National Workshop on the Formation of Industry-University Partnerships for Doctoral Training
National Academies Building, Washington, DC. August 4-6, 2025

Himanshu Jain and Nathan Urban
Lehigh University
(September 19, 2025)

Outcome Report

Executive Summary

Partnerships between industry and universities are a vital first step in addressing persistent shortcomings of U.S. doctoral education. Although often challenging to establish, these collaborations are essential for preparing a doctoral workforce that meets the evolving expectations of most employers. Students trained through such partnerships would gain a research mindset oriented towards solving real-world problems, an outcome not usually delivered by the current system.

To overcome this problem, seventy-seven leaders from academia, industry (including corporations, national laboratories, etc.), funding agencies, nonprofit organizations, professional societies, and international institutions convened in Washington, D.C., during August 4-6, 2025. Building on earlier workshops in this series held in 2010-2021, the present event focused on generating actionable solutions to three barriers that consistently impede partnerships: (i) Limited corporate capacity to commit support for the duration of PhD projects; (ii) Complexities surrounding intellectual property (IP) and publication agreements; and (iii) Misaligned timelines of research pursued by universities and industry.

Through structured discussions, case examples, and synthesis of various perspectives, participants identified key takeaways for systemic change:

- Approach partnerships strategically, not transactionally.
- Introduce flexibility into PhD requirements.
- Develop standardized agreement templates related to IP and publications.
- Explore alternatives to the traditional PhD model.

Participants also highlighted practices needed to put these ideas into action:

- Adopt collective approaches to forming partnerships.
- Maintain consistent, transparent communication.
- Prioritize follow-up actions with sustained attention.

From these insights, nine potential solutions were developed, ranked in increasing implementation complexity:

1. Involve graduate students in shaping their programs.
2. Increase flexibility in project start dates.
3. Improve the process for forming partnerships.
4. Shorten the duration of PhD programs by re-examining the coursework and other milestones.

5. Revise faculty reward criteria.
6. Build strategic, institution-to-institution relationships.
7. Establish upfront alignment between academic and industry researchers.
8. Create standardized national templates for agreements.
9. Establish university consortia to address common STEM graduate education issues collectively.

While many of these solutions (e.g., 1–5) can be pursued independently by universities, the more complex reforms (e.g., 6–9) will require coordination with industry partners and leadership from funding agencies. Note that such coordinated models are already standard in several countries (for instance, UK, Germany, Belgium, etc.) where industry-university partnerships are central to doctoral training.

Finally, participants produced actionable recommendations tailored for the four stakeholder groups: academia, industry, government, and doctoral students. Post-workshop survey results indicated optimism about adoption, with most respondents affirming a strong likelihood of implementing key recommendations at their institutions. Collectively, these outcomes represent an important first roadmap for strengthening STEM doctoral training in the United States.

1. Background

1.1 Past Workshops

Shortcomings of STEM doctoral training in the US have been known for decades.[1,2] While targeted improvements have been implemented in select departments and institutions, the current system generally falls short in preparing students for careers outside academia, despite most graduates being employed in industry (private corporations, national laboratories, regulatory agencies, healthcare organizations, etc.).[3-4] Traditional PhD programs provide strong subject-matter expertise but often fail to equip students with the skills and mindsets required to solve real-world problems. In particular, PhD students frequently lack:

- Meaningful exposure to industrial research and development challenges.
- Understanding of how industry conducts research to drive innovation.
- Non-technical professional competencies that are essential for career success.

To address these gaps, over one hundred leaders from academia, industry, national labs, government funding agencies, and professional societies convened for three workshops in 2020-2021.[5] The group recommended creating student-centered doctoral training focused on use-inspired research through industry-university partnerships. This led to the development of a pilot program: **Pasteur Partnership PhD (P3)**.[6] Prospective PhD applicants expressed overwhelming interest in this program, and faculty were eager to collaborate with industry.[7] However, the limited availability of industry-university partnerships restricted student enrollment.

