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CONTRIBUTORS

Paula Whitacre, Rapporteur; Government-University-Industry Research Roundtable; Policy and Global Affairs; National Academies of Sciences, Engineering, and Medicine

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Proceedings of a Workshop

IN BRIEF

September 2018

Strategies for Engagement of Non-Traditional Partners in the Research Enterprise

Proceedings of a Workshop—in Brief

Partnerships between government, universities, and industry have formed the foundation of the national research enterprise for more than half a century, driving science and technology breakthroughs that have created significant social and economic benefits for the nation and the world. However, there is growing recognition that the partnerships supporting the U.S. innovation ecosystem extend beyond the "triple-helix actors" to include other stakeholders. Philanthropic institutions, angel and venture capital groups, political advocates, and nongovernmental organizations participate as partners in funding, influence, and support of basic science and research and development (R&D). How these partnerships are established and maintained, how effective they are in supporting science and innovation, and how to assess their overall impact on the U.S. research enterprise are increasingly relevant questions for leaders in both science and policy.

To address these and related questions, the Government-University-Industry Research Roundtable (GUIRR) held a workshop at the National Academy of Sciences on **June 12–13, 2018**. Through presentations and robust discussion periods, workshop participants explored the engagement models, goals, incentives, and risk tolerance of some non-traditional research partners and discussed how their efforts intersect with those of the federal government, universities, and industry.

Marilyn Simons, president of the Simons Foundation, delivered the meeting's keynote address. She described the mission and efforts of the Simons Foundation and, more broadly, the role of philanthropy in supporting scientific research. The foundation began in 1994 with a $1 million contribution from Jim and Marilyn Simons. Built on the mission to advance the frontiers of research in mathematics and the basic sciences, it now has an endowment of $2.5 billion, supports 1,750 active grants, and is structured to exist in perpetuity. The foundation funds individual researchers, institutions, and collaborations.

"The important first step in making decisions about what to fund is to ask the scientists," Simons stressed. At the Simons Foundation, 12 scientific department heads—with input from colleagues—have the flexibility to design programs in their fields. Roundtables, workshops, and other external consultations bring additional voices to the table. Key questions that guide funding decisions include:

- Will this program encourage the best science?
- Will it advance the output of the grantees?
- For collaborations that focus on a targeted area, will Simons Foundation support help move the needle in the next 7 to 15 years?
- Is the goal important, with progress representing a major scientific milestone?
- Is the time right, with new datasets, results, or technologies now available that bring an elusive goal closer?
- Can the best and most innovative thinkers be recruited and retained to participate?

Simons shared three examples that illustrate the foundation's approach in action. Simons Investigators in mathematics and physical sciences are awarded $100,000 per year, with the flexibility to do what they think is important with the funding. Also, the Simons Foundation Autism Research Initiative (SFARI) supports autism

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research, infrastructure, and community building. Lastly, Simons described the Flatiron Institute, a more recent, intramural research division that focuses on computational approaches to basic research.

Scientific advisory boards provide feedback and insights, but Simons acknowledged the lack of definitive metrics to assess impact at the foundation. She noted such qualitative measures as whether new researchers have entered a field, as has happened in autism research. The foundation aims to complement the existing research landscape, especially in underfunded fields, and to support open access infrastructure and journalism that other entities are not in a position to fund.

Simons concluded by asking participants to consider the role of philanthropy in supporting scientific R&D. "Philanthropic funding cannot replace government and industry, but it has flexibility and agility that the others may not have," she said. "It can support research into riskier ideas until they have a more solid base, as well as projects that are independent of public sentiment or commercial interest. Philanthropy can help provide infrastructure for the benefit of all; it can make long-term commitments as well as respond to immediate funding needs."

Simons emphasized that the existing system has produced great science, but she expressed concern about a disconnect in which awe-inspiring discoveries do not receive the public interest they deserve. She urged a stronger connection between science and society to achieve greater goals.

