes may or may not include a cash component.

In addition to recognizing achievement, these awards may also have other purposes. For example, the Lasker Awards in medical science have the explicit purpose of

publicizing medical advances so as to help build public support for biomedical research. Many sponsors of recognition prizes also hope that their prizes will encourage young people to go into engineering and science.

1.2 Contests

Prizes often are awarded through contests. Recognition prizes, for example, usually involve a contest-like process in which nominators submit names and a panel of judges picks the best entries among those nominations. In the case of inducement awards, there are two types of contests: best-entry contests and goal-oriented contests.

1.2.1 Best-Entry Contests

One type of contest gives a prize for the best entry submitted during some period of time, often a year.[1] Judges pick this best entry and award a prize, even if the progress falls short of some overall objective. One recent example of this type of contest is the annual privately funded Loebner Prize, which each year gives a cash award and a medal for the computer that is the most "human" in its responses to inquiries.

1.2.2 Goal-Oriented Contests

In the second type of contest, the sponsor sets a technical objective or goal. The prize goes to the first person or group who meets the stated objective (and is verified as having met it).

In the twentieth century, aviation has seen many examples of this type of contest. In 1919, for example, New York businessman Raymond Oertig offered a $25,000 prize to the first person or team who could fly nonstop from New York to Paris, or vice versa. Charles Lindbergh won that prize in 1927. Another example is a second type of Loebner Prize. Dr. Hugh Loebner has pledged $100,000 and a gold medal for the first computer whose responses to questions are indistinguishable from a human's.

1.3 Objectives of Inducement Prizes and Contests

All inducement-type technology contests seek to encourage technological accomplishments. However, sponsors offer prizes to promote different types of objectives. In general, these can be divided into the four types described below.

1.3.1 New or Best Inventions

A sponsor offers a reward to the first person or group who can invent a new technology or technique that meets some technical objective—or who offers the best technology within a specified period of time. As discussed in the next section, one notable example is the cash prize offered by the British Parliament in 1714 to the first person who could develop a reliable method to measure longitude at sea.

1.3.2 New Applications

Here the sponsor offers a prize to the person who can refine or integrate existing technologies to meet a new objective. Meeting the objective may involve some degree of invention, but the real goal is to stretch existing technology in a new way.

Most of the aviation prizes of the early twentieth century fit this category. Airplanes already existed, but the contests asked people to try to use (and refine) aircraft in new ways—such as making the first nonstop flight between New York and Paris. It is important to note that prizes in this category can be designed either to encourage a technological achievement or to encourage a combination of technological achievement and commercial innovation.[2] For example, Lindbergh's flight was a great technical and personal achievement, but it did not prove the economic viability of carrying passengers or mail across the Atlantic.

1.3.4 Performance Improvements

Sponsors also can offer a prize to those who can improve the performance of an existing product used for an existing application.[3] The next section discusses one such case, in which utility firms offered a cash prize for a refrigerator company that could best reduce energy costs.

1.3.4 Technology Diffusion

Most prizes go to those who do something for the first time, but it is also possible to reward those who offer a new technology broadly in the marketplace. For example, the prize in the super-efficient refrigerator contest mentioned above provided part of the prize money for each of the new refrigerators the company sold. The prize explicitly rewarded the diffusion of the new innovation.

2.0 Examples of Inducement and Recognition Prizes

This section briefly presents several case studies of past and present technology inducement and recognition prizes, some offered by governments and others sponsored by private groups. These cases illustrate the different purposes for which prizes can be used.

2.1 Inducement Prizes

2.1.1 Longitude Prize

In 1714, the British Parliament offered a prize of £20,000 pounds (millions of dollars in today's money) for a "practical and useful" means of determining longitude at sea. British naval and merchant vessels faced serious problems because they could not

accurately determine their locations. The size of the prize reflected both the importance of the issue and the fact that no reliable method was close at hand.[4]

A remarkable British clockmaker, John Harrison, eventually solved the problem by developing the first accurate marine chronometer. He was drawn by the size of the prize and sustained for many years by research grants from the group administering the prize, the Board of Longitude. However, despite successful sea tests of his timepieces the Board never gave him the prize money—a step attributed by historians to the fact that over time the Board became dominated by astronomers who favored a rival, astronomy-based method of determining longitude. The longitude case illustrates both the ability of a large prize to draw serious proposals and the problems that can arise if the judges have conflicts of interest.

This case study also illustrates an important point about prizes and intellectual property. As a condition for continued research funding, the Board of Longitude required Harrison to provide written details on his design and to build duplicate timepieces the Board could make available to other watchmakers. As a result, the technology quickly became available to other producers, leading to several competing manufacturers. Harrison did not receive patent protection, but since the government paid his research costs one can argue that this arrangement was fair. In any event, it led to the speedy diffusion of a very important new technology.

