Academic Alignment Study

AIChE
The Global Home of Chemical Engineers

AIChE-NSF Chemical Engineering Industrial-Academic Alignment Study

Final Report

February 2015

amg RESEARCH
Providing Strategic Guidance
www.amg-research.com

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I. EXECUTIVE SUMMARY

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Executive Summary

- **AMG Research contracted with the American Institute of Chemical Engineers (AIChE) to conduct a study to better understand the alignment between academic outcomes and industry expectations.**

- **Out of the 13,088 contacts provided by AIChE, a total of 570 people completed the online survey - a 4.4% response rate.**

- **The 570 online surveys consisted of the following:**
  - Academic (66)
  - Senior Non-Academic (Bachelors before 2001) (267)
  - Junior Non-Academic (Bachelors after 2001) (237)

- **Based on the 570 surveys, the following observations have been made:**

  - Less than half of faculty members have non-academic chemical engineering experience. Only about a fourth of institutions screen applicants based on this.
  - The chemical engineering field covers a wide variety of work sectors. About half of those working in industry work as Process Engineers or in Research & Development.
  - Almost all institutions either survey alumni or use industrial advisory boards to obtain ABET-process feedback.
  - Energy is the area where respondents expect the most potential for growth in career opportunities for chemical engineering graduates in the near future.

Executive Summary (Cont.)

- **Observations (Cont.):**

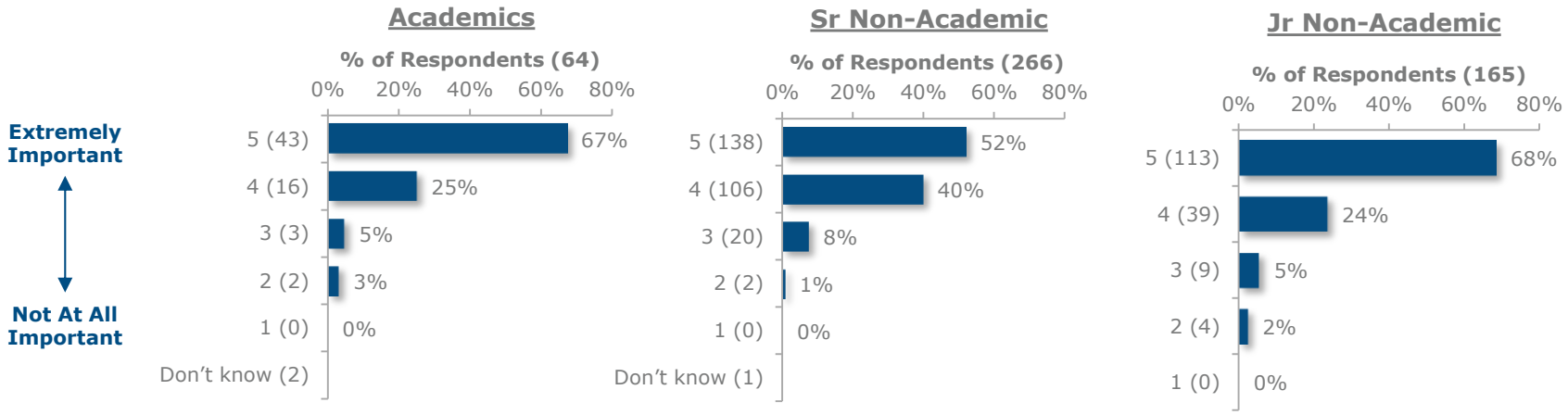
  — While the academic segment placed slightly higher importance on the subject areas investigated compared to the non-academic segment, both almost completely agree on the order of importance.

Areas	Academic Average Importance	Sr Non-Academic Average Importance	Difference
Core chemical engineering sciences	4.78	4.48	-0.30
Engineering and process knowledge	4.65	4.39	-0.26
Math and chemical, physical, and biological sciences	4.35	4.27	-0.08
Co-ops, internships, and/or faculty-supervised research	4.31	3.72	-0.59
Business, leadership, and project management	4.02	3.96	-0.06
Advanced chemical engineering	3.72	3.23	-0.49

  — A recent shift in research interests can be seen among faculty. This has not affected what is being taught thus far, but is predicted to have an impact in the future.

Executive Summary (Cont.)

- **Observations (Cont.):**
  - PhD graduates are viewed as being more prepared for the positions they are hired for compared to BS/MS graduates.
  - Most new hires need some type of additional workplace preparation or training when starting their jobs. This is more true for BS/MS grads than PhD grads.
  - Companies are more likely to hire individuals who have practical experience on their resume.
  - Practical experience is viewed as being extremely or very important to respondents in all segments interviewed. This is particularly true for BS/MS graduates.



  - **However**, very few (12%) recent graduates were required to complete practical experience as part of their degree requirements.

II. OBJECTIVES/ METHODOLOGY

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Objectives

Study Objectives

Overall:

- Obtain opinions on how prepared undergraduates and PhD graduates are for the jobs they are hired for.
- Assess if graduates need more workplace preparation, and in what areas.
- Assess a number of different subject areas in terms of career importance, present level of academic preparedness, and the need for more academic preparation.
- Identify areas of growing career opportunities for chemical engineering graduates.
- Assess the need for practical and/or intern experience for chemical engineering undergraduate students, graduate students and faculty.