PHILANTHROPIC SUPPORT FOR SCIENCE AND INNOVATION

The workshop resumed the next morning with a panel of representatives from five philanthropic partners of research, moderated by outgoing GUIRR industry co-chair **Gordon England**. In addition to the Simons Foundation, partners included the Bill & Melinda Gates Foundation, Howard Hughes Medical Institute, Alfred P. Sloan Foundation, and the Chan Zuckerberg Initiative.

Daniel Goroff, vice president and program director at the Alfred P. Sloan Foundation, explained that the foundation's activities are guided by a series of letters that founder Sloan wrote in 1934 supporting outreach and research in science, technology, and economics. Goroff picked up on Simons' point from the previous evening about the role of philanthropy in basic research to complement government and industry funding. He contextualized philanthropic efforts and the original design of the foundation's mission to fund basic science in terms of resolving externality, uncertainty, and public goods problems. The externality problem in science often prevents companies from investing in discoveries that external parties may use without paying a share of the cost. The uncertainty problem describes the tendency of traditional research funders to be reluctant to support some research because of the unpredictability of pay-off, which in some cases may not occur at all. The public goods problem refers to a concept in economics describing a commodity—a lighthouse, a park, or an open dataset—from which everyone benefits but few people want to pay for individually.

According to Goroff, the Sloan Foundation embraces the economic problems created by externalities, uncertainty, and public goods in its funding decisions; he described himself as "in the public goods business." Examples include the foundation's support for public radio, Wikipedia, and Jupyter notebooks—an open source web application for creating and sharing documents that contain live code, equations, visualizations, and narrative text. "The 'sweet spot' of funding for the Sloan Foundation is an effort that is too large for an individual to fund but too small for a government initiative," Goroff said. The Sloan Digital Sky Survey, one of the largest, most detailed, and most often cited astronomical surveys, was one of the first established with a goal to share data. The Sloan Research Fellowships support early career investigators, 45 of whom have gone on to win Nobel Prizes in their fields. The foundation was also an early proponent of behavioral economics, funding some of the earliest research in the field.

Another area of interest for the foundation is the study of the economics of science and technology, supporting an effort to make research investments more productive. For example, a Sloan-supported randomized controlled trial conducted at Harvard University found that research groups with some management expertise within them were more productive than those without this type of expertise. Having the evidence about this variable can help Sloan and other funders as they make funding decisions. "This kind of application of scientific methods to understanding the scientific enterprise is something, I believe, Mr. Sloan would smile upon as an effort to make organizations run well."

The next speaker, **Kedest Tesfagiorgis**, senior program officer at the Bill & Melinda Gates Foundation, said the foundation spends about $3 billion of its $4.7 billion annual budget on global health and development

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to fulfill the mission that "all lives have equal value." The foundation keeps people's well-being, especially the well-being of children, at the heart of its mission; indeed, Tesfagiorgis showed a photo of the "boss" of the endeavor—a small child looking into the camera. Funding decisions aim to prioritize areas of greatest need where the foundation can have the greatest impact. The foundation's 12 areas of strategic focus have different goals: for example, the goal within the portfolios related to polio and malaria is to eradicate these diseases, and other foundation goals include reducing the disease burden of pneumonia and reducing poverty within farming families through increased agricultural productivity.

The Gates Foundation launched one of its most innovative funding mechanisms in 2005, known as the Grand Challenges. In this model, the foundation identifies a large issue—such as saving lives at birth—and partners with governments and others to openly invite solutions to these identified problems. Grand Challenges seeks to engage the world's most creative minds across sectors, organizations, and geographies through open requests for proposals; support high-risk, high-reward research on pressing issues that partners would not have the ability to address on their own; and bring innovation to scale by partnering with the private sector and others.

The model has proven adaptable, and several countries have launched their own Grand Challenges. It embodies a key principle of the Bill & Melinda Gates Foundation—that partnerships are critical to successfully bringing in new ideas and to broadening the global talent pool to solve problems. Unlike some organizations with a board of directors or other form of governance, the foundation is guided by the co-chairs' priorities. Under their direction, the foundation assesses the current state of the field in question, identifies scientific gaps, and develops targeted strategies.