2.1.2 Aviation Prizes

In the twentieth century, aviation has seen more contests and prizes than any other technical field. Aviation prizes generally come in three types.

- Prizes for accomplishing some feat (e.g., Lindbergh's flight or the $1 million Budweiser Cup that will now go to the two men who just completed the first nonstop global balloon flight).
- Prizes for accomplishing a certain feat using a prescribed type of technology (e.g., the Kremer Prizes for human-powered flights).
- Air races. The prizes can be designed either to encourage new types of technologies or aircraft or to encourage pilots to stretch existing aircraft types to accomplish new tasks.[5]

Related to aviation prizes are what one can call "aviation procurement contests." Air forces have long offered funding to enable competing teams of contractors to build prototypes of new aircraft. Officials then hold "fly-offs" to see which prototype best meets government needs. The "prize" becomes the resulting procurement contracts.[6]

In the decades between 1900 and World War II, aviation was a dramatic field and newspapers, governments, businesses, and individuals offered dozens of prizes. The prizes definitely encouraged early contest and innovation in aircraft design, but by World War II most aircraft innovation appeared to come from military contracts, government-sponsored research (such as that of the U.S. National Advisory

Committee on Aeronautics), and airline contracts for commercial planes. Since World War II, the number of aviation prizes has fallen sharply.

2.1.3 FCC Pioneer's Preference Program

In 1991, the U.S. Federal Communications Commission (FCC) offered what amounted to a technology prize. It offered guaranteed slices of the telecommunications spectrum to companies that committed to developing and implementing innovative communications services and technologies—particularly in the areas of wireless personal communications services (PCS) and low-earth-orbit (LEO) communications. In October 1992, the FCC tentatively granted pioneer's preferences to three companies.

The program made a certain sense in an era when spectrum allocations were based on either administrative decisions or lotteries. The FCC recognized that companies would not develop expensive new technologies unless they had some assurance that they would receive licenses and thus be able to recoup their investments. The pioneer's preference program sought to give those assured licenses in return for credible commitments to develop and deploy the innovative technologies.

However, in 1993 Congress sought new sources of government revenue and authorized the FCC to hold auctions of telecommunications frequencies. A market quickly developed for those parts of the spectrum subject to auctions. That market, in turn, raised serious questions for the preference program. Was it still necessary or fair to give preferences in an era when other companies, including innovative companies, would pay for their licenses? Even before the auctions, companies denied pioneer's preferences complained that the program gave unfair economic advantage to a few. Those complaints grew after the auctions began. The FCC planned to terminate the program in September 1998, but a new act of Congress led to its termination in September 1997.

2.1.4 Energy-efficient Appliances

In 1992, 24 major American utility firms created a new nonprofit corporation, the Super Efficient Refrigerator Program (SERP). The utilities pooled together $30 million as a reward to the manufacturer that could develop and successfully market a refrigerator which used at least 25 percent less energy than required by existing regulations. An interesting feature of this contest was the stipulation that part of the prize money would be awarded for each refrigerator sold—an inducement not only to develop but also to market the new product.

Whirlpool Corporation won the contest and did indeed manufacture and market a super-efficient refrigerator. However, as energy prices fell during the 1990s, no large market developed for this product. Whirlpool eventually discontinued the refrigerator—although it continues to market products with moderate energy efficiency. This case illustrates three points: (1) a sizable prize can indeed induce

innovation, (2) tying prize money to sales can encourage the production of an innovative product, and (3) even the most well-designed program will encounter problems if the marketplace changes and demand for a product falls.

2.1.5 Malcolm Baldrige Quality Awards

Congress established the Baldrige Awards program in 1987 to recognize U.S. companies for their achievements in quality and business performance and to raise awareness about the importance of quality and performance excellence as a competitive edge. There is no cash prize, but there is prestige.

While this is a primarily a recognition prize, it also serves as an inducement for firms to adopt the techniques of total quality management. Many companies have upgraded their quality programs in the hope of being considered for the awards. The program is a public-private partnership: applicant fees and a privately funded foundation pay for the reviews, but the Commerce Department is involved in the final judgments and the President traditionally makes the awards. The Baldrige program shows that monetary awards are not necessary to have a successful contest, provided that the awards are prestigious and make good economic sense for the applicants.

