

CRA Industry/Academia Committee Report

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Executive Summary

Recent trends have prompted the need for a fresh look at the relationships between academia and industry. These trends include increasing industry demands for technical talent from academia, as well as changes in the academic environment with increased industry interactions. This document contains the report by a recently formed CRA ad hoc committee on Industry/Academia Interactions created in late 2019 to study these trends. The findings in this report are based on a survey sent to 221 computing department chairs in January 2020 which resulted in 105 responses, indicating strong interest in this topic.

Our findings from the January 2020 survey show that significant industry engagement is underway between computing departments and industry, with an increasing trend. While there is a mix of positive and negative aspects to the interactions, the positives clearly outweigh the negatives. There are also correlations between industry interactions and department size, as well as between department size and proximity to a “tech hub” geographic region. It is important to note that these findings pre-date the recent worldwide impacts of the COVID-19 pandemic.

Based on the findings thus far, the committee’s recommendations include the following (discussed in more detail in the report):

1. Conduct additional surveys to get a more complete picture of current opportunities and challenges related to industry-academia interactions:
2. Create a follow-on report on best practices for departments and companies in industry/academia engagements related to computing research.
3. Consider forming a new CRA programmatic committee focused on fostering, amplifying, and sustaining industry’s contributions to the broad landscape of computing research.

Background

A recent report¹ released by the Computing Community Consortium (CCC) in June 2019 identified some recent trends in industry-academia interactions, along with their potential to positively or negatively impact computing departments; the report also recommended a follow-up activity to study these impacts in more detail and to establish best practices that can be shared across academia and industry. The conclusions of the CCC report included the following:

- There is a significant increase in interaction levels between faculty and industry in certain computing disciplines, such as artificial intelligence.
- Companies view computing research and technical talent as critical to innovations needed for business success, and are highly motivated to engage faculty and graduate students working in specific technical areas.
- There is a potential for principles and values from academia (e.g., ethics, human-centered approaches, privacy and security, societal good) to inform future products and R&D roadmaps in new ways through increased industry collaborations.
- The increased level of interaction with industry has the potential to impact (either positively or negatively) many aspects of academic research including academic culture, research topics, ability to solve bigger problems with bigger impact, ability to train undergraduate and graduate students, and models for how companies and universities cooperate, share, and interact with each other.
- It is recommended that a follow-up activity measure the degree and impact of these recent trends and establish best practices that are shared widely among computing research institutions in academia and industry.

Given the alignment with CRA's mission to join with academia, industry, and government in strengthening research and advanced education in computing, CRA created an *ad hoc* committee on Industry/Academia Interactions in late 2019 to study this topic more broadly. This report contains the findings and recommendations from this committee.

Findings: January 2020 CRA Survey Results

The findings in this report are based on a survey sent to 221 computing department chairs in January 2020 which resulted in 105 responses, indicating strong interest in this topic. From past experience with other CRA surveys, our expectation is that these responses were completed by the chairs themselves rather than being delegated to someone else. With that in mind, the survey was intentionally designed to be brief so that it could be completed in under 15 minutes. It included seven questions that spanned the types of engagement with industry, types of companies involved (tech vs. non-tech), the computing sub-areas involved, whether the trends were increasing, decreasing or stable,

¹ [“Evolving Academia/Industry Relations in Computing Research”](#), June 2019, CCC.

and, perhaps most importantly, how the respondent would describe the impact of faculty engagements with industry in their department. Three of the seven questions were write-in only, and the remaining four also included the option of providing write-in responses. Appendix A lists all the survey questions.

Figure 1 summarizes responses to the survey question related to types of current or recent faculty engagements that occurred with industry in the respondent’s department. The x-axis shows the percentage of the 105 respondents for each option. The y-axis lists the options that were provided in the survey, but respondents could write in forms of engagement that were not included in the options. It is notable that only 3.8% of the respondents reported no current/recent engagement with industry. 63.8% of the respondents reported significant research funding provided by industry, and 53.3% of the respondents reported faculty sabbaticals in industry. 43.8% of the respondents reported cases of potential faculty hires choosing an industry career instead². In terms of workforce retention, there is clearly a two-way street between academia and industry with 38.1% of respondents reporting faculty being hired into the department from industry and 32.4% of respondents reporting faculty leaving for industry employment. The write-in comments describe a broad spectrum of other forms of engagement including: affiliate/partnership programs, co-authoring of research papers, co-development of teaching material, co-teaching of classes, co-mentoring of class projects, industry funding of endowed chairs, and faculty consulting arrangements.