Industry

- Assess the importance of recent hires possessing the skills that directly match their position requirements.
- Identify any technical training programs offered to newly graduated hires.

Objectives (Cont.)

Study Objectives (Cont.)

Academic

- Assess the importance of recent hires possessing the skills directly matched to the position.
- Identify additional coursework or other preparation required for non-chemical engineers entering chemical engineering graduate programs.
- Identify preparation provided to faculty who do not have chemical engineering degrees for teaching undergraduate courses.
- Identify what non-academic experience is useful for faculty members.
- Determine if the research interest of faculty limit their interest or ability to teach courses across the curriculum.
- Determine if respondents feel the shift has had an impact on what is being taught to chemical engineers.
- Obtain opinions regarding ABET-process feedback about students preparation upon graduation.

Recent Hires

- Identify areas where recent graduates feel coursework left them unprepared for their current position.
- Identify what type of additional training was needed for their current positions.

Methodology

Pre-Project Planning

- A kickoff meeting was held via conference call on October 23, 2014.
- A draft questionnaire was provided to AIChE on December 4, 2014.
- The questionnaire was approved on December 23, 2014.
- A link was provided for AIChE to test on December 30, 2014.
- The online version of the survey was approved on January 12, 2015.
- Pilot interviews were conducted January 13 thru January 15, 2015.

Database Management

- A database of academic professionals, established professionals, and early career professionals was provided by AIChE.
- The database included approximately 13,088 email addresses.

Data Collection

- A total of 570 surveys were completed online.
- All surveys were completed between January 13 and February 9, 2015.
- Respondents needed to either work in academia or industry to participate.
- Responses were restricted to 100 industry respondents who do not have hiring or management job functions.

Report Preparation

- Data from the surveys was assimilated and prepared for analysis.
- Appropriate charts, tables, and graphs were developed to illustrate the study results.
- A final report was provided to AIChE on February 27, 2015.

III. STUDY RESULTS

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Respondent Profile

Respondents' status determined the line of questions they were asked in the survey. Almost all respondents have a degree in Chemical Engineering or Chemical and Biomolecular Engineering.

570 Respondents Representing a Cross-Section of:

Status

- Work at a university (66) 12%
- Industry, B.S. before 2001 (267) 47%
- Industry, B.S. after 2001 (237) 42%

Level of Education

- Bachelors (260) 46%
- Masters (119) 21%
- Doctorate (191) 34%

Degree Field*

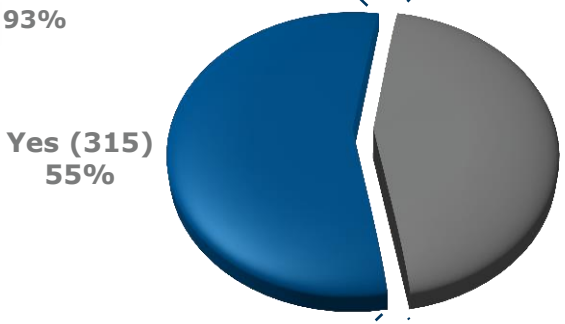
- Chemical Engineering or Chemical and Biomolecular Engineering (537) 94%
- Chemistry (23) 4%
- Other Engineering (20) 4%
- Other Science (11) 2%
- Math (6) 1%
- Biological Engineering or Biomolecular Engineering (2) 0%
- Physics (2) 0%
- Other (9) 2%

*Multiple responses accepted.
( ) = Number of respondents.

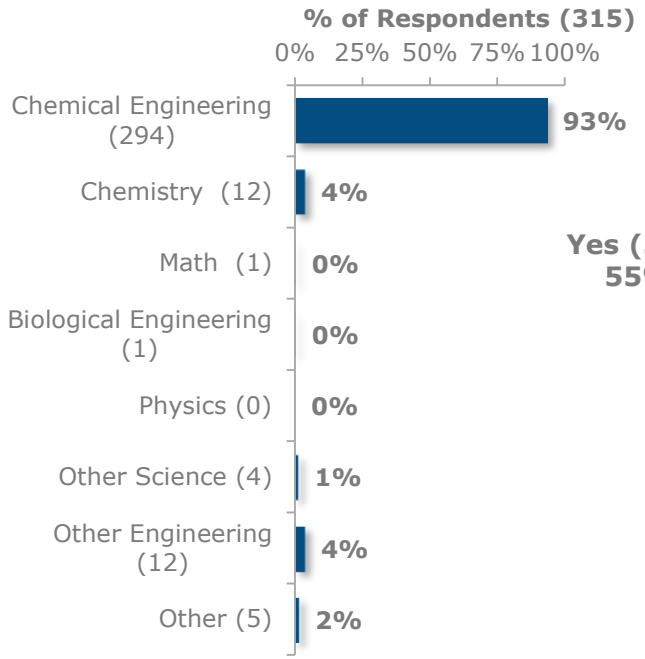
Bachelor's Degree Field

A good split of new and seasoned professionals was obtained. The types of degrees obtained has not changed over the years.