2.1.6 X PRIZE

The X PRIZE is a modern-day version of the traditional aviation prize. In 1996 the privately-funded X PRIZE Foundation of St. Louis announced that it would give $10 million to the first private team that develops and safely flies a spacecraft capable of carrying three passengers into suborbital flight and back. The craft must make two suborbital flights within a two-week period, meaning that the prize will go to a reusable vehicle.[7]

The X PRIZE comes at a time when rocket technology is relatively well known and a number of entrepreneurial companies are interested in getting into the space launch business. Thus, some of the conditions that make prizes a realistic means to encourage innovation exist. However, there are concerns—particularly about safety. To minimize the possibility that the prize will encourage risky or particularly dangerous entries, the Foundation requires that each applicant meet the regulatory requirements of its home country—including requirements regarding licenses, safety features, and insurance.

2.1.7 CATS Prize

On November 18, 1998, the Space Frontier Foundation (SFF) and the Foundation for the International Nongovernmental Development of Space (FINDS) announced another private space prize. They offered the $250,000 “Cheap Access to Space” (CATS) Prize for the first private team to launch a two kilogram payload into space, 200 kilometers or higher, by November 8, 2000. No government funding may be used. In addition, $50,000 will be awarded for the first “near miss” that fails to reach

200 kilometers but does exceed 120 kilometers, provided that the $250,000 prize has not already been won. The CATS prize has a detailed set of rules, including compliance with applicable government laws and regulations.[8]

Both the X PRIZE and CATS Prize illustrate the growing interest in encouraging private innovation in space technology, and both are aimed particularly at entrepreneurial firms with innovative, low-cost ideas. However, one policy question that arises is whether the size of these prizes will be sufficient to draw serious and sustained entries. This is a particularly important question in the case of the X PRIZE, since a vehicle that can carry humans even into suborbital flight will be very expensive to develop and build. An apparent assumption behind both prizes is that the potential for commercial markets and government contracts will add to the incentives provided by the prizes themselves.

2.1.8 International Computer Go Championship

This prize offers 40,000,000 Taiwanese dollars (about $1.6 million in U.S. currency) for any computer program that can beat a professional player at the oriental game of Go. The sponsors are the computer company Acer and the Ing Chang-Ki Wei-Ch'i Education Foundation of Taipei. They also sponsor annual contests that award NT$200,000 (about U.S. $8,000) for the best computer program for Go entered that year.[9]

2.1.9 Loebner Prize

In 1990 Dr. Hugh Loebner pledged a grand prize of $100,000 and a gold medal for the first computer whose responses were indistinguishable from a human's. Every year an annual prize of $2,000 and a bronze medal are awarded to the "most human" computer. The winner of the annual contest is the best entry relative to other entries that year, regardless of how good it is in an absolute sense. The contest was inspired by mathematician Alan Turing, who asked, "Can a machine think?" Turing's suggestion was this: If the responses from a computer were indistinguishable from those of a human, then the computer could be said to be thinking. No one has won the grand prize to date.

2.1.10 EFF Cooperative Computing Challenge

On March 31, 1999, the Electronic Frontier Foundation (EFF) announced prizes up to $250,000 for the discovery of large new prime numbers. According to EFF's press release:

> The first million-digit prime found will be worth $50,000; a ten-million-digit prime will claim $100,000; a hundred-million-digit prime garners $150,000; and the finder of the first billion-digit prime will receive $250,000. The largest known prime number . . . has 909,526 digits.[10]

The prizes are designed to encourage cooperative computing. No single supercomputer is likely to solve this problem soon, but large numbers of personal computers linked through the Internet could tackle the problem. "In the process," according the EFF press release, "EFF hopes to inspire experts to apply collaborative computing to large problems, and thereby foster new technologies and opportunities for everyone."

2.1.11 Feynman Prizes

The Foresight Institute, a nonprofit educational foundation in Palo Alto, California, offers a set of prizes named for the late physicist Richard Feynman. These prizes encourage and reward scientific and technical progress in the field of nanotechnology, which the Institute defines as "the coming ability to build materials and products with atomic precision."

The grand prize will be at least $250,000 and will be awarded for the demonstration of a 50-nanometer 8-bit adder and a 100-nanometer robot arm. Starting in 1997, the Institute awards two $5,000 prizes each year—one for the best work published in recent years on experimental aspects of nanotechnology, and one for the best theoretical work of recent years. The Institute will award annual prizes until someone wins the grand prize, at which point the series of annual prizes will end.[11]

2.1.12 EU Information Technology Prize

The annual European Information Society Technology (IST) Prize[12] is organized jointly by the IST program of the European Commission's DG XIII and Euro-CASE, the European Council of Applied Sciences and Engineering. The contest is open to companies, laboratories, universities, and others in Europe and Israel. Each year, three grand prizes are awarded (200,000 euros and a trophy) and 25 winner prizes are awarded (5,000 euros and a certificate). Unlike most of the contests described above, this one does not have a precise technical objective. The prize's Web page states that awards "are made for outstanding contributions to generating and converting innovative ideas and R&D results into marketable products."[13]

The IST Prize can be labeled a combination inducement/recognition award. Along with the recognition of past efforts, this contest also encourages European researchers to develop new technologies. The program then tries to help winning researchers refine and market their products by publicizing the results and providing what the Web page calls a "blue-chip reference for all stakeholders, whether upstream financiers or downstream customers."