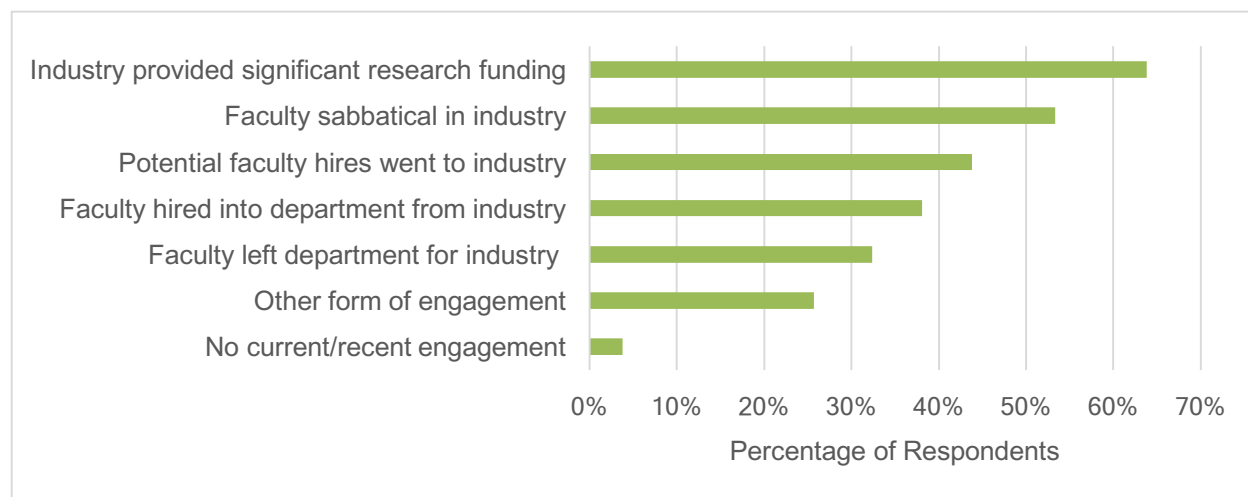


Figure 1: Types of current/recent faculty engagements with industry in department

² As context, the 2019 Taulbee Survey data show that 59.2% of new PhDs among CRA members take industry positions, compared with 19.6% who take tenure-track or teaching positions in academia. Another 13.8% take postdoc positions, which could feed into academia or industry.

Figure 2 summarizes the results of the survey question asking department chairs for their perception of the impact of engagements with industry on different constituencies in the department, and for the department as a whole. For each constituency, a respondent could choose one of five options from Very Negative (red) to Very Positive (green); the intermediate options were Mostly Negative (purple), Mix of Positive and Negative / Neutral (yellow), and Mostly Positive (blue). Each element of a stacked bar shows the percentage of responses received for the corresponding option with respect to a specific constituency. The last bar summarizes the responses received for the department as a whole, in which the Mostly Positive and Very Positive segments are significantly larger than the Mostly Negative and Very Negative segments. This trend can also be seen for undergraduate, masters, and PhD students, and for faculty for participating with industry. For faculty not participating with industry, there is an equal match between positive and negative responses, and one does not dominate the other. These results indicate that, according to computing department chairs, the positives of industry engagement far outweigh the negatives.