Marc Malandro, vice president for operations at the Chan Zuckerberg Initiative (CZI), presented next, and explained that CZI was set up as a LLC, rather than a nonprofit foundation in 2015, to enable the use of different mechanisms to fund its initiatives. CZI supports programs in education, science, and justice, and opportunity. In science, the goal is to cure, prevent, or manage all diseases by the end of the 21st century. The program also supports a 10-year goal to accelerate biomedical science by developing new tools and technologies, and supports open, collaborative models of research. It awards grants and has its own research organization. Echoing others, Malandro said CZI determines needs by consulting with scientists to understand what is slowing down discovery in their areas. It then considers whether proposals seeking funding offer solutions that can have systemic effects and are scalable, and to what extent CZI's involvement can make a differentiated impact in that scientific area.

Focus areas include the CZI Biohub, an independent research organization that brings together scientists, technologists, and engineers to work collaboratively to solve problems. A major CZI project is the Human Cell Atlas consortium, which convenes an international effort to develop a free, open reference map of all cells in the healthy human body. CZI-supported transformative technology promotes tools that are robust, reliable, scalable, and shareable to further scientific breakthroughs. Some are external efforts that CZI helps fund, such as bioRxiv, a preprint server for biological research papers. CZI also acquired the company Meta, which is an AI-powered feed tool to help analyze and present biomedical literature. CZI also works with others in the development of tools, such as a data coordination platform in support of the Human Cell Atlas project to allow for more accessibility and analysis of data. "Software engineering and computational biology expertise is one of CZI's differentiators," Malandro said, and they welcome partnering with others.

The Howard Hughes Medical Institute (HHMI) represents a different model of science funding, explained **Bodo Stern**, chief development and strategy officer. While HHMI does fund education and research through grants, most of its resources go to HHMI's own scientists in two programs: the HHMI Investigators Program and the Janelia Research Campus.

The HHMI Investigators Program supports about 300 biomedical scientists at 60 institutions across the United States. The investigators are HHMI employees but have second affiliations as faculty members at their institutions. With 7-year renewable terms and access to funds for equipment, the investigators are freed from the pressure of having to secure funding more frequently.

The Janelia Research Campus opened in Virginia in 2006. Its unique culture includes small research groups (two to six people) in which group leaders—unburdened by the pressures of grant writing and teaching—can focus on research. In addition to biologists, Janelia has technologists who develop cutting-edge tools to break new ground. Thus, Stern said, tool builders and tool users can collaborate intensely. HHMI recognizes the unique position that Janelia can play to tackle big barriers in technology that help biologists move forward.

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Its support for circuit neurobiology in model organisms created momentum for what is now the federally supported Brain Initiative. HHMI will actively seek new research areas that similarly can be mainstreamed after Janelia scientists have broken through technological or conceptual challenges.

HHMI does not engage in many direct partnerships, given its model. However, it helps Janelia scientists transfer to academic institutions through transfer packages and access to tools, thus hoping to export its culture and methods of tackling research beyond its Virginia campus.

Marion Greenup, vice president for administration at the Simons Foundation, expanded on the overview of the foundation presented by Marilyn Simons in her keynote. She explained that the Simons Foundation supports grants and collaborations in the areas of life sciences, autism research, mathematics and physical sciences, and outreach and education. Its new Flatiron Institute supports computational sciences.

Greenup focused on collaborations, which the foundation defines as efforts that bring together scientists across disciplines to address topics of fundamental scientific importance in which a significant new development has created a novel area for exploration in an established field. Among the collaborations are the Simons Collaboration on Ocean Processes and Ecology, in which multidisciplinary teams from 16 institutions are studying the North Pacific subtropical gyre (large-scale ocean currents). Another is the Simons Observatory, with 200 team members from 5 institutions studying how the universe began and evolved. SFARI has developed a range of research resources, including a genetic database, data analysis tools, and opportunities for scientists to convene and share knowledge.