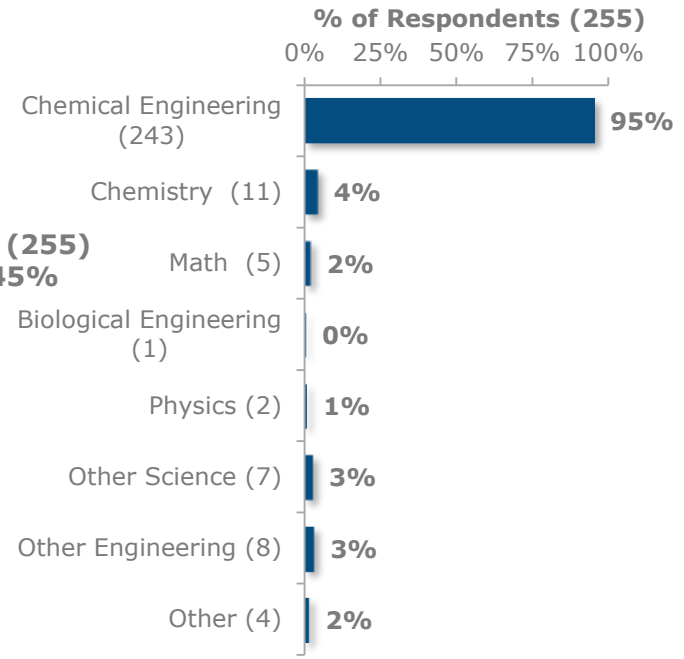
Did you receive your bachelor's degree before 2001?
(570 Respondents)



In what field did you obtain your bachelor's degree?*



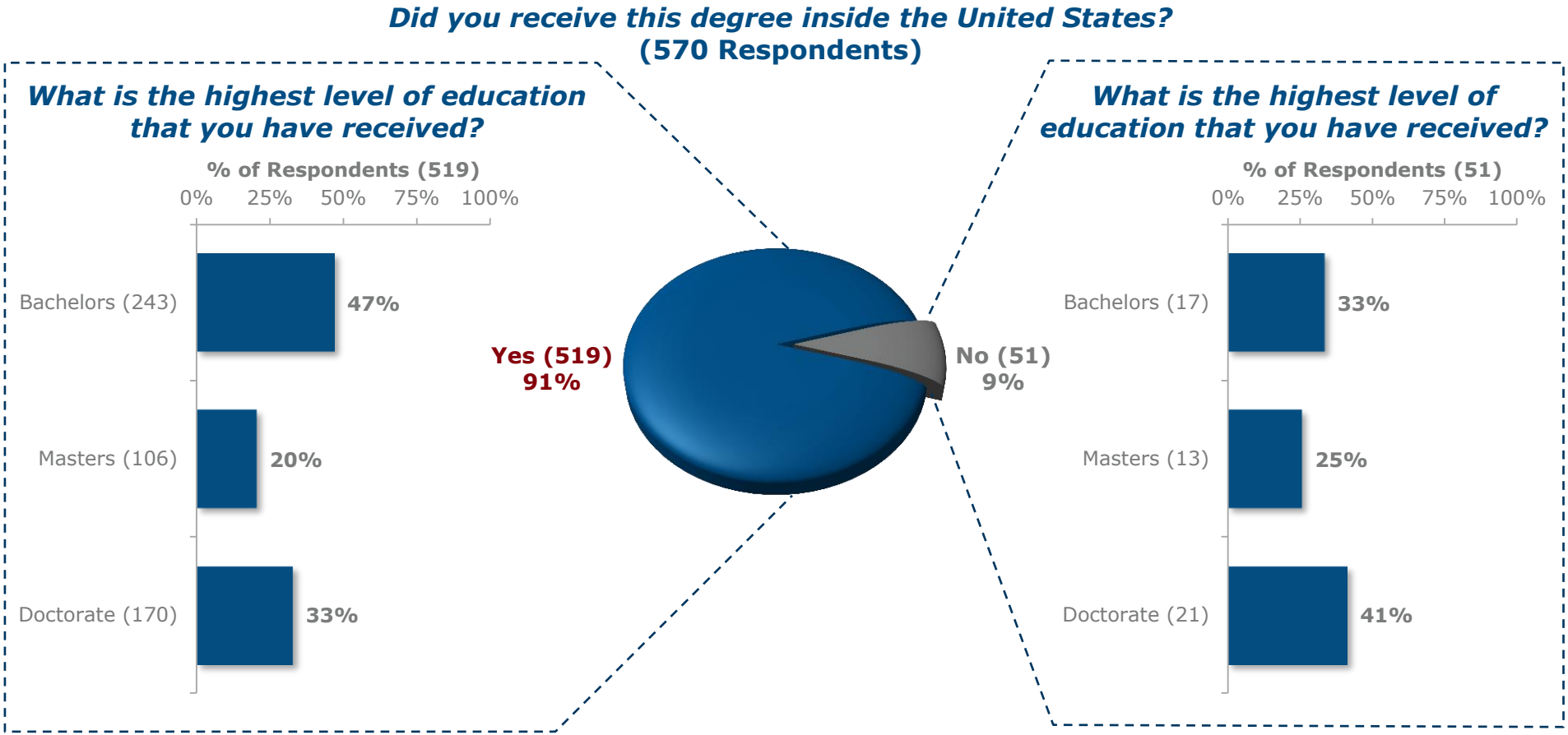
In what field did you obtain your bachelor's degree?*



( ) = Number of respondents or times mentioned. *Multiple responses were accepted.