Through extensive discussions, three primary challenges to forming such partnerships were identified:[8-10]

1. Difficulty for corporations to commit resources for the duration of a PhD.
2. Complexities surrounding intellectual property (IP) and publication agreements.
3. Misaligned timelines of research pursued by universities and industry.

Despite these obstacles, international models demonstrate that such partnerships can be established to successfully train STEM PhDs.

1.2 Present Workshop

The goal of the present workshop was to move beyond already completed analysis of problems to find actionable solutions. The seventy-seven participants included leaders from industry, academia, funding agencies, and international institutions already engaged in graduate training through industry-university collaborations. The workshop was deliberately limited in size to enable meaningful engagement while ensuring representation of diverse perspectives.

The workshop's structure and methods are detailed elsewhere; the remainder of this report focuses on points of agreement, points needing further discussion, takeaways, solutions, and actionable recommendations.

2. Points of Agreement

2.1 State of Doctoral Training in the U.S.

The workshop revealed strong consensus that the traditional model of doctoral education requires significant updates to reflect the evolving needs of students and the nation.[11] Two key factors drive this urgency: the increasing diversity of career paths for PhD students and the national demand for talent to fuel economic growth, exemplified by high compensation packages for leaders in emerging technologies such as Generative AI. There is substantial opportunity for mutual benefit by connecting universities and industry; however, success depends on acknowledging and respecting the differing objectives of each sector. The core principle of any reform must be to keep students at the center, as universities have a fundamental responsibility to prepare them for diverse career trajectories. Bridging the gap between academia and industry will require clear, data-driven arguments demonstrating benefits for companies and the broader societal and economic returns of aligning doctoral training with industry needs.

2.2 Required Skills and Experiences for STEM Doctoral Training

The workshop participants agreed that PhD trainees preparing for careers in industry should develop four core competencies:

1) Technical subject-matter knowledge and tools, as provided in traditional programs.
2) Professional skills, such as leadership, communication, critical thinking, teamwork, etc.
3) Practical experience to develop viable solutions.
4) A research mindset oriented toward real-world problem-solving.

The current system effectively delivers 1) and, to a varying degree, 3), while 2) has been offered to a limited number of students in recent years through programs like NSF's NRT. However, 4) remains largely absent from most programs.

2.3 Learnings from European Models

The workshop highlighted international models that successfully integrate all four core competencies through industry-university partnerships. For example:

- **German Model of Science and Innovation:** Germany is investing over €500 billion in research and development over ten years, driven by both federal/state governments and the private sector. The Fraunhofer model fosters collaboration between universities and industry, where master's and doctoral students work on specific projects supported by companies.
- **Belgian Model:** Funded by the federal government, a consortium of five universities facilitates the transfer of PhD talent into the non-academic labor market. This program includes a successful job-shadowing initiative, guided by an advisory board of ten companies and recognized by university chancellors, illustrating how a collective, government-supported approach can overcome systemic challenges in industry-university collaborations.

The participants agreed that these models demonstrate the success of structured partnerships for effectively equipping doctoral students with technical expertise, professional skills, practical experience, and a real-world research mindset, providing instructive examples for U.S. reform efforts.

3. Points Needing Further Discussion

While participants agreed on the need for reform, several challenges remain, particularly regarding financial support. The participants acknowledged that industry cannot not be viewed as an unlimited source of funding for university research. Instead, universities must recognize industry as an equal partner, bringing expertise and resources that complement academic capabilities.

Financial investment in partnerships should be directly linked to the benefits for each stakeholder—universities, companies, government, and students alike. A key point of contention was the recognition that universities must exercise strategic flexibility in allocating resources. This may involve redirecting funds from other areas, at least in the short term, to invest in developing new models of industry-university collaboration.

The financial commitment from all parties must be grounded in a clear return on investment, both in terms of tangible outcomes (e.g., research outputs, patents) and broader impacts (e.g., workforce readiness, societal benefit). Addressing this issue is critical to establishing sustainable industry-university partnerships that can effectively prepare doctoral students for diverse career paths.