Greenup elaborated on key roles for philanthropic funders: to fund higher risk projects, recruit investigators and partners to the field, and explore and expand partnership models. She also identified challenges to improving relationships between institutions and funders. They include funders' preferences toward data sharing versus others' tendency toward intellectual property ownership; a sense of urgency of disease/disorder funders versus longer academic and publishing timetables; and the administrative resources required by universities to comply with the diversity of application platforms and reporting requirements used by funders.

After listening to the panelists, Gordon England, GUIRR's industry co-chair, asked the presenters whether and how they coordinate their funding with each other or other organizations. Goroff said the basic principle among foundations should be "anti-correlation:" in other words, diversity in their missions and investments. Several panelists brought up the Science Philanthropy Alliance, which was initially created to educate high net worth individuals about the importance of including basic research in their philanthropic giving, and has evolved into a resource for donors to exchange information about what they are funding—often areas for which they are especially passionate. Others brought up the Funders Forum and the Health Research Alliance as venues for sharing information. Malandro noted that philanthropies are able to talk to each other about their funding without the constraints that can inhibit governments or industry. The emphasis, several of the panelists suggested, is to collaborate and learn from each other, rather than coordinate efforts. Support for early career investigators, minority-serving institutions, and the scientific institutions in lower income countries were also brought up during the discussion period.

DE-RISKING INVESTMENTS IN INNOVATION THROUGH PARTNERSHIP

The second panel, moderated by **Laurie Leshin**, president of Worcester Polytechnic Institute and GUIRR university co-chair, presented two different models that minimize the risks involved in funding innovation. Leshin invited audience participants to share other models during the discussion period.

Mark Burns, executive director of Mcubed at the University of Michigan, described Mcubed as a seed-funding mechanism that involves faculty across the university. As background, he noted that institutions already invest significant money in research—second only to the federal government—and have increased their investment by about 25 percent since 2016, according to the National Science Foundation. While universities can and do strategically invest in research, they face a number of constraints. Burns suggested that traditional review mechanisms can be biased against novel, interdisciplinary research; it is difficult for researchers to collectively advocate for central resources; and the size of many research-intensive universities makes it hard to know about research across the institution. Mcubed was set up to provide immediate seed funding without traditional review to multidisciplinary faculty and student research teams, which are known as cubes. Rather than the approximate year-long lag in traditional funding from idea generation to start of a research project, once it has collaborators, a Mcubed project can start within days.

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Mcubed provides each faculty member with a virtual "token." Those with research ideas seeking collaborators post their project ideas on the Mcubed website (mcubed.umich.edu), and other faculty members participate by chipping in their tokens. Three faculty from at least two different units combine tokens to create a $60,000 interdisciplinary cube for 1 year. The money can be used to fund undergraduate or graduate students, postdocs, or for any other purpose to further the research. The only deliverable requirement is to present at a symposium.

With no formal review or proposal process, Mcubed provides a unique "peer-to-peer" review in several ways. First, faculty must publicly post their ideas, which provides accountability. Second, each faculty member can join only one cube in each 3-year cycle; thus, they must choose how to spend their token carefully. They have the freedom to work on the problem they think has the most impact. A recent Mcubed round generated an additional $60 million in external funding; 300 presentations, publications, and patents; and involved 1,000 trainees and 700 faculty members. "Mcubed is more efficient than traditional review because researchers vote with their feet," Burns argued. "It diversifies risk by spreading smaller amounts of money to larger numbers of researchers and teams."

The second presentation about a different model for funding innovation came from Osage University Partners (OUP), a venture capital fund that invests in spin-out projects that emerge from universities and research labs. **Kirsten Leute**, senior vice president for university relations, explained its operations—OUP partners with research organizations invest in early, middle, and late-stage spinouts; the institutions share in OUP's fund profits in return for assigning their participation rights. OUP completed making investments in new companies out of its first fund ($100 million) in 2015 and invested in a total of 39 companies in the fund. A second fund ($215 million) has made most of its initial investments, and OUP is now fundraising for a third fund. OUP is usually a co-investor, rather than the lead investor, which Leute noted results in a larger number of startups represented in their portfolio than most venture capital funds.