2.1.13 Wolfskehl Prize for Proving Fermat's Last Theorem

Inducement prizes can be offered to encourage advances in science and mathematics as well as technology. An example is the Wolfskehl Prize, created in 1908 to reward whomsoever could prove Fermat's Last Theorem. The 17th century French

mathematician Pierre de Fermat argued, in what became known as his Last Theorem, that the equation $x^n + y^n = z^n$ has no whole number solutions for *n* greater than 2. Paul Wolfskehl, a German industrialist, had an interest in mathematics, and upon his death in 1908 his will bequeathed a large portion of his fortune for the prize.[14]

Initially, the prize attracted few ideas from serious mathematicians, since the problem has longed seemed difficult, even a lost cause. However, the prize did attract a whole new audience of eager amateurs, none of whom succeeded. In the early 1990s, British-born Princeton professor Andrew Wiles began an eight-year intensive effort to prove the theorem. He finally succeeded, and on June 17, 1997, Wiles collected the Wolfskehl Prize, worth $50,000.

2.2 Recognition Prizes

The number of recognition prizes in science and technology is large and growing. Harriet Zuckerman estimates that as of 1992 there were some 3,000 science prizes available in North America alone, 5 times as many as 20 years earlier. Some of the newer awards are in the same fields as the Nobel prizes, while others are conscious attempts to create prestigious awards in fields not covered by the Nobels.[15]

As mentioned earlier, recognition prizes may have multiple purposes. Some, such as the Lasker medical awards, explicitly try to build public support for research as well as recognize the achievements of individuals. Prizes also may seek to encourage young people to enter careers in science, engineering, and medicine.

2.2.1 Typical Recognition Prizes

Some of the better-known recognition awards in science, engineering, and technology are listed below.[16] (The names of the administering organizations are included in parentheses.)

- Nobel prizes in physics, chemistry, and physiology and medicine (Royal Swedish Academy of Sciences)
- Japan Prize for science and technology (Science and Technology Foundation of Japan, a Japanese government agency)
- Draper Award for engineering (National Academy of Engineering)
- Lemelson-MIT Prize for innovation and invention (MIT)
- MacRobert Award for engineering (Britain's Royal Academy of Engineering)
- Robert J. Collier Trophy for aeronautics and astronautics (National Aeronautic Association)
- Goddard Astronautics Award (American Institute of Aeronautics and Astronautics)
- A.M. Turinig Awards (Association for Computing Machinery)

- Lasker Awards for Medical Research (Albert and Mary Lasker Foundation)
- Bower Awards for science and business leadership (the Franklin Institute)
- Fields Medals for mathematics
- Tyler Prize for Environmental Achievement (University of Southern California)
- Vetlesen Prize for earth sciences (Columbia University)
- Crafoord Prize for mathematics, astronomy, biosciences, and geosciences (Royal Swedish Academy of Sciences)
- Rolf Schock Prizes for logic and philosophy and mathematics (Royal Swedish Academy of Sciences)
- Kyoto Awards for advanced technology and basic sciences (Inamori Foundation)
- Wolf Prizes for agriculture, chemistry, mathematics, medicine, and physics (Wolf Foundation, Israel)
- Balzan Prizes for physical, mathematical and natural sciences, and for medicine (International Balzan Foundation, Switzerland and Italy)
- General Motors Cancer Research Center Awards (GM Cancer Research Foundation)
- Honda Prize for "eco-technology" (Honda Foundation, Japan)
- Marcus Wallenberg Prize for research of importance to forestry and forest industries (Marcus Wallenberg Foundation, Sweden)
- Italgas Prize for Research and Technological Innovation (Italgas Prize Secretariat, Italy)
- Volvo Environment Prize (Volvo Corporation, Sweden)
- Enrico Fermi Award (U.S. Department of Energy)

2.2.2 Combination Recognition Prizes/Grant Awards

The following are examples of prizes that are not just honorific but also provide support for future research. The first two are sponsored by the U.S. government agencies:

Alan T. Waterman Award

The purpose of this annual National Science Foundation award is provide recognition for and support of outstanding young researchers who are in the forefront of their field of science, mathematics, or engineering. One does not apply for the award; the National Science Board solicits nominations and makes an annual selection. United States citizens or permanent residents who are 35 years of age or younger, or not more than 5 years beyond receiving their Ph.D. degrees, are eligible. Each winner receives a medal and a grant of $500,000 over a 3-year period. The award thus combines a recognition component and a grant component. Congress authorized the award in

1975, in honor of Alan T. Waterman, the first NSF director, and to mark the twenty-fifth anniversary of the NSF.