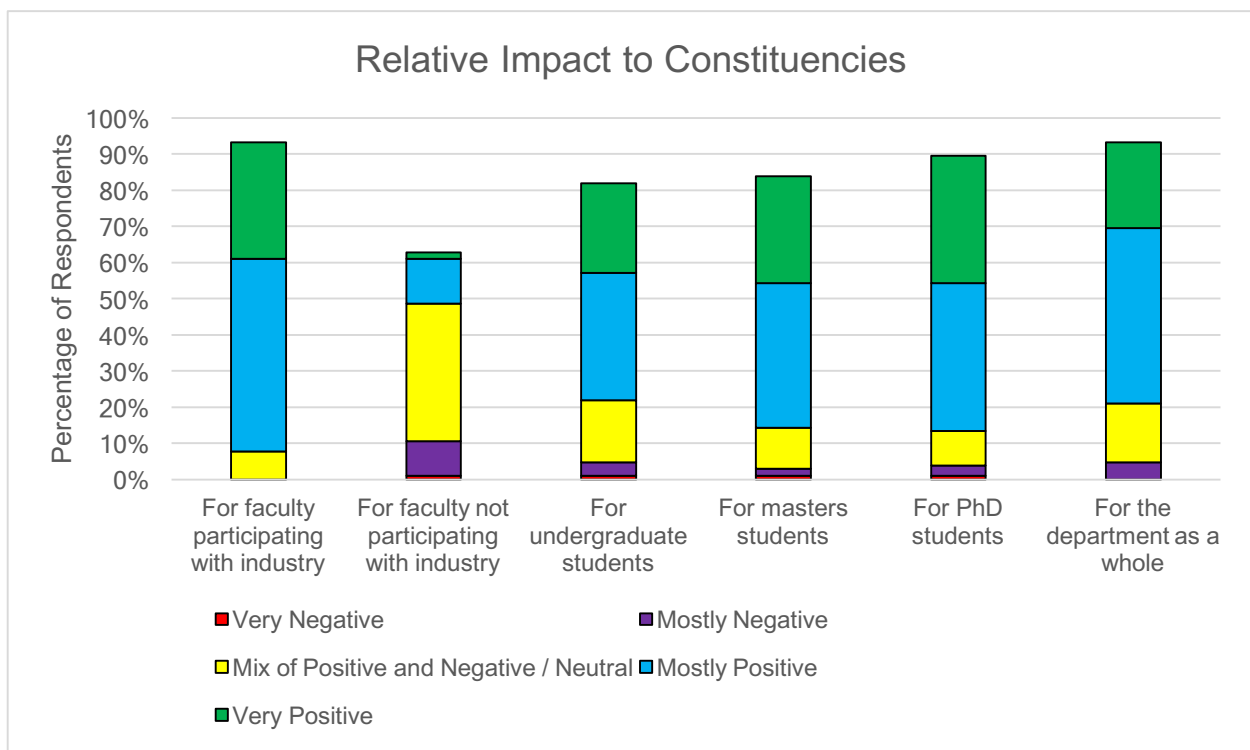


Figure 2: Department chairs’ perception of impact of faculty engagements with industry on different constituencies in department

To provide a more qualitative sense of the sentiments expressed by the respondents, we include below some of the write-in responses received for a question that asked for



information/context/examples related to industry engagements with their department, especially for the most positive and most negative impacts.

Some of the comments related to positive impacts were as follows:

- "All positive. We have had success in engaging with research focused companies."
- "Positive impacts have usually been access to data, funding to support research, collaboration on research, internships for PhD students, and job opportunities for PhD students."
- "Bringing real-world problems into the academic environment helps students in the classroom and in research."
- "enables transitioning of research contributions to practice resulting in higher impact."
- "senior projects sponsored by companies"
- "No negative experiences -- benefits have included placement for students and project sponsorship for faculty"
- "We find that industry sponsors require somewhat more care and feeding, but that when they feel we're on top of their concerns, they are generous and swift with funding."
- "Most positive - funding for creation of labs and collaborations in creating new academic programs"
- "Industry has provided funding for faculty research projects, especially in the form of research assistantships for Ph.D. students."
- "Several companies are interested in supporting undergraduate activities with a view to connecting with future employees. Most of the engagement is with respect to research however."
- "Faculty are getting funding. Students are getting practical experience and learning about the applications of technology. Student programming skills are improving as they see what is required to be successful in a job."
- "very positive for the faculty who got funding from industry, and their students"
- "All our industry engagements have been VERY positive."

And some of the comments related to negative impacts were as follows:

- "Negative impacts are usually industry hiring away PhD students (before they're done)"
- "Multi-year leaves are a drain on dept resources"
- "It leaves a heavy service load on those that remain. It has made hiring horrible."
- "Looking for labor not true partnerships ..."
- "Contracts are very time consuming and do not have much original research"
- "Industry engagement creates an uneven and unpredictable environment for assigning teaching tasks to faculty members"

- “My pet peeve is that companies have an unrealistic notion of how much they should be able to influence our curriculum”
- “There have been more protests around companies with an ICE relationship. No clear how general this is beyond that issue.”

These comments suggest that while the positives clearly outweigh the negatives in industry-academia interactions, there is room for further improvement in reducing the negative impacts and related perceptions on both sides.

Figure 3 shows the recent trends for the different types of faculty engagement listed in Figure 1. This chart underscores the fact that industry-academia interactions are on the rise, as can be seen by the very small occurrences of purple bars which represent decreasing trends. The increasing trends (red bars) are most pronounced for industry funding for faculty research, faculty sabbaticals in industry, and faculty time-sharing across industry and academia.