Education Level Achieved

A large majority of respondents received their degrees within the United States.

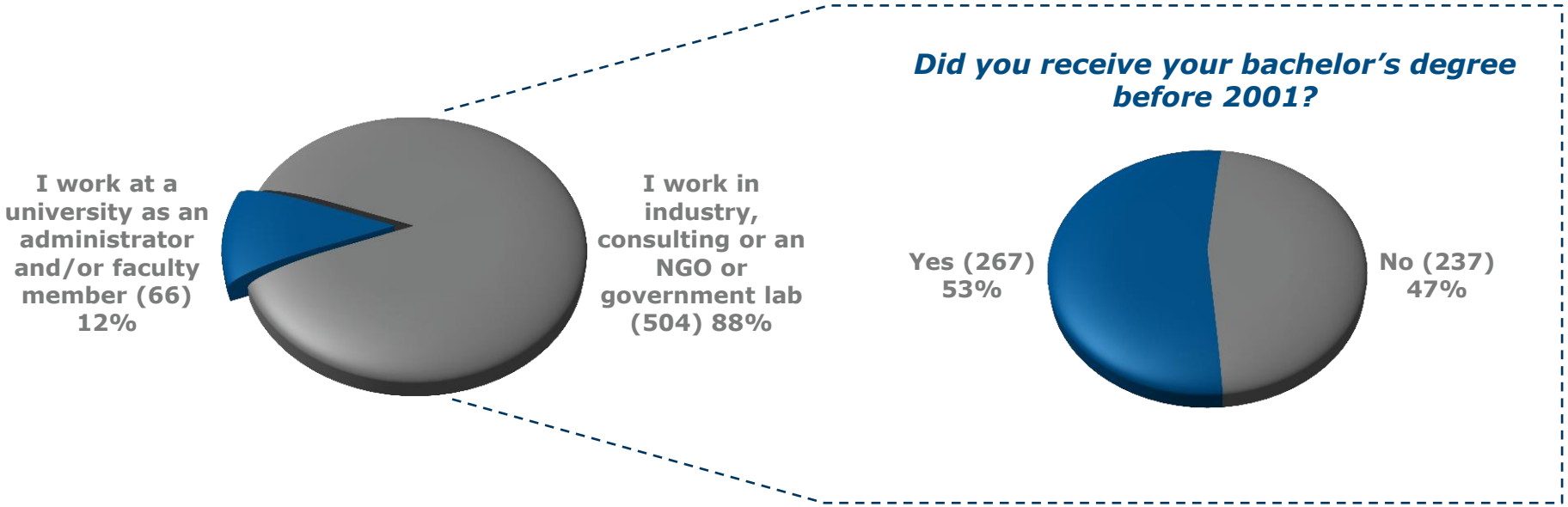


( ) = Number of respondents.

Employment Status

The number of respondents in each category is a direct reflection of the database that was provided to AMG Research.

Which of the following best describes your status?
(570 Respondents)



( ) = Number of respondents.

ACADEMICS

(66 Respondents)

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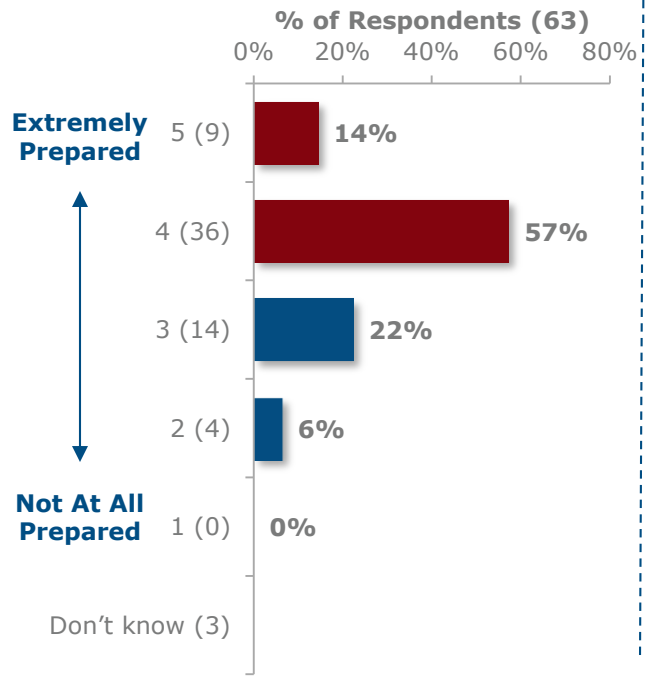
Undergraduate Preparations