Christopher Columbus Fellowship Foundation

The Christopher Columbus Fellowship Foundation, an independent federal agency established by Congress in 1992, gives an annual $100,000 Columbus Foundation Award. First presented in 1996 and awarded in conjunction with *Discover* magazine, the Foundation calls these awards "fellowship grants." Each "is intended to recognize an individual American who has improved, or is attempting to improve, the world through ingenuity and innovation, and to provide incentive and opportunity for continuing research." These prizes, by themselves, are unlikely to induce researchers to undertake work that they would not otherwise have pursued, but the prize money does support additional research that the Foundation thinks is useful.

Privately Funded Awards

Zuckerman identifies several private awards that provide both recognition and research funding. They include the Donald Bren Fellowships at the University of California at Irvine, the Prix Louis Jeantet, and MacArthur Fellows Awards.[17]

Notes

[1] In some nontechnology contests, the winner is picked through a random selection process. Ordinary raffles are one example. However, this paper focuses on technology contests in which people submit prizes that are judged for technical merit.

[2] One needs to distinguish between the terms "technology," "technological innovation," and "innovation." One can design a contest to promote one or more of them, but they are different. A technology is a specific tool or technique. A technological innovation, as the term is used in this paper, is the ability to achieve some practical goal but not necessarily in an economically viable way. Lindbergh's flight is an example. A technological innovation may or may not involve research or new technologies; often it involves the creative integration or extension of existing technologies. A full innovation is viable in the marketplace as well as technologically viable. The distinctions made here build on Stephen J. Kline and Nathan Rosenberg, "An Overview of Innovation," in Ralph Landau and Nathan Rosenberg, editors, The Positive Sum Strategy, Washington: National Academy Press, 1986. They cite three features of innovation. First, in the commercial world a successful innovation must not only be technically sound but also in tune with the market. Second, innovations often involve the creative integration of a number of technologies. Third, innovations may or may not involve new research and new technologies.

[3] Racing events, such as car races and aircraft races, may or may not qualify as technology contests. If the contests encourage and reward improvements in performance, then they qualify as technology contests. But if they require fixed technology, they are not events that promote technological innovation.

[4] The discussion here draws on Dava Sobel, Longitude: The True Story of the Lone Genius Who Solved the Greatest Scientific Problem of His Time, New York and London: Penguin Books, 1995.

[5] This section draws, in part, on a memorandum from Roger D. Launius of NASA, "Talking Points on Aeronautical Prizes and Innovation," dated November 5, 1998. His assistance is gratefully acknowledged.

[6] Defense procurement in general can be seen as a way to create prizes for innovation in the form of positive economic profit on production contracts. Companies submit bids and compete for the "prize" of procurement

contracts. For discussions of this issue, see two articles by William P. Rogerson: "Profit Regulation of Defense Contractors and Prizes for Innovation," Journal of Political Economy, 1989, vol. 97, no. 6, pp. 1284–1305; and "Economic Incentives and the Defense Procurement Process," Journal of Economic Perspectives, vol. 8, no. 4, fall 1994, pp. 65–90.

[7] See www.xprize.org. Last date accessed: 15 June 1999

[8] For a general description of the CATS Prize, see www.space-frontier.org/EVENTS/CATSPRIZE_1/. For detailed rules, see http://www.space-frontier.org/EVENTS/CATSPRIZE_1/rules.html. Last date accessed: 15 June 1999.

[9] See www.usgo.org/computer/icgc.html. Last date accessed: 15 June 1999.

[10] See http://www.eff.org/coop-awards/prime-release1.html. Last date accessed: 15 June 1999.

[11] Foresight Institute Web page, www.foresight.org.

[12] Through 1998 the prize was called the European IT Prize. For 1999, the name was changed to the European IST Prize.

[13] www.it-prize.org

[14] This description of the Wolkskehl prize is taken from Simon Singh, Fermat's Enigma: The Epic Quest to Solve the World's Greatest Mathematical Problem, New York: Doubleday, 1997, particularly pages 121–125 and 284.

[15] Harriet Zuckerman, "The Proliferation of Prizes: Nobel Complements and Nobel Surrogates in the Reward System of Science," Theoretical Medicine, 13: 217–231, 1992, page 217.