According to Leute, universities try to launch about 1,000 startup companies every year, but usually have difficulty getting funding. When they do, their equity stake at the time of the companies' exit may not be worth much. They also often have contractual rights to make investments in the companies, but rarely have the funds available to exercise these rights. "In this model, universities assign their rights to OUP, which then makes investment decisions from among thousands of possibilities," said Leute. The universities can share in the profit based on all of the fund's investments and not just those at their own institutions.

Institutions can be OUP core partners, in which they assign rights for a period of time, or associate partners, assigning rights on a deal-by-deal basis. OUP also facilitates meaningful introductions and connections and provides insights from its proprietary data. They offer in-person and online seminars on licensing, financing, and other topics of interest, as well as those that are more life science or technology based.

During the discussion period, a participant explained a model used at the Pacific Northwest National Laboratory that is somewhat similar to Mcubed—people post ideas related to lab research or programs on an internal website, and each staff member receives a small amount of money and selects program(s) to which they wish to contribute. It has widespread participation and buy-in, and has generated ideas that would not be funded through normal channels. Significantly, it involves all staff, not just researchers. Discussion ensued about how to make programs like this or Mcubed work in other settings. In answer to a concern that non-tenured faculty may get sidetracked, Burns said it has turned out to be a great mechanism for assistant professors to reach out on an equal footing to tenured faculty. In his experience, assistant professors tend to get involved in collaborations sooner than tenured faculty.

Several participants asked how researchers can get involved in venture capital projects. First, Leute stressed that only a minority of potential startups are viable to receive funding. The researchers who are most successful have either gone through the process before or have partnered with someone who has. An important piece of advice they give to principal investigators is not to be the CEO as well, and to reach out to venture capitalists for advice, not just money.

Another participant noted the potential of recipients of Small Business Innovation Research (SBIR) grants collaborating to a greater extent, suggesting that universities or federal agencies can help these recipients connect through a platform similar to that developed to facilitate Mcubed.

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MISSION-DRIVEN PARTNERSHIPS THROUGH THE RESEARCH ENTERPRISE

The final panel, also moderated by Leshin, brought up some benefits and barriers to linkages between government agencies and other partners. Oceanographic, agricultural, and energy research efforts were discussed.

Alan Leonardi, director of the Office of Ocean Exploration and Research at the National Oceanic and Atmospheric Administration, discussed the National Oceanographic Partnership Program (NOPP), created by public law in 1997. While it has undergone several changes in structure and oversight since then, NOPP continues to identify priorities and goals for ocean science and to support the research and development needed to meet them. The priority themes address cross-agency issues and typically require $15 million to $25 million in total investment.

In keeping with the goals of the program, projects are ideally sponsored by more than one partner, each of whom contributes money or other resources. Awardee proposals must include members from at least two different sources from within government, academia, and industry. Mechanisms include annual Broad Agency Announcements (BAAs), individual topic competitions, and in-kind partnerships. Projects involve brainstorming and communication with potential partners in the early stages before being developed into more formal project proposals.

Successes initiated through NOPP include the U.S. Integrated Ocean Observing System, a study of the effects of hydrokinetic energy on marine life, and marine mammal tagging. NOPP topics for FY2018 focus on cube satellites, global high-resolution sea surface temperature modeling/validation, and in situ ocean sensor R&D. Other areas of potential partnerships relate to ocean plastics, autonomous marine data collection, risk management data integration, ocean information systems, and comprehensive mapping/characterization. Leonardi acknowledged that outreach is critical to facilitate a dialogue about common priorities and interests to formulate future focus areas for NOPP, and welcomed participants to learn more about how NOPP works with public and private groups and to consider NOPP as a potential venue for partnerships.