4. Overall Takeaways

To address the three key challenges noted in Section 1.1, the workshop structured separate half-day sessions dedicated to each topic. However, discussions frequently overlapped, as many solutions applied across multiple challenges. Therefore, key takeaways and proposed solutions are presented collectively.

Participants identified several overarching takeaways that highlight how academia, industry, and government can collaborate to reimagine STEM doctoral training and better align it with the evolving research and innovation landscape.

- **Consider Partnerships with Strategic Vision, Not Just Transactions**
  Industry-university relationships should be treated as long-term, strategic partnerships rather than short-term transactions. Graduate student success should remain the central goal, with academic integrity preserved. Participants emphasized that developing transferable problem-solving and critical thinking skills is more important than strict alignment with industry-specific tasks.
- **Add Flexibility to PhD Requirements**
  Flexible, student-centered PhD pathways are essential for delivering the four core competencies highlighted in Section 2.2, particularly the research mindset oriented toward real-world problem-solving, while aligning with industry goals. Participants recommended differentiated tracks, restructured curricula, and updated program models that balance academic rigor with practical application.
- **Develop Standard Templates**
  Standardized national templates are critical to streamline agreements for intellectual property, publications, and student engagement. Master templates can be adapted with addenda to account for institutional and disciplinary differences, reducing administrative burden and facilitating partnerships.
- **Consider Alternatives to the Traditional PhD**
  The workshop highlighted the potential to evolve the traditional PhD to incorporate new approaches and technologies. Participants also suggested reconsidering alternative doctoral degrees, such as the Doctor of Engineering, to better meet industry needs.
- **Develop Collective Approaches to Form Partnerships**
  Moving beyond individual agreements, forming consortia of universities aligned with industry sectors can drive systemic change. This effort will require engagement of funding agencies and

innovative collaboration models to ensure doctoral education remains relevant, equitable, and career aligned.

- **Pursue Consistent Communication**
  To overcome cultural differences and misaligned timelines between academia and industry, participants emphasized the need for clear and consistent communication. This expectation includes identifying shared goals, understanding sector-specific priorities, and potentially forming consortia focused on specific technology areas.
- **Consider the Relative Importance of Follow-Up Actions**
  Participants prioritized initiatives tied to funding and research. Encouraging funding agencies to create graduate fellowships linked to industry-university collaboration and supporting student research through partnerships received the strongest support. Establishing consortia of universities to partner with companies in specific technology areas was also valued, though responses reflected recognition of implementation challenges.

These takeaways underscore a persistent "readiness gap," driven by traditional academic curricula, cultural differences, and the absence of structured collaboration. Addressing this gap is an ecosystem wide challenge requiring coordinated effort and shared responsibility as well as further research to innovate STEM graduate education. To be successful in industry, a PhD should cultivate, in addition to technical expertise, transferable skills and a problem-solving mindset that are highly sought after.

5. Solutions to the Three Key Challenges

Building on the overall takeaways, the workshop generated concrete solutions to advance industry-university partnerships. Some solutions are considered "small steps" that can be implemented immediately. Examples of immediate or "small step" solutions are: separating coursework from the research phase, creating more flexible academic calendars, and encouraging, even requiring industry partners to serve on student dissertation committees to integrate real-world perspectives into research projects.

By comparison, "big steps" would require strategic, long-term planning, greater understanding of industry needs and the support of governmental agencies. Examples are: implementing Individual Development Plans (IDPs) for students, creating consortia, and developing standardized contract templates. These approaches provide clarity, efficiency, and uniformity, while also making a stronger case with national agencies.

5.1 Potential Solutions (in Order of Increasing Complexity)

1. **Involve Students:** Engage students in developing their educational plans and in understanding partnership agreements, licensing, and related processes. Creative approaches, such as flexible fellowship structures, can support this involvement.
2. **Add Flexibility to Project Start Dates:** Adjust project start dates to accommodate industry timelines, reducing delays from months to weeks. This is increasingly important in rapidly evolving technological areas and for engaging students in startups and translational research.
3. **Improve Partnership Forming Process:** Streamline processes using templates and automated tools. Institutions should share knowledge and resources, and designate a central office to handle industry inquiries, reducing administrative burden on potential partners.
4. **Shorten PhD Duration:** Reduce pure research time to 2–2.5 years, aligning with European models. This can be achieved by separating coursework and research phases, replacing traditional

coursework with the courses needed for dissertation research, reducing credit requirements where appropriate, or recognizing prior knowledge through exams. Shortened programs may also attract more industry partners.