[16] Notes: This brief list is not meant to be comprehensive. For a complete list, see Gale Research International, editor, Awards, Honors and Prizes, 15th edition, Volumes 1-2, Detroit: Gale Research International, 1999. Almost all of the prizes in the brief list above have Web pages; URLs for these are available from this paper's author. Also, several of the organizations listed above give prizes not only in science and technology but also in other fields, such as the arts; the Schock, Kyoto, Wolf, and Balzan prizes are examples. Only their science and technology awards are mentioned in this list.

[17] Zuckerman, page 218.

Appendix B
Participants, Prospectus, and Agenda

Workshop to Assess the Potential for Promoting Technological Advance through Government-Sponsored Prizes and Contests

Participants

Workshop to Assess the Potential for Promoting Technological Advance through Government-Sponsored Prizes and Contests

April 30, 1999

National Academies Building
2100 C Street, N.W.
Washington, D.C. 20418

M Steering Committee Member

Erich Bloch, *Chair*[M]
President
The Washington Advisory Group, LLC

Bruce Alberts
President
National Academy of Sciences

Alan H. Anderson
Consultant

Claude Barfield
Research Scholar
American Enterprise Institute
for Public Policy Research

Joseph Bordogna
Acting Deputy Director
National Science Foundation

David Brown
Executive Director
U.S. FIRST

Rita R. Colwell
Director
National Science Foundation

Marc D. Cummings
Assistant for Policy Development
Office of the Under Secretary for
Technology
U.S. Department of Commerce

Peter H. Diamandis
Chairman and President
X Prize Foundation

Richard L. Dunn
General Counsel
Defense Advanced Research Projects Agency

Robert W. Galvin
Chairman of the Executive Committee
Motorola, Inc.

Lori Garver
Associate Administrator for Policy and Plans
National Aeronautics and Space Administration

Penelope Gibbs
Administrative Assistant, Program Office
National Academy of Engineering

Newt Gingrich
Senior Fellow
American Enterprise Institute

Greg Henry
Program Examiner, National Security Division
Office of Management and Budget

Harry S. Hertz
Director, Baldrige National Quality Program
National Institute of Standards and Technology

David F. Heyman
Special Assistant
Office of the Secretary of Energy
U.S. Department of Energy

Christopher T. Hill
Vice Provost for Research and Professor of Public Policy and Technology
George Mason University

Neen Hunt
Executive Director
The Lasker Foundation

Steve Isakowitz
Branch Chief, Science and Space Programs
Office of Management and Budget

Anita K. Jones
University Professor
Department of Computer Science
University of Virginia

Thomas A. Kalil
Senior Director
National Economic Council

Ronald L. Kerber
Executive Vice President and Chief Technical Officer
Whirlpool Corporation

Genevieve J. Knezo
Specialist, Science and Technology Policy
Congressional Research Service
Library of Congress

Sylvia K. Kraemer
Director of Policy Development
National Aeronautics and Space Administration

John S. Langford
President
Aurora Flight Sciences Corp.

Stephen A. Merrill
Executive Director
Board on Science, Technology and Economic Policy
National Research Council

William G. Morin
Vice President
R. Wayne Sayer and Associates

David C. Mowery[M]
Haas School of Business
University of California at Berkeley

Proctor P. Reid
Associate Director, Program Office
National Academy of Engineering

Del Ritchhart
Vice President, Domestic Operations
Lockheed Martin Corporation

Daniel Rodriguez
Senior Evaluator
U.S. General Accounting Office

Nam P. Suh
Professor
Massachusetts Institute of Technology

James Turner
Senior Democratic Staff Member for Technology and Counsel
House Committee on Science
U.S. House of Representatives

Harold Varmus
Director
National Institutes of Health

Robert S. Walker[M]
President
The Wexler Group

R. Thomas Weimer
Director, Program Office
National Academy of Engineering

Steve Wesbrook
Gingrich Group

Robert M. White
Principal
The Washington Advisory Group, LLC

Patrick H. Windham
Windham Consulting

Wm. A. Wulf
President
National Academy of Engineering

Prospectus

Workshop to Assess the Potential for Promoting Technological Advance through Government-Sponsored Prizes And Contests

Summary

In response to a request from the President's National Economic Council, the National Academy of Engineering is organizing a day-and-a-half workshop on April 29–30, 1999 to assess the potential of government-sponsored prizes in stimulating technological innovations of significant societal impact. Erich Bloch, President of the Washington Advisory Group, chairs the NAE workshop steering committee. The project will result in a summary report from the NAE steering committee to the NEC, the workshop sponsor (the National Science Foundation), other interested federal agencies, and members of Congress. NSF has provided a grant of $65,115 to the NAE to cover costs associated with the workshop.