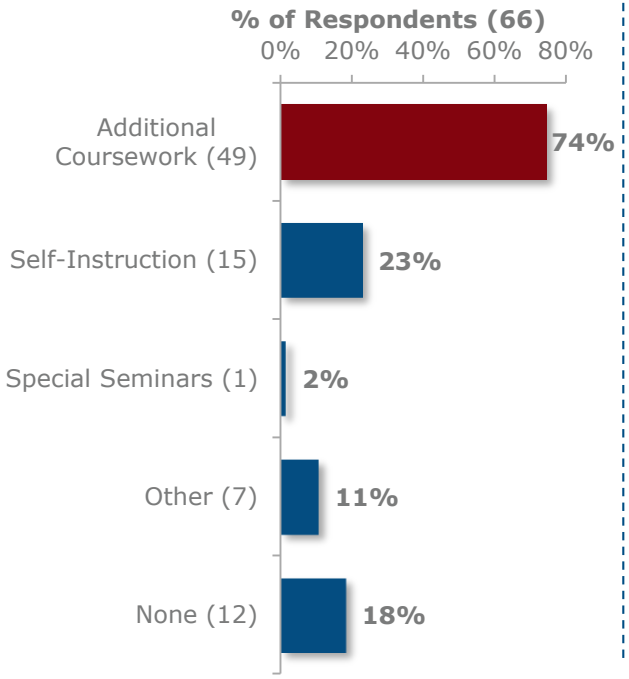
Academics

Respondents feel that undergrads are fairly well prepared for the positions for which they are hired. Additional course work is most likely necessary for a non-chemical engineer who is entering a graduate program. A third of schools do not have faculty who do not have a background in chemical engineering.

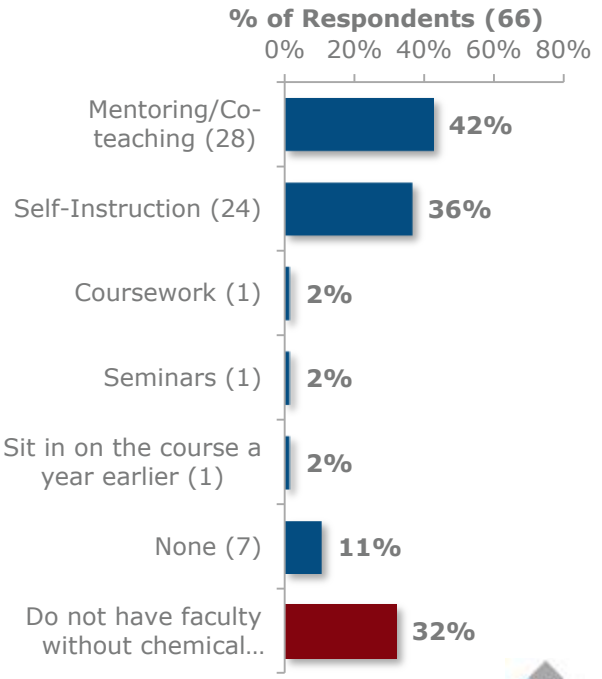
How prepared do you believe today's chemical engineering undergraduates are to meet the needs of the positions for which they are hired? (66 Respondents)



*What preparations do you require for non-chemical engineers entering your graduate program?** (66 Respondents)



*What preparations do you provide for faculty who do not have undergraduate degrees in chemical engineering so they are comfortable with the material?** (66 Respondents)



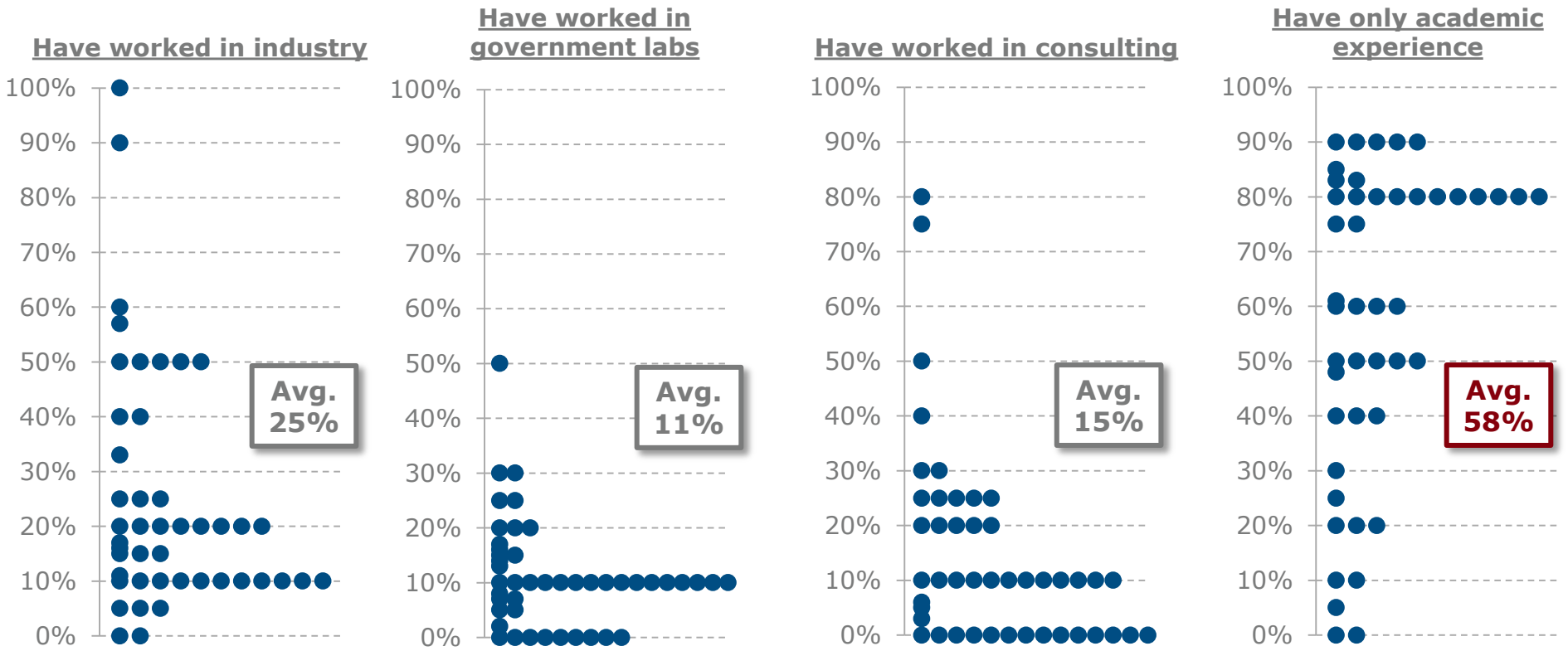
( ) = Number of respondents. *Multiple responses accepted.