5. **Develop Alternative Faculty Rewards Criteria:** Revise promotion and tenure criteria to formally recognize industry collaboration and applied research. For example, some institutions accept letters of support from industry partners as part of faculty evaluation under "publicly engaged research" options.
6. **Develop Strategic, Institution-to-Institution Relationships:** Create institution-level agreements rather than relying on individual faculty-led arrangements, fostering sustainable and scalable partnerships.
7. **Establish Upfront Alignment:** Align expectations among academic and industry researchers before formal agreements. Simplified non-disclosure agreements (NDAs) can outline essential points and determine collaboration feasibility.
8. **Develop Standardized National Templates:** National contract templates for financial, IP, and publication agreements can simplify and standardize interactions. These templates, like the UK's Lambert agreements, may be incorporated into government solicitations, with project-specific details handled via annexes.
9. **Establish Consortia:** Form consortia based on the P3 model to provide comprehensive doctoral training and engage a wide range of partners, including small and non-traditional organizations. Government, industry, and philanthropic resources can support these consortia, following European examples such as Germany's Fraunhofer Institutes. Additional measures include centralized databases of industrial opportunities, templates, case studies, and combining structures of existing programs (e.g., A2i and P3). Scalability, accessibility, and sustainability should guide national-level initiatives.

6. Actionable Recommendations by Stakeholder

The workshop generated detailed recommendations tailored for the four key stakeholder groups: academia, industry, policymakers, and PhD candidates.

6.1 For Academia (Graduate Schools, Universities)

- **Curriculum Redesign:** Separate the preparation (coursework) and research phases of the PhD. Shorten the duration of both phases based on student background and research topic. Embed transferable skills and interdisciplinary training into curricula to ensure graduates acquire all four core competencies.
- **Industry Liaisons:** Establish dedicated offices for industry engagement and well-resourced collaboration programs. This ensures students develop a problem-solving mindset aligned with industry expectations.
- **Faculty Incentives:** Revise promotion and tenure criteria to formally recognize and reward applied research and industry collaborations. Increase faculty awareness of PhD competencies.
- **Career Development:** Invest in robust career development services tailored for PhD students and leverage alumni networks for mentorship opportunities.

6.2 For Industry (Companies, National Labs, Defense Organizations, etc.)

- **Direct Engagement:** Participate in curriculum design, deliver guest lectures, and mentor PhD students. Establish exchange programs for researchers in industry as well as university faculty.

- **Joint Research and Sponsorship:** Increase investment in collaborative research projects and consider creating industry-sponsored PhD positions.
- **Internship Pathways:** Offer structured internship and postdoctoral opportunities specifically tailored for PhD graduates.
- **Value PhD Skills:** Recognize and leverage the problem-solving capabilities and analytical rigor of PhD-trained graduates beyond immediate technical needs.

6.3 For Policymakers (Government and Funding Agencies)

- **Incentivize Collaborations:** Implement funding schemes that explicitly support industry-academia research partnerships and PhD placements, for example by broadening programs like NSF's GRFP, NRT-IPP and SFS, or DoD's NDSEG and SMART.
- **Establish National Platforms:** Develop platforms or consortia to facilitate alignment between academic research groups and industry needs.
- **Incorporate IP Regulations:** Integrate appropriate intellectual property expectations into funding structures to foster collaborative innovation.

6.4 For PhD Candidates

- **Engage Proactively:** Seek industry internships, networking opportunities, and professional development experiences during doctoral studies.
- **Broaden Horizons:** Develop awareness of diverse career paths and tailor development of skills accordingly, considering options beyond traditional academic trajectories.