Background

Throughout recent history, governments, private foundations, companies, and individuals have sponsored contests and prizes designed to promote technological advance in particular fields for the public good. For example:

- In response to the loss of 4 warships and over 2,000 sailors and officers of the British Navy in a wreck off the Scilly Isles attributed to navigational error, the British Parliament passed the Longitude Act of 1714, which offered 20,000 pounds (the equivalent of millions of dollars today) to anyone who could solve the problem of determining longitude at sea. A British clockmaker named John Harrison rose to meet the challenge by developing the first stable nautical chronometer in 1737.

- Prizes played an important role in the development of the civil aviation industry in the early 20th century by rewarding advancements in speed, distance, safety, and endurance. New York hotel owner Raymond Orteig offered $25,000 as a prize for the first aviator to cross the Atlantic from New York to Paris, a prize won by Charles A. Lindbergh in 1927. Between 1926 and 1927, Daniel Guggenheim offered aviation-related cash awards and trophies worth approximately $100 million in today's dollars.

- In 1992, the Super Efficient Refrigerator Program (SERP), a nonprofit corporation of 24 major public and private American utilities, pooled together $30 million to reward the manufacturer who could build the most efficient CFC-free refrigerator at the lowest cost. The winner, Whirlpool Corporation, received guaranteed rebates from the SERP pool to offset the incremental product cost. SERP would be the first of a series of "Golden Carrot" programs, whereby utilities have offered financial incentives to manufacturers to make major advances in energy efficiency and product performance.

- The Feynman Prize in Nanotechnology was established in 1993 to recognize researchers whose recent work has most advanced the development of molecular nanotechnology.

- The European IT Prize, organized by the European Commission and the European Council of Applied Sciences and Engineering, offers cash awards and widespread promotion to companies that have made outstanding contributions in generating and converting innovative ideas and R&D results in information technology into marketable products. The objectives of the annual IT Prize are to promote excellence in European Information Technology performance and to stimulate innovation and competitiveness in industry.

In essence, the logic or rationale for "innovation" prizes and contests such as these is quite similar to that of government R&D tax credits or other "extra-market" incentives to private investment in research and technological innovation. In general, technology prizes or contests seek to advance technological solutions to important societal challenges (safety, energy efficiency, public health, etc.) in areas where market forces alone have been unable to induce adequate private-sector investment in R&D and innovation. As is the case with tax credits, sponsored prizes would allow the government to set a goal without dictating how it should be achieved, thereby leveling the playing field for researchers or companies that want to experiment with unconventional approaches. However, by underscoring through publicity the linkages between science and technology and particular societal challenges, sponsored prizes would seem to offer greater opportunity for public outreach and education than many other government incentives to technological advance.

At present, innovation prizes of this type are not part of the U.S. federal government's portfolio of science and technology policy instruments. Current Federal Acquisition Regulation (FAR) appears to present legal impediments to the use of such prizes by federal agencies. More importantly, public understanding of the potential costs and benefits of innovation prizes as an instrument of federal technology policy is very limited, i.e., the knowledge base for making intelligent policy decisions in this area is underdeveloped. The objective of the planned workshop is to build a useful knowledge base regarding innovation prizes and their potential as federal policy tools for fostering technological innovation of benefit to society.

Proposed Plan of Action

To assess the potential of sponsored prizes and contests as an additional tool of federal science and technology policy, the National Academy of Engineering will convene experts at a day and a half workshop dedicated to the subject on April 29–30, 1999. The meeting will involve roughly 35 invitees from industry, academia, and government with expertise regarding R&D, innovation, technology commercialization, the history of technology, and science and technology policy. A background paper on the role of sponsored technology prizes and contests in advancing technology is being prepared by the NAE for distribution to participants in advance of the workshop.

Topics to be explored by the workshop and the commissioned background paper will include

- Case studies of previous or existing prizes
- Issues associated with the design of contests and prizes, including partnerships with foundations and the private sector
- Current barriers to the use of prizes as an instrument of technology policy
- Possible technical areas and goals for prizes

Anticipated Results

In December 1998, NAE President Wm. A. Wulf appointed a five-member workshop steering committee,* chaired by Erich Bloch, President of the Washington Advisory Group. The committee met on January 12, 1999 to identify prospective workshop participants, structure the workshop agenda, review the draft background paper, and identify additional background materials for distribution to attendees in advance of the meeting. Following the workshop, the committee, with support from NAE staff, will prepare a brief report for delivery to the Chairman of the National Economic Council, the Director of the National Science Foundation, the heads of other interested agencies, and members of Congress.

The committee report will be reviewed in accordance with Academy procedures and will draw on the workshop discussion, but will not necessarily reflect any consensus reached during the workshop.