Non-Academic Chemical Engineering Experience

Over half of faculty members do not have any non-academic experience. Experience working in industry is most common.

Academics

Approximately what percent of your faculty members have the following non-academic chemical engineering experience?
(45 Respondents)*



*Question asked only to respondents that work at a university with faculty that has non-academic experience.

Most Useful Experience

Industry experience is viewed as the most useful out-of-classroom experience for faculty members.

Academics

What non-academic chemical engineering experience would be/is most useful for your faculty members?
(45 Respondents)*

- **Industry experience (18)**
- Consulting (4)
- Project management (3)
- Advisory board experience (2)
- Design experience (2)
- Internships (2)
- Lab experience (2)
- Out of class experiences (2)
- Analytical training (1)
- International experience (1)
- Process engineering (1)
- Product development (1)
- Technical experience (1)
- None (1)
- Don't know (2)

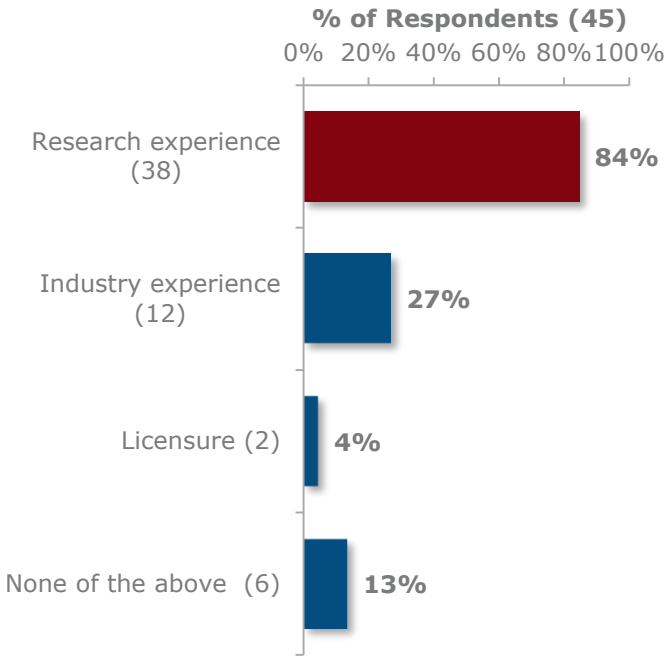
*Question asked only to respondents that work at a university with faculty that has non-academic experience.
( ) = Number of respondents.

Screening Applicants

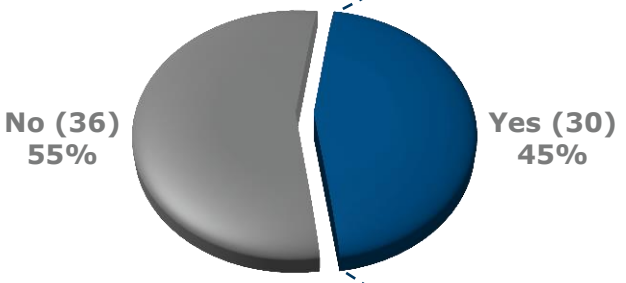
Academics

Research experience plays a huge role in being hired for a faculty position. Almost half of respondents believe research interests limit faculty's ability to teach across the curriculum.

Do you screen applicants for faculty positions based on any of the following?**
(45 Respondents)*



Do you believe the research interests of faculty in your department limit their interest or ability to teach courses across the curriculum?
(66 Respondents)



Why?

