The second event in the three-part Workshop Series: Role of Industry-University Partnership in Doctoral Education convened virtually March 16, 2021, hosted by Lehigh President John Simon. The workshop series brings together a set of high-level stakeholders in technological advancement from across industry, government, academia, and professional societies. The objectives of this series are:

- To develop a robust understanding of the current status of the pipeline from graduate degree programs in science, technology, engineering, and mathematics (STEM) into professional research environments;
- To promote innovation in industry-university partnership around doctoral education;
- To introduce and solicit feedback on Lehigh University’s innovative Pasteur Partners PhD (P3) Fellowship pilot program.

Layne Scherer, senior program officer and study director, National Academies of Sciences, Engineering, Medicine provided the second event keynote, sharing insights from the Academies’ consensus study report Graduate STEM Education for the 21st Century. In addition to discipline specific subject matter expertise, developing professional skills for the various careers a student may pursue was among the top recommendations of this study.

Extending on that recommendation, the event continued with focus on the definition of the top 3-5 high priority non-technical essential skills needed for success in industry careers, a discussion further informed by discussions in the first workshop and pre-event survey of workshop participants. A panel discussion featuring cross-sector experts in doctoral student career readiness and industry hiring practice provided additional context for work to follow. The panel included Brianna Konnick, President, Graduate Career Consortium; Dan Meyers, Talent Acquisition Partner, Siemens US; and, Luciana Xavier, Assistant Director for Workforce Development, Lawrence Livermore National Laboratory. Next, small break-out groups turned to honing a long list of important non-technical skills to a list of the top 5 and then top 3 highest priority non-technical essential skills for industry careers. The final list included: (i) Effective communication; (ii) Teamwork, people skills; and (iii) Learning agility, openness to collaboration, cross-disciplinary interest, broad perspective, as top three, followed by (iv) Critical, independent thinking; and (v) Ethics, research integrity, to make up the top five most valuable professional skills. Of note is our observation that the top 5 skills identified for industry career success were the same as top 5 skills identified for academic career success in the pre-event survey. This finding supports the hypothesis that, although focused on careers in industry, workshop recommendations are likely to support careers in the academy and other sectors too.

The workshop series concluded with a final event convened virtually June 24-25, 2021, hosted by Lehigh Provost Nathan Urban. The focus for the concluding event was the translation of the opportunities and needs identified in the first two workshop events to next step actions. F. Fleming Crim, Chief Operating Officer, National Science Foundation, provided the first day keynote, sharing an NSF perspective on the critical role of cross-sector partnership in its three-pillar vision: advancing frontiers of research; ensuring accessibility and inclusivity; and, securing global leadership. Crim’s presentation was followed by Brennon Marcano, CEO of The National GEM consortium, who added a diversity lens for formulating the future action items. Marcano concluded his remarks with note of elements which would grow the success of diverse students in industry careers: strong mentorship in both academic and industry environments; sponsorship presence in industry; more sustained interaction between industry and
academia; the buildout of a supportive community – noting that the growing, successful GEM community of alumni provides a strong support system for current students.

The first day concluded with two small group break-out sessions. In the first session, the groups defined the essential skills in more detail from an industry perspective. For example, that asked what does effective communication mean in industry and how is that different or the same than what it means in an academic environment. In the next session, groups led by industry participants identified important barriers at a local/institutional and national/systemic level to greater university-industry partnership. Answers included partnership barriers associated with expectations for intellectual property and collaboration agreements, different project time cycles, non-aligned funding mechanisms, different incentives (papers vs. products), lack of national convening organizations open to all, lack of flexibility on the part of both partners, lack of non-faculty specific on-ramps that serve all students, sense in some faculty that status quo is good enough.

Nimmi Kannankutty, Senior Advisor to the Director, National Science Foundation, opened the second day of the concluding workshop with focus on the need of new and expanded models for partnership for innovation in doctoral education. Her remarks included the NSF director’s goal of transformation at speed and scale, and possible solutions for overcoming barriers to expanded industry-university partnership for doctoral training; matchmaking hub to connect faculty/students to industry partners; master partnership agreements; national job fairs for federally funded doctoral students; support through federal programs (e.g. INTERN, PFI, NRT, GERMINATION, including possibilities of placing some 20 students in internships at a company rather than one by one); cohorts of faculty and students participating in internships together; and co-mentoring with industry partners.

