National Science Foundation Industry/University Cooperative Research Centers (IUCRC) Program

Primer on IUCRC Program Background, Status and Evaluation Findings

Denis Gray, Ph.D.
Principal Investigator, IUCRC Evaluation Project
www.ncsu.edu/iucrc
North Carolina State University
denis_gray@ncsu.edu

Background

The IUCRC Program began as an experimental program in the early 1970s and was formally launched during 1979-80. It is one of several partnership-based programs supported by the Industrial Innovation and Partnerships (IIP) Program in NSF's Engineering Directorate[i]. IUCRC Centers are university-based industrial consortia; member firms provide financial support, help steer the research agenda and share all results. The program has initiated more than 110 Centers. IUCRCs were designed to serve as institutional structures to promote and sustain scientific cooperation between industry and universities. **In an environment where "open innovation" has become something of a "buzz" word with little substance, IUCRC program has been producing open innovation outcomes quite successfully for more than three decades and is believed to be the longest operating partnership-based program sponsored by NSF**. More detailed description of program goals and objectives can be found in its current announcement[ii] and recent DVD[iii]. A management guide is also available[iv].

Current Status

- **NSF Funding.** For FY 2011-12 the IUCRC program had a budget of approximately $16 million (with roughly $4.5 million of this support coming from the CISE Division of NSF). This funding was allocated to 56 centers with sites at over 170 universities. Centers receive 5-year awards that can be renewed for a second five year period[v]. The average multi-site IUCRC receives approximately $230,000/year from NSF; the average university site within an IUCRC receives approximately $90,000/year. NSF support for other center programs includes: Engineering Research Center; Science and Technology Centers, ; MRSEC.

- **Technological Focus.** Centers address a variety of topics, including alternative energy (e.g., biofuels and photovoltaics), advanced materials and manufacturing, energy and environment, advanced electronics, homeland security (identification technology) and many others. A complete list of IUCRCs by technological thrust can be found at here.

- **Membership and Funding.** Organizations support IUCRCs by paying an annual membership fee to support Center research and operation. Approximately 700 organizations hold about 1100 memberships (a significant number of organizations are members of multiple IUCRCs). Large firms hold roughly half of all memberships. The percentage of memberships held by small firms has doubled over the past four years and stands at 26 percent. Government agencies (including many defense labs) and non-profit organizations hold the balance of the memberships.

- **Collateral Funding and Leveraging.** In addition to receiving support from members, most centers receive additional support from a variety of sources, including federal agencies and laboratories, state government, foundations and their host universities. Last year IUCRCs reported over $134 million in funding from all sources. Over the past five years, NSF's investment in IUCRCs has been leveraged between 6 to 8-to-one. This level of leveraging is unmatched by other federal S&T programs.

Leveraging realized by individual member organizations varies from center to center. The Berkeley Sensor and Actuator Center (BSAC) is among the most successful IUCRCs[vi]. During FY2011-12, average member leveraging was 56-to-1. As an outlier, NSF IUCRC invested $44,000 and BSAC reported $16 million in support from various sources. Thus, an individual member's support was leveraged an amazing 320-to-one in this particular center.

- **Human Capital.** Most IUCRC funding provides support for faculty and students to conduct Center research. For the most recent fiscal year, IUCRCs supported about 900 faculty, 170 post docs, 1700 graduate students, and 400 undergraduates.

- **Geographic Distribution.** IUCRCs have been launched in virtually ever state in the country. Based on recent estimates, IUCRC Centers or sites have been established in approximately 44 states.

Program Evaluation

Perhaps the most persuasive evidence of IUCRC impact is the fact that firms invest their own money (not in-kind) year-after-year to support the Centers. However, formal program evaluation has been built into center operations by providing support for on-site evaluators who follow a standardized evaluation protocol[vii]. Data are collected annually from member firms and faculty about their satisfaction and a variety of outcomes and impacts. In addition, periodic targeted studies address specific evaluation issues in more detail. **These studies have consistently demonstrated that members and other stakeholders, including students, have benefited in a variety of ways.** Although a complete summary of these findings is beyond the scope of this primer, the following is a sampling of some relevant evaluation findings. (Our website contains a more detailed information: www.ncsu.edu/iucrc)

- **Impact on R&D**: **Member Follow-on Funding.** Each year members are asked to indicate if center research has triggered research projects within their laboratories, and if so, the dollar value of these investments (follow-on funding). Over the past four years, program-wide estimates of follow-on funding have averaged $100 million per year.

- **Impact on R&D Efficiency.** Members consistently report that participating in an IUCRC allows them to both amplify and streamline their own research efforts. One study that examined these issues found that the vast majority of members reported that participating in the center allowed them access to research that was a priority for them but might be too risky for them to do themselves[viii]. Recent assessments indicate that the average IUCRC member reports $487,000 in research cost avoidance annually and $226,000 in research savings annually.

- **Impact on Intellectual Property (IP).** While IUCRCs tend to focus on performing pre-competitive research that is shared with all their members, they nonetheless consistently produce research that results in the creation of IP. During the most recent FY, centers reported the following IP events: 66 invention disclosures; 48 patent applications; 30 patents granted; 13 license agreements; and 9 copyright granted. Over the years, many of these inventions have been licensed to firms, including start-ups and spin outs, and resulted in commercialized products and processes.