- Prefer comfort zone courses (10)
- Lack of multi-field knowledge (6)
- Not seen as a viable funded research area (2)
- A must to achieve tenure (1)
- Different course interest (1)
- Different subject matter (1)
- Lack of interest in subject matter (1)
- Lack of undergrad education (1)
- No incentive to teach other courses (1)
- Researchers can buy out of teaching (1)
- Don't know (1)

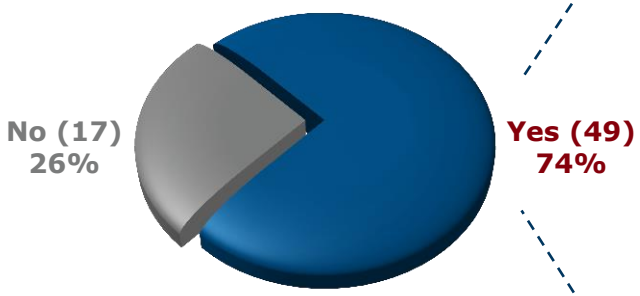
*Question asked only to respondents that work at a university with faculty that has non-academic experience.
( ) = Number of respondents. **Multiple responses accepted.

Institution Shift

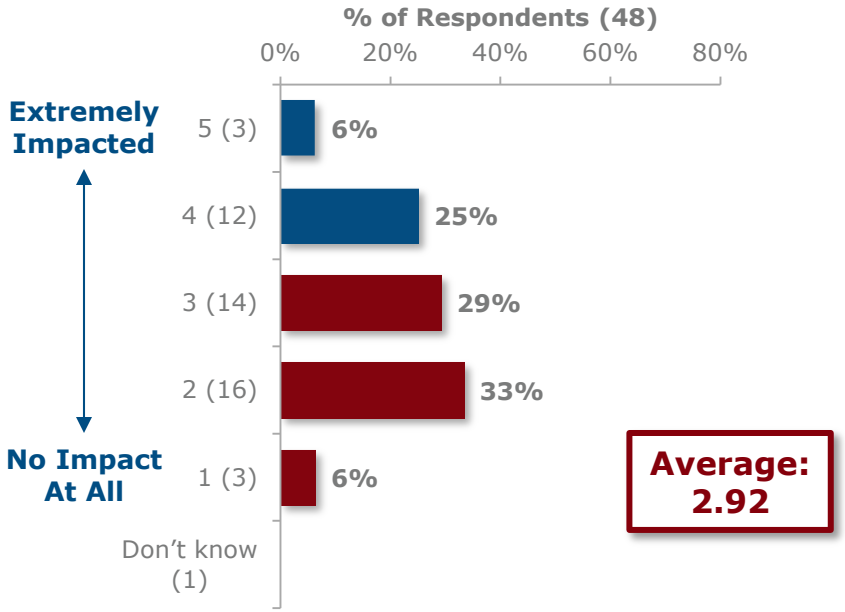
Academics

Three-fourths of those in academics agree that there has been a shift in research interests recently. Those who acknowledge the shift do not feel it has had a huge impact thus far.

Some observers suggest there has been a shift in the research interests of faculty recently. Have you seen a shift at your institution?
(66 Respondents)



How strong an impact do you feel that the recent shift in the research interests of faculty has impacted what is being taught to undergraduate chemical engineering students?



( ) = Number of respondents.

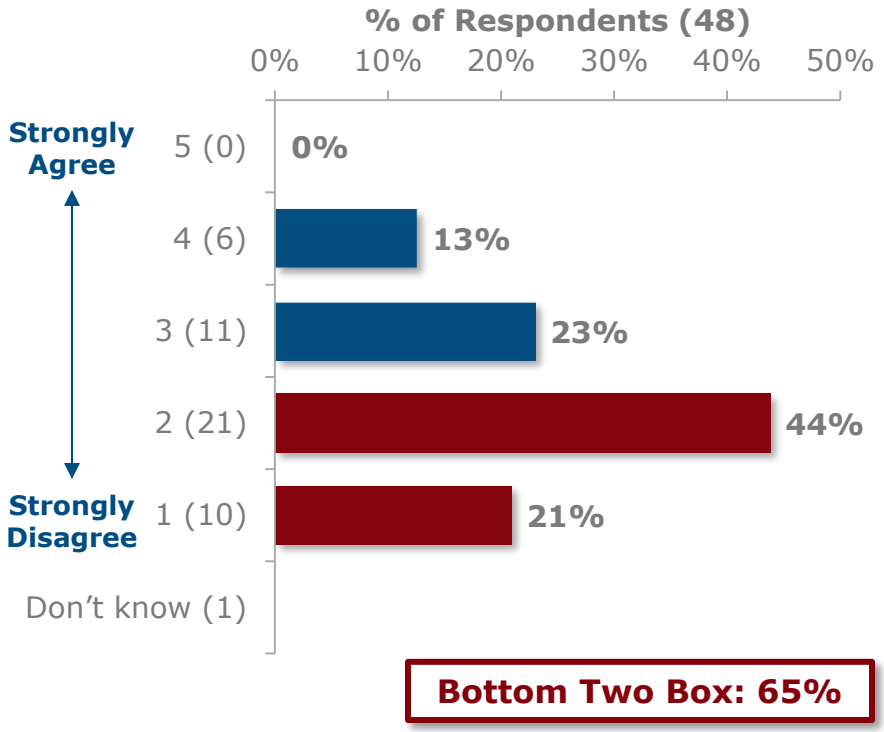
Institution Shift Opinions

Even though there has not been much impact yet, many feel there are going to be changes coming in the future.