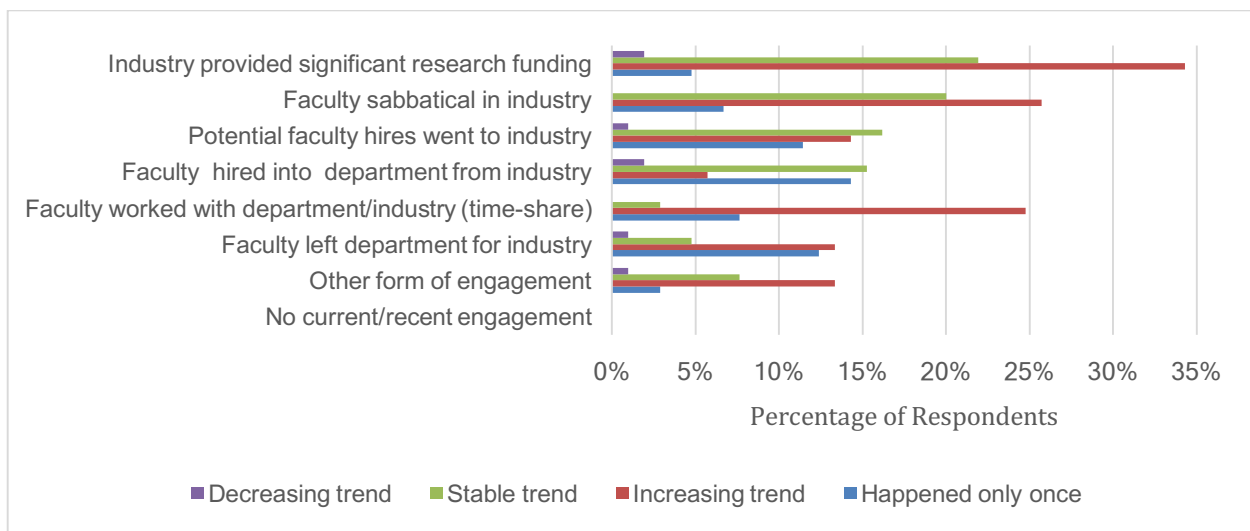


Figure 3: Trends for different types of faculty engagement that occurred in recent years

Finally, Figure 4 summarizes the types of industry organizations involved in faculty engagements according to four simple categories -- large tech companies, tech startups, non-tech companies, and other. While tech companies dominate the responses, it is interesting to see that 33% of the respondents reported faculty engagements with non-tech companies.



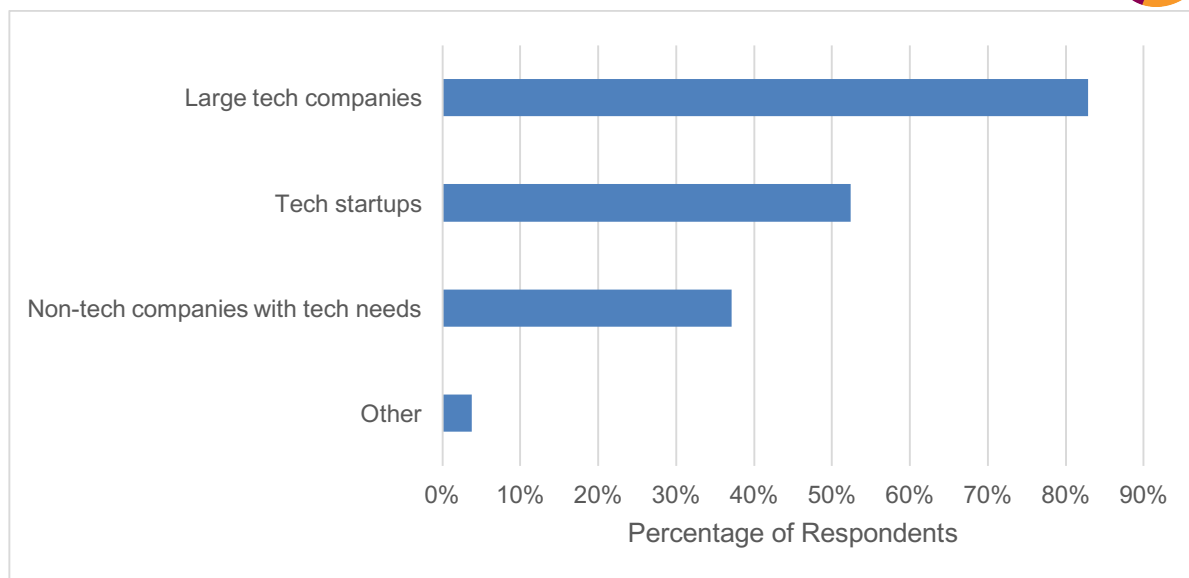


Figure 4: Types of industry organizations involved in faculty engagements

A related finding is that while the overall level of interaction between industry and academia is on the rise in the context of computing research, there is a lack of resources to guide computing departments and companies (especially non-tech companies) that are looking to increase their engagement levels. There is an opportunity for CRA to provide this guidance through best practice documents, facilitating discussions of joint research agendas, and the fostering of a vibrant industry-academia community for precompetitive research. This role can complement other resources relevant to industry-academia interactions that go beyond CRA’s focus on research, e.g., organizations like UIDP (<https://uidp.org>) that address broader issues related to university-industry interactions.