The next presentation featured Gerhard Schembecker, Professor, TU Dortmund; President & Treasurer, UA Ruhr New York and Christian Schröder, Professor and Vice President – Research, Development and Transfer, Bielefeld University of Applied Sciences. Schembecker and Schröder shared highly-evolved and varied models for industry-university partnership in Germany, and provided participants insight into possibilities for doctoral education different from current U.S. models. This theme continued with the next presenter, Himanshu Jain, T.L. Diamond Distinguished Chair in Engineering and Applied Science, Lehigh University. Jain, NSF IGE grant PI, shared an overview of Lehigh’s innovative Pasteur Partners PhD (P3) program, piloted through NSF IGE-funding. P3 includes multiple important elements raised by workshop participants: use-inspired research, co-advising by an industry scientist, required courses in essential non-technical skills, and a 1-2 semester residency at a company. Moreover, Jain shared that initial enrollment in P3 indicates that it is particularly attractive to underrepresented communities, suggesting that it may provide an innovative model for growing diversity in the STEM doctorate.

Using Lehigh’s P3 program as a starting point, the workshop continued with two small-group break out discussions. The first discussion focused on using Lehigh’s P3 model as a starting point and asked participants to explore a minimum viable product and comprehensive models for industry-university partnership for doctoral education at scale. Groups next transitioned to a final break-out session focusing on defining near-term (3 months) processes to move forward industry-university partnership for student-centered doctoral education at a national scale starting with proposal for design and implementation of an education-forward, cross-sector consortium working model as a logical next step action. Additional design constraints included:

- Student-centered - contributes to expanded opportunities for doctoral students
- Shared value - all partners gain through investment
- Shared resources - all partners contribute
The workshop concluded with a panel discussion that focused on how best to capture workshop momentum through actionable deliverables. Panelists included Gary Calabrese, SVP, Director, Global Research, Corning; Daniel Denecke, Program Director, Division of Graduate Education, NSF; Beth Dolan, Interim Dean, College of Health, Lehigh University; and, Dave Williams, Professor and Former Dean, College of Engineering, Ohio State University. Suggestion for next step actions included: (a) raising the visibility and urgency of the themes of the workshop discussion; (b) drafting and circulating a starting consortium mission statement, (c) developing boilerplate agreements; (d) pushing our institutions to greater flexibility; (e) considering small- and large-scale consortia efforts to engineer flexibility to meet different partner needs, and (f) considering focus on sector-specific current and future workforce and societal needs (e.g. agriculture, food-energy-water nexus, advanced manufacturing, infrastructure, reviving rural America).

Work to capture the momentum for change is underway. Accordingly, a collaborative effort of all stakeholders is planned, which will include a group of diverse universities, companies, national labs, funding agencies responsible for ensuring a competitive workforce, professional societies and relevant nonprofit organizations. A meeting of these stakeholders is planned in late fall 2021 with the goal of establishing a consortium of universities and companies interested in training a new class of STEM PhDs through a redesigned doctoral program. The resulting diverse group of doctorates is expected to be better equipped to meet the needs of industry and also better trained as faculty and researchers in academia, government labs, and other sectors.

Total workshop series registration included 111 participants from university, industry, government, and nonprofit sectors. Participants represented 33 universities, including the ones ranked in top 50 universities overall and top 50 in # of engineering PhDs, and 19 companies, including Fortune and Global 500 corporations. Representatives from the National Science Foundation, National Academies, and national laboratories (LLNL, NIST) participated as did representatives from national non-profit organizations with interest in STEM doctoral training and workforce development (American Chemical Society, American Society for Engineering Education, Council of Graduate Schools, Graduate Career Consortium, National GEM Consortium). Workshop materials together with participant contact information is available to all workshop participants on the event website.