Academics

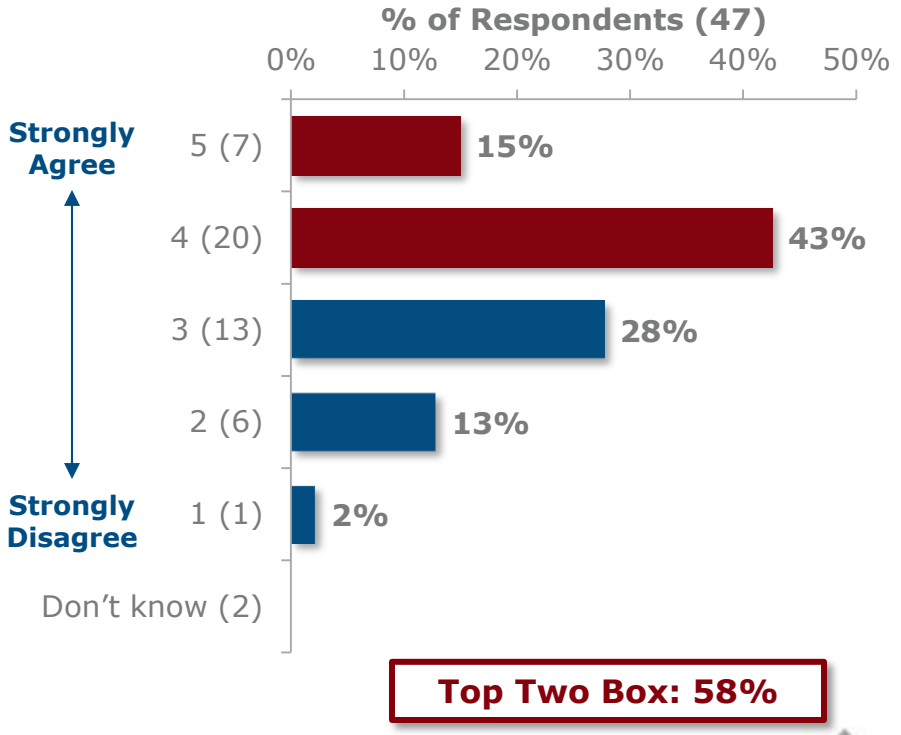
How strongly do you agree with the following statements?
Please use a 5 point scale where 5 = Strongly Agree and 1 = Strongly Disagree.
(49 Respondents)*

The shift in faculty interests is restricted to the short term.



Bottom Two Box: 65%

The shift in faculty interests is indicative of more drastic future changes.



Top Two Box: 58%

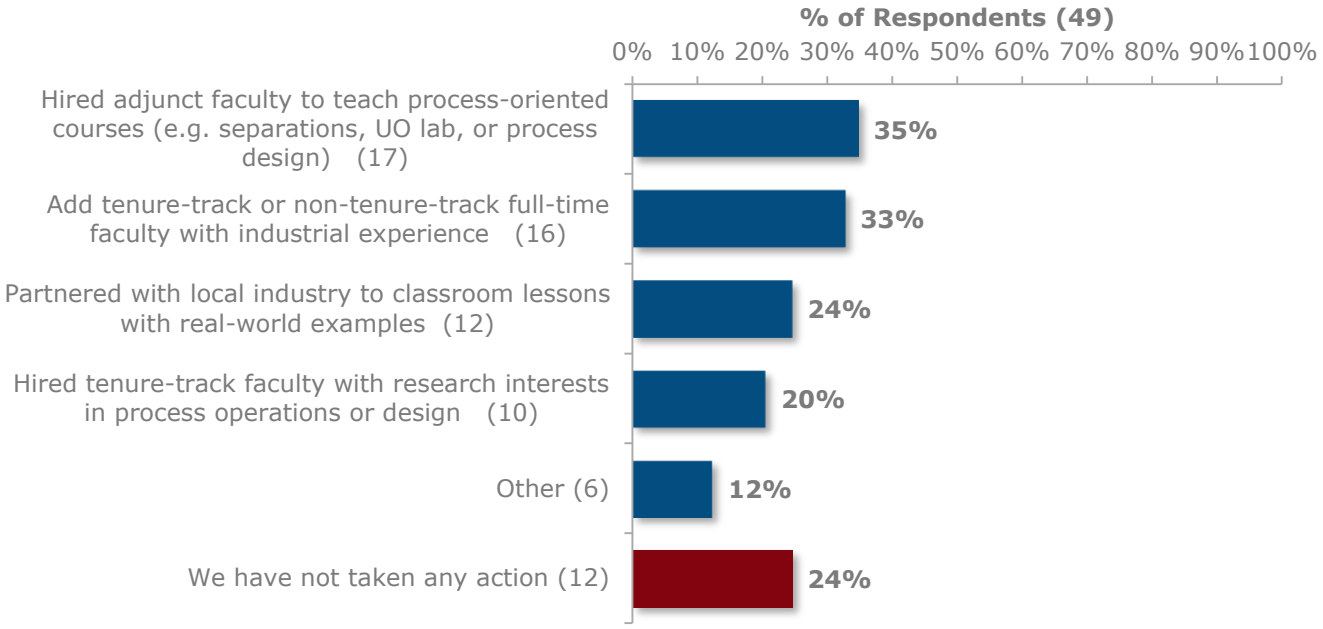
*Questions asked only to respondents who acknowledge a shift in