Analysis: Impact of department size on industry-academia interactions

One question that arose during the committee’s discussions of industry-academia interactions was the possibility of a correlation between department size and the degree of industry-academia interactions. While there are many metrics that can be used to measure the size of a computing department, we decided to use a standard metric from the Taulbee Survey --- the number of Tenure-track and Tenured (TT) faculty --- as a proxy for department size. We did not have a survey question related to TT size, but our survey administrator was able to correlate TT size with respondents by using data from the most recent Taulbee survey. By grouping departments based on TT faculty counts of 18 or fewer, 19 to 27, 28 to 39, and 40 or more, we obtained a partitioning with approximately equal numbers of departments in each group (approximate quartiles) as shown in the table below.



	No. TT faculty				
	18 or fewer	19 to 27	28 to 39	40 or more	Total
Total	25	26	25	29	105

Figure 5 shows a refinement of Figure 1 as a function of department size. For each kind of engagement, there are four bars corresponding to the four size groups defined above. For any engagement that is expected to be independent of department size, we should see bars of approximately equal length for the four groups. However, that is not the case for the engagements listed below. For the six forms of engagement surveyed, a larger percentage of departments with 40 or more faculty (purple bars) reported occurrences of the engagement relative to smaller departments. This is perhaps unsurprising since larger departments offer more points of contact for industry interactions, but it is still interesting to see it confirmed in the survey data.

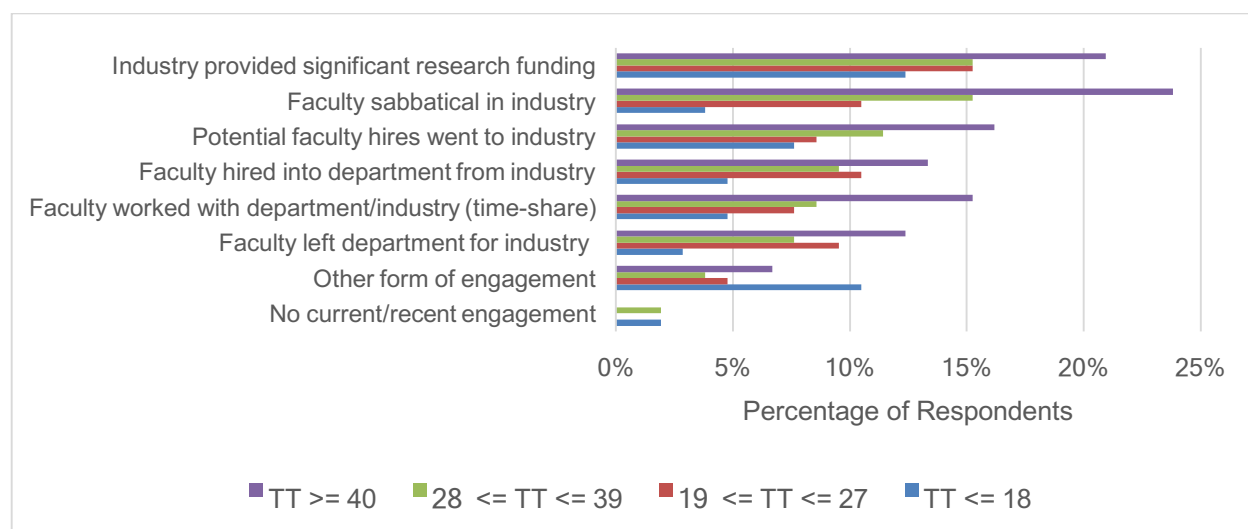


Figure 5: Types of current/recent faculty engagements as a function of department size

Analysis: Impact of “tech-hub” location on computing departments

Another question that arose during the committee’s discussions of industry-academia interactions was the impact that geographic proximity to tech companies may have on the degree of industry-academia interactions. Since we could not easily find a standard definition of “tech-hub” geographies, we decided to undertake an initial analysis by considering any university located within 100 miles of the following geographic areas to

be in/near a tech-hub region: Atlanta, Austin, Boston, DC, NYC, Raleigh-Durham, Seattle, SF Bay Area. According to this initial analysis, 25 of the 105 respondents are located in/near tech-hub geographies. We plan to refine this initial analysis by using a more systematic definition of “tech hub” in the future.

One surprising outcome of this initial analysis is that there is a statistical correlation between department size quartile and the tech-hub attribute³, as indicated in the table below. For example, 56% of the respondents in tech-hub locations have 40 or more TT faculty, whereas such departments only constitute 29% of all respondents. Alternatively, we can see that 48% of respondents with 40 or more TT faculty are in tech-hub locations.