- **Impact on Commercialization.** Because IUCRCs primarily engage in pre-competitive research, which typically takes many years to be commercialized, it is difficult to adequately assess its impact on commercialization. Nonetheless, over the years, hundreds of firms have reported commercializing products, processes and/or services based on the research conducted by their IUCRCs. For instance, research at one of the earliest IUCRCs contributed to the production of the protective tiles used on the space shuttle. To date, four separate *Compendia of Technology Breakthroughs of the IUCRC Program* (2004, 2007, 2009, and 2012) have been produced to catalog industry-nominated breakthroughs growing out of IUCRC research. Some examples in the compendia include:

  - *Berkeley Sensors and Actuators Center (BSAC) and Smart Dust:* Research on "Smart Dust", autonomous network of highly miniaturized "motes" containing microradios and microsensors, was begun at BSAC over ten years ago. This led to a $1.7 million DARPA "Smart Dust" program and eventually led to a groundswell of industrial and new venture capital investments in wireless sensor networks (WSN). Market forecasts of more than $10B/year, now seem like low estimates as the technology promises to revolutionize homeland security, environmental control, power management, and infrastructure monitoring. BSAC research has also contributed to the creation of long list of start up companies.
  - *Center for Process Analytical Chemistry (CPAC) and New Sampling and Sensor Initiative (NeSSI).* Researchers at CPAC pioneered research on the development of devices allowing continuous analysis of chemical samples extracted from process equipment. The commercialized outcome of this work was NeSSI. It has been used for years by the petrochemical, chemical, and oil refining industries to more accurately monitor and control their production facilities. Firms have estimated tens of millions of dollars in cost savings per year.

Obtaining an accurate estimate of the economic impact of the kind of pre-competitive research IUCRCs conduct is challenging. However, a recently published study of three mature (15 years or older) was able to document net present value impacts of $1.25 billion based on reports of 15 member companies[ix].

- **Impact on Human Capital.** Because the overwhelming majority of IUCRC research involves graduate student theses and dissertations, IUCRCs have been a major vehicle for training the next generation of scientists and engineers. Firms often

report that IUCRC-trained students are more productive, particularly when they first begin their employment, than non-IUCRC students. Data indicate several thousand students gained their graduate degree through IUCRCs over the years; many are now eminent industry and academic scientists and executives. A follow-up evaluation of IUCRC graduates demonstrated significantly higher objective and subjective outcomes[x]. A new study suggests a high percentage of IUCRC faculty directors subsequently assume important leadership roles in academe, industry and government[xi].

- **Self-Sustaining IUCRC Impacts.** One of the goals of the IUCRC program has been to create **lasting institutional structures for cross-sector collaboration**. Since the program began over seventy IUCRCs have "graduated" from the program and are no longer funded by NSF IUCRC. A recent study has demonstrated that over two-thirds of these centers are still operating, with some operating continuously for over 30 years. Collectively these centers reported over $100 million/year in research funding[xii]. Many, like the Edison Welding Institute, have achieved international prominence. Evidence demonstrates these centers continue to provide the same benefits listed above years after NSF funding ends.

National Asset for Advancing Open Innovation through Leveraged, Industry-University Cooperation

Among the world's longest-standing programs for fostering scientific cooperation between industry and universities, the NSF IUCRC Program has demonstrated substantial benefits extending well beyond taxpayers' initial investments. IUCRCs have generated industry support for scientific research representing 8 to 10 times the NSF funding *during* their NSF support, by itself a remarkable return on investment. Even *after* NSF support has ended, IUCRCs have continued to generate human capital, scientific infrastructure, intellectual property, technological advances, and financial returns. As documented by the IUCRC Evaluation Project, the IUCRC Program has developed unique, institutional expertise at its mission – to foster leveraged, industry-university cooperation in applied science – and remains a significant, national asset for the future.

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[i] Program website found at: http://www.nsf.gov/eng/iip/iucrc/
[ii] http://www.nsf.gov/pubs/2012/nsf12516/nsf12516.pdf
[iii] http://www.nsf.gov/eng/iip/iucrc/iucrc_video.jsp
[iv] Gray, D.O. & Walters, G.W. (1998). Managing the IUCRC: A Guide for Directors and Other Stakeholders. Columbus, OH: Battelle. http://www.ncsu.edu/iucrc/PurpleBook.htm
[v] A recently approved Phase 3 funding mechanism will allow centers to apply for a third five-year funding period and receive $15,000/year.
[vi] BSAC website: http://www-bsac.eecs.berkeley.edu/
[vii] The IUCRC Evaluation Project website can be found at: http://www.ncsu.edu/iucrc/
[viii] Gray, D.O. & Steenhuis, H-J (2003). Quantifying the benefits of participating in an industry university research center: An examination of research cost avoidance. *Scientometrics*, 58, 281-300.
[ix] Rivers, D. & Gray, D. (2013). Evaluating cooperative research centers: A strategy for assessing proximal and distal outcomes and associated economic impacts. In Link, A. & Vonortas, N. *Handbook on the theory and practice of program evaluation*. Eheltenham, UK: Edward Elgar.
[x] Scott, C., Schaad, D.C., & Brock, D.M. (1991). *A Nationwide Follow-Up Study of Graduates of NSF Industry/University Cooperation Research Centers (1989-1990).* Seattle, Washington: University of Washington, Department of Medical Education.
[xi] See: http://www.ncsu.edu/iucrc/careers/
[xii] McGowen, L. (2010). Predictors of cooperative research center post-graduation survival and success. Unpublished masters thesis. North Carolina State University, Raleigh.