Federal Advisory Committee Act

The Academy has developed interim policies and procedures to implement the Federal Advisory Committee Act, 5 U.S.C. § 1 et seq. (FACA), as amended by the Federal Advisory Committee Amendments Act of 1997, H.R. 2977, signed into law on December 17, 1997 (FACA Amendments). The FACA Amendments exempted the Academy from most of the requirements of FACA, but added a new Section 15 that includes certain requirements regarding public access and conflicts of interest that are applicable to agreements under which the Academy, using a committee, provides advice or recommendations to a Federal agency. In accordance with Section 15 of FACA, the Academy shall deliver along with its final report to the National Science Foundation a certification by the Responsible Staff Officer that the policies and procedures of the National Academy of Sciences that implement Section 15 of FACA have been complied with in connection with the performance of the contract/grant/cooperative agreement.

For further information regarding the project, please contact Proctor Reid, Associate Director, Program Office, National Academy of Engineering at tel. 202–334–2467, or fax 202–334–1595; or email <preid@nae.edu>.

*Other members of the workshop steering committee include Paul Kaminski (Technovation, Inc.), David Mowery (University of California at Berkeley), Daniel Tellep (retired, Lockheed-Martin), and Robert Walker (The Wexler Group).

Agenda

Workshop to Assess the Potential for Promoting Technological Advance through Government-Sponsored Prizes and Contests

April 29–30, 1999

National Academies Building
2100 C Street, N.W.
Washington, D.C. 20418

Thursday, April 29, Members Room

6:00 p.m. Reception and Dinner

6:30 Welcome by NAE President Wm. A. Wulf

8:00 Brief Remarks by Workshop Chairman Erich Bloch

8:30 Adjourn

Friday, April 30, Lecture Room

7:30 a.m. Continental Breakfast in Anteroom

8:00 Chairman's Opening Remarks
Terms of Reference; Definitions; Objectives

8:30 **Keynote Address**
Incentive Technology Prizes as Instruments of Federal Policy:
For and Against

Moderator: Erich Bloch, Workshop Chair and President, The Washington Advisory Group

Speakers: An Advocate: Newt Gingrich, Former Speaker of the U.S. House of Representatives
A Skeptic: Claude Barfield, American Enterprise Institute

Q&A and General Discussion

10:00 Break

10:15 **Panel 1: Established Prizes and Their Lessons: Case Examples of Inducement and Recognition Prizes**

Moderator: David Mowery
Haas School of Business, University of California, Berkeley

Background Paper: Patrick Windham
Consultant to Workshop Steering Committee

Panelists:

The X Prize
Peter Diamandis, Chairman, X-Prize Foundation

Industrial Prizes Can Drive Innovation
Ronald Kerber, Chief Technical Officer, Whirlpool Corporation

Learning from the Lasker Award: The Jewel in the Crown of Medical Research Achievement
Neen Hunt, Executive Director, The Albert and Mary Lasker Foundation

The Malcolm Baldrige National Quality Award
Harry S. Hertz, Director, Baldrige National Quality Program, National Institute of Standards and Technology

12:00 p.m. Lunch

1:00 **Panel 2: Policy Perspectives on the Potential Role of Inducement Prizes**

Moderator: Robert Walker, President, The Wexler Group

FEDERAL AGENCY PERSPECTIVES:

A New Look for Supporting Technology Development through DARPA
Richard Dunn, General Counsel, Defense Advanced Research Projects Agency

Incentive Innovation and the NSF Portfolio
Rita Colwell, Director, National Science Foundation

Harold Varmus, Director, National Institutes of Health

Lori Garver, Associate Administrator for Policy and Plans, National Aeronautics and Space Administration

INDUSTRY PERSPECTIVE:

Robert Galvin, Motorola

2:45 p.m. Break

3:00 Chairman's Summary Discussion of Day's Findings

3:45 Closing Remarks: Erich Bloch, Workshop Chair

4:00 Adjourn

Panel Focus Questions

Panel 1

- What are the motivations and goals of prize sponsors and prize recipients?
- How would you define and measure the effectiveness of the existing prize?
- What elements are critical to the effective structuring and administration of prizes and contests?
- Lessons for potential government sponsors of prizes?
- How would you compare the role of prizes with that of other factors (e.g., the availability of venture funding) that have promoted technological advance in the field or industry?

Panel 2

- Are there areas where federal inducement prizes are likely to be useful?
- What can prizes or contests do that other policy instruments cannot? (E.g., innovative procurement mechanisms, CPIF contracts, etc.?) What are the advantages and disadvantages of prizes?
- How should inducement prizes be structured and administered in the federal context? (E.g., treatment of intellectual property generated? How to fund?)