	No. TT faculty				Total
	18 or fewer	19 to 27	28 to 39	40 or more	
Non Tech Hub	23	21	21	15	80
In/Near Tech Hub	2	5	4	14	25
Total	25	26	25	29	105

Figure 6 shows a refinement of Figure 2 into two charts for respondents in tech-hub locations and in non-tech-hub locations, showing the relative percentages for each category. An interesting observation that can be made from Figure 6 is that, even though the positives outweigh the negatives overall, certain constituencies in departments in tech-hub locations appear to experience more negatives relative to departments in non-tech-hub locations. This is most pronounced for faculty not participating in industry engagements. One hypothesis is that industry engagement may be a more prominent part of department culture in tech-hub locations, thereby putting faculty not participating in industry engagements at a disadvantage (according to the department chairs who responded to the survey).

³ Specifically, the null hypothesis that size quartile is independent of the tech-hub attribute can be rejected with high probability since the chi-square statistic for the null hypothesis is significant, at 14.15 for $p < 0.05$.

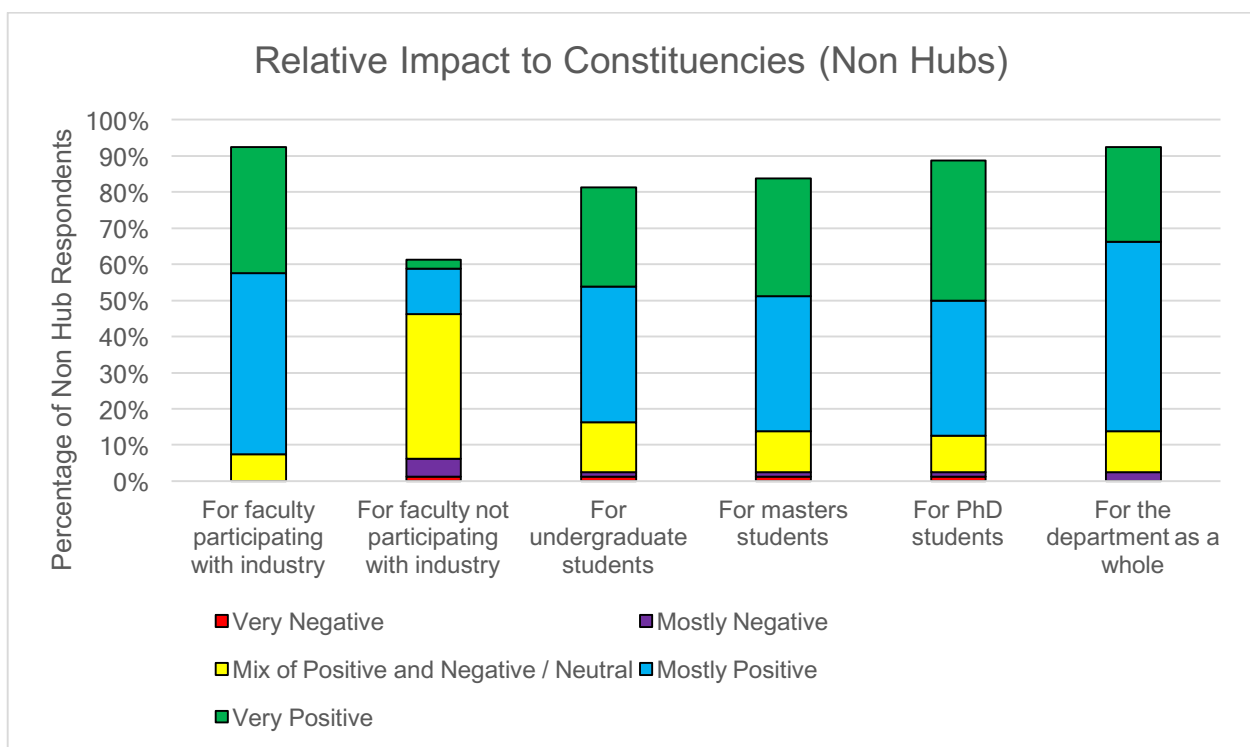
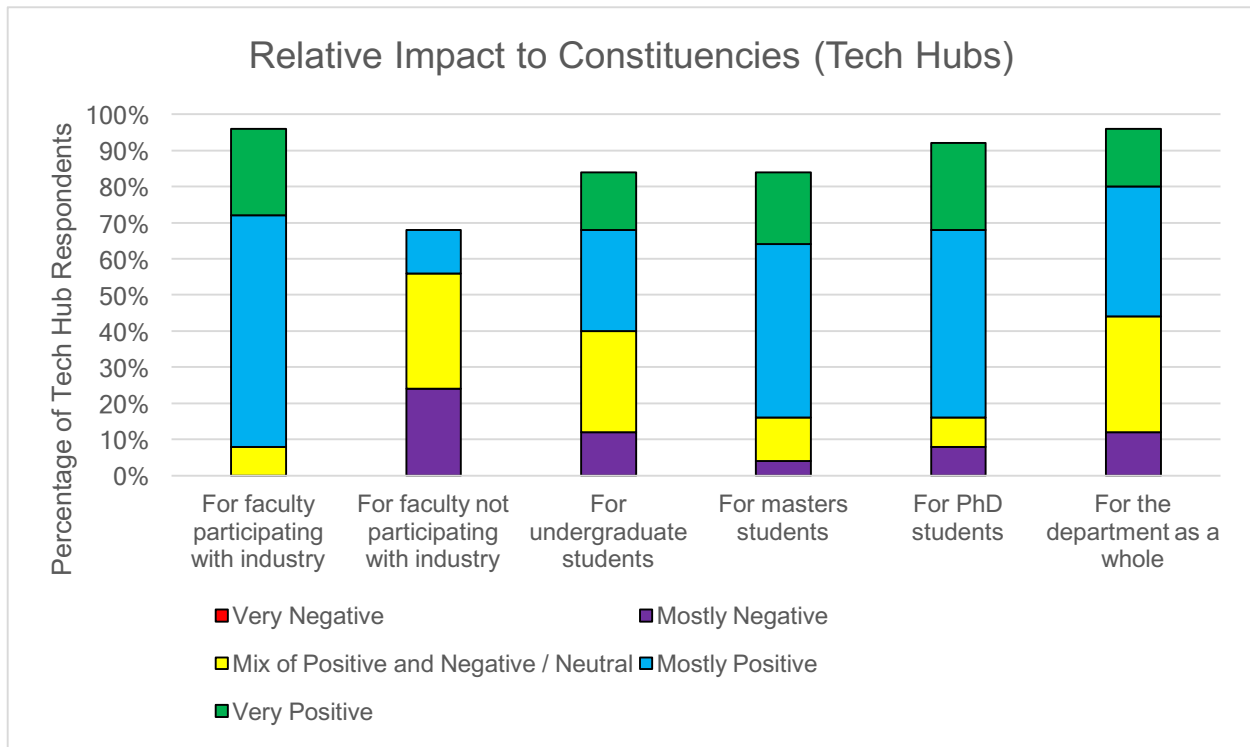