7. Concluding Remarks

The workshop proved highly informative and engaging for all participants. Its structure, particularly small-group discussions, provided ample opportunity to share diverse perspectives and experiences. Subsequent panel discussions and plenary debates enabled participants to synthesize solutions and recommendations by consensus. Overall, there was a unanimous agreement that the workshop successfully accomplished its goals.

To assess potential long-term impact, participants were surveyed on the likelihood that their organizations would adopt workshop outcomes. Most respondents indicated they were extremely or somewhat likely to implement key recommendations. Partnership agreements and timelines for addressing research challenges received strong support, though some neutral or cautious responses reflected the complexity of adoption. Financial models received the most measured responses, indicating uncertainty around implementation of more resource-intensive approaches.

Notably, 85% of respondents reported that their institutions were extremely or highly likely to collaborate with others to form consortia, suggesting a broad willingness among universities to pursue collective approaches. These findings indicate optimism that the workshop has established a foundational roadmap for improving STEM doctoral training in the United States.

8. Acknowledgement

The support from National Science Foundation (Innovation in Graduate Education program, DGE-1806904) and Lehigh University for hosting the subject Workshop and preparation of this report is gratefully acknowledged.

9. References

[1] *Reshaping the Graduate Education of Scientists and Engineers. National Academy of Engineering, 1995, Washington, DC: The National Academies Press. https://doi.org/10.17226/4935.*

[2] *Graduate STEM Education for the 21st Century. National Academies of Sciences, Engineering, and Medicine 2018, Washington, DC: The National Academies Press. https://doi.org/10.17226/25038.*

[3] *Editorial, "Nature," vol. 613, p. 414, 2023. Available: https://doi.org/10.1038/d41586-023-00084-3.*

[4] *L. Cassuto and R. Weisbuch, 2021. The new PhD: How to build a better graduate education. Johns Hopkins University Press.*

[5] *Evaluation and Identification of Deficiencies Within the Current STEM Doctoral Training Programs, https://sites.google.com/lehigh.edu/pasteur-partners-phd-program/past-workshops. Also, see this report.*

[6] *H. Jain, V. Dierolf, A. Jagota, Z. Pan and N. Urban, "Redesigning US STEM Doctoral Education to Create a National Workforce of Technical Leaders," ASEE Annual Meeting Proc., Paper ID #37003, pp. 1–20, 2023. Available: https://peer.asee.org/44062.*

[7] *Z. Pan, A. Jagota, V. Dierolf and H. Jain, "Faculty Perspectives on Their Role in the Training of STEM Doctoral Students," in 2024 ASEE Annual Conference & Exposition, Portland, Oregon, June 2024. ASEE Conferences, 2024, pp. 1–24. DOI: 10.18260/1-2—47458. Available: https://peer.asee.org/47458*

[8] *H. Jain, V. Dierolf, A. Jagota, Z. Pan, and N. Urban, "Redesigning US STEM Doctoral Education to Create a National Workforce of Technical Leaders," ASEE Annual Meeting Proc., Paper ID #37003, pp. 1–20, 2023. Available: https://peer.asee.org/44062.*

[9] *Z. Pan, A. Jagota, V. Dierolf and H. Jain, "Faculty Perspectives on Their Role in the Training of STEM Doctoral Students," in 2024 ASEE Annual Conference & Exposition, Portland, Oregon, June 2024. ASEE Conferences, 2024, pp. 1–24. DOI: 10.18260/1-2—47458. Available: https://peer.asee.org/47458*

[10] *Z. Pan, V. Dierolf, A. Jagota and H., 2025, June. Role of industry-university partnership in STEM graduate training: industry mentors' perspective. 2025 ASEE Annual Conference & Exposition, Montreal, Canada, June 2025. ASEE Conferences, 2025. 10.18260/1-2—57150. https://peer.asee.org/role-of-industry-university-partnership-in-stem-graduate-training-industry-mentors-perspective*

[11] *National Academy of Engineering, Reshaping the Graduate Education of Scientists and Engineers. Washington, DC: National Academies Press, 1995. [Online]. Available: https://doi.org/10.17226/4935*