The next presenter was **Sally Rockey**, executive director of the Foundation for Food and Agriculture Research (FFAR). The nonprofit foundation is linked to the U.S. Department of Agriculture (USDA) and came out of the 2014 Farm Bill. FFAR is not bound by the federal agency rules and regulations, but is required to partner on all projects, with at least 50 percent of funding for projects obtained through a non-federal source (state or foreign governments, foundations, nongovernmental organization, the private sector, etc.). FFAR can work with USDA to identify areas of research that would benefit from a public-private partnership, and then pursue those ideas rapidly.

The foundation came about because USDA's share of federal research is just 2 percent, most of which goes to intramural research or capacity funds for land grant institutions. Yet, there is tremendous potential for impact through innovative agricultural research. FFAR seeks to address complex problems that take more than one group to think about and share the risk. "Much cutting-edge agricultural research is taking place and the products of that research can be applied rapidly in production," she noted. Grants range from $45 million with the Bill & Melinda Gates Foundation to study photosynthesis to increase yields, to individual grants of $50,000. FFAR has contributed to the creation of two consortia of private companies—one related to crops of the future and the other to irrigation. They have also collaborated with the XPrize to set up a prize competition called Feeding the Billions.

Across projects, the foundation looks for shared missions and goals for the public good. "Results or data should be available publicly—when working with some partners, this may mean an embargo or licensing agreement to incentivize them to participate," said Rockey. She explained that FFAR works in what is considered the precompetitive space, which she defined as research that will benefit all, not just a single entity.

According to Rockey, one of the challenges facing agriculture research is that agriculture-related groups have diverse positions on many issues, and some only want to fund science that promotes their issue. The foundation positions itself as a neutral party that conducts evidence-based science for all. "Agricultural research began with a production focus—grow enough food for the world's population—but now has an overlay of consumer preferences around such issues as organic farming, pesticide use, acceptance of genetically modified crops, industrial versus small farms, animal welfare, and others. Malnutrition, whether because of hunger or obesity, affects millions, connecting agriculture to health. The foundation believes that more can be accomplished together than alone, and that its flexibility to pursue innovative research will benefit agriculture and fulfill its mission," said Rockey.

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David Hart, senior fellow at the Information Technology and Innovation Foundation and professor and director of the Center for Science, Technology, and Innovation Policy at George Mason University's Schar School, used the workshop to float the idea for a potential new foundation, somewhat similar to those discussed by Rockey and Leonardi, which would be linked to the Department of Energy (DOE). "The DOE national laboratories are a tremendous resource, but they have the capability to be more productive, especially accelerating the transition to clean energy," he noted. Early meetings to gauge interest have brought together supporters from across the political spectrum, and bipartisan legislation has been introduced in Congress.

Two broad purposes for such a foundation have emerged—as a vehicle for science philanthropy and as a broker of public-private partnerships. In energy, it is the private sector that must bring ideas to scale. Hart argued that partnerships between experts at the DOE labs and those in the private sector can accelerate the scaling process. Many details remain to be worked out, however, before such a foundation should be established.

In the discussion period, many attendees voiced support for the idea of a DOE-related foundation. One person noted that introducing new ideas will mean a culture change in many labs, especially those that are focused on national security. Another participant noted that Idaho National Laboratory and Battelle Foundation have a partnership, and that the University of Idaho and the State of Idaho have partnered on high computing and cybersecurity; both partnerships may merit consideration in relation to the DOE foundation proposal. A participant familiar with public-private partnerships at the National Institutes of Health stressed the importance of thinking through the mission and purpose of such a foundation—not just now but into the future, in order to build a structure capable of accommodating future needs.

Leshin closed the session by stressing the importance of non-traditional partnerships and approaches. With the pace of change accelerating, these models provide insight and inspiration for new ways of supporting innovative, impactful research.

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PLANNING COMMITTEE: Nicholas Wigginton (*Chair*), University of Michigan; **Travis Johnson**, Arizona State University; **Margaret Moerchen**, Carnegie Institution for Science.

STAFF: Susan Sauer Sloan, Director, GUIRR; **Megan Nicholson**, Program Officer; **Claudette Baylor-Fleming**, Administrative Coordinator; **Cynthia Getner**, Financial Associate.

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For more information, visit http://www.nas.edu/guirr.

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