Figure 6: Impact of tech-hub location on department constituencies

Recommendations

Based on the findings in this report, the committee would like to make the following recommendations:

1. Conduct additional surveys to get a more complete picture of current opportunities and challenges related to industry-academia interactions:
 - a. Create and administer a corresponding survey to industry partners.
 - b. Create and administer a follow-on survey to computing department chairs (over 60% of the respondents said that they were open to engaging further on this topic), and explore ways to directly survey constituencies in the departments.
 - c. Collect survey data on a regular basis from departments and industry partners on industry/academia interactions.
2. Create a follow-on report on best practices for departments and companies in industry/academia engagements related to computing research. The scope of this report should include guidance to departments and companies (tech and non-tech) looking to increase their level of activity in industry/academia interactions.
3. Consider forming a new CRA programmatic committee focused on fostering, amplifying, and sustaining industry's contributions to the broad landscape of computing research. The scope of this committee will include industry-academia engagements discussed in this report, increasing participation of industry partners in CRA activities, and development of broader strategic initiatives related to industry's role in computing research (including connections with federal organizations engaged with computing research). A draft charter for such a committee, tentatively named CRA-I, is included in Appendix B. CRA's ongoing strategic planning process will likely surface ideas that will influence the creation, design and operation of such a committee.

Acknowledgments

The committee would like to acknowledge the comments and suggestions received from the CRA and CCC communities, and also give special thanks to Betsy Bizot for all her hard work on administering the survey described in the report.

Appendix A: Survey Questions

1. What types of current or recent faculty engagements with industry occurred in your department? Check all that apply.
 - a. Faculty left the department for industry employment
 - b. Faculty worked under cooperative agreements with time shared between the department and industry
 - c. Faculty went to industry for a sabbatical
 - d. Faculty were hired into the department from industry positions
 - e. Faculty candidates you wanted to hire took industry positions instead
 - f. Industry provided significant funding for faculty research
 - g. Other form of engagement, please specify: (*write-in option*)
 - h. No current or recent faculty engagement with industry has occurred
2. Of the types of faculty engagement that have occurred, what has been the trend in recent years?
 - a. Happened only once
 - b. Increasing trend
 - c. Stable trend
 - d. Decreasing trend
3. What types of industry organizations were involved in faculty engagements with your department? Check all that apply.
 - a. Large tech companies
 - b. Tech startups
 - c. Non-tech companies with tech needs, e.g. manufacturing, transportation, agriculture, etc. (*what type of industry? write-in option*)
 - d. Other, please specify (*write-in option*)
4. To the best of your recollection, please share the names of companies that were involved most actively in these engagements. (*write-in option*)
5. What CS subareas in your department were involved in faculty engagement with industry? (This list is the CRA Taulbee Survey list of specialty areas.) Check all that apply.
 - a. Artificial Intelligence/Machine Learning
 - b. Computing Education
 - c. Databases/Information Retrieval
 - d. Graphics/Visualization
 - e. Hardware/Architecture
 - f. High-Performance Computing
 - g. Human-Computer Interaction
 - h. Informatics: Biomedical/Other Science
 - i. Information Science

- j. Information Systems
 - k. Networks
 - l. Operating Systems
 - m. Programming Languages/Compilers
 - n. Robotics/Vision
 - o. Scientific/Numerical Computing
 - p. Security/Information Assurance
 - q. Social Computing /
 - r. Social Informatics / Computer Supported Collaborative Work
 - s. Software Engineering
 - t. Theory and Algorithms
 - u. Other, please specify (*write-in option*)
6. How would you describe the impact of faculty engagements with industry in your department? (Very Negative, Mostly Negative, Mix of Positive and Negative / Neutral, Mostly Positive, Mostly Positive, Very Positive)
- a. For faculty participating with industry
 - b. For faculty not participating with industry
 - c. For undergraduate students
 - d. For masters students
 - e. For PhD students
 - f. For the department as a whole
7. Please share any information / context / examples related to industry engagements with your department, especially for the most positive and most negative impacts. Feel free to include any aspect of industry engagement that has been significant for your department in recent years, e.g., research, teaching, students welcoming/protesting tech companies on campus. (*write-in option*)
8. Are you willing to be contacted for more details on this topic and its impact?
- a. Please contact me
 - b. I'm open to it
 - c. Please don't contact me
9. As the CRA continues to explore issues of faculty-industry interactions, is there anything specific they should be sure to take into account? (*write-in option*)

Appendix B: Draft Charter for potential CRA-I Programmatic Committee

Vision

Increase industry engagement with CRA to create a computing research ecosystem that fully leverages the potential synergies between industry, government, and academia for mutual benefit and improved societal outcomes.

Mission

The CRA-I bridges between its industry members and CRA's academic and government constituents to facilitate progress and mutual benefit on jointly relevant issues.

Membership

CRA-I is a membership organization of North American companies with a significant vested interest in the effective progress of computing research.

- **Board.** A board of advisors will be established, to which each member company will be allowed to nominate up to one board representative. The board will also include up to one liaison from each CRA peer committee, as well as individuals appointed by the CRA-I steering committee. In the steady state, the board is intended to comprise a lower bound of $\frac{2}{3}$ industry representatives. Members of the board are expected to be thought leaders who are poised to set research-related policies within their companies, and are also positioned to be aware of a broad range of computing research dimensions (science, business, government, workforce development, diversity & inclusion, and corporate social responsibility writ large). The board is the voice of its constituent members to surface issues and help drive CRA opportunities at the intersection of industry, academia, and government.
- **Steering committee.** The CRA-I steering committee is a subset of the board (following a bootstrap period) and serves to catalyze and track project-based activities that fulfill CRA-I's vision and mission.
- **Project teams.** At the discretion of the steering committee, project teams will be established to execute on CRA-I projects, and can draw on a wider community of participants. Each project team must include at least two CRA-I board members.

Responsibilities, methods and activities

The CRA-I serves to advance aspects of CRA's overall mission that touch on industry. For example, CRA-I is expected to articulate, represent, and coordinate an industry perspective on computing research to CRA and its various working groups and constituents; CRA-I will also represent academic and government perspectives to industry for mutual progress and benefit. As a byproduct, the CRA-I's influential board representatives also serve as a conduit for conveying CRA's broader points of view to their respective companies and industry segments. CRA-I's steering committee operates by convening quarterly to review, propose, and conduct activities that contribute to the broader CRA mission. These activities, in most cases supported by CRA-I project teams

and CRA staff, can include surveys and data gathering, visioning workshops, long-range studies, and working sessions/collaborations with other CRA working groups on topics of interest.

Value proposition to industry members

Through interactions with other CRA standing committees, CRA-I's industry participants are provided with broader industry perspective, information, and insights that advance their corporate function and their company's success. CRA-I is also a forum to increase academia's visibility/awareness of participants' entities, with potential benefits to their research, recruiting, and diversity goals. CRA-I serves as a tool for exploring topical issues relevant to the participant's role, and the success of their company. Through the CRA government team, CRA-I members leverage government policy insights and have a stronger voice in formulating policy to government entities. Finally, CRA-I serves to build and maintain a professional network amongst thought-leading industry peers.

Success criteria

Indicators of success include: that committee members "vote with their feet" to participate; that other working group work products are visibly influenced; that other working groups see the improved conduits/outlets for their work; and that CRA industry membership as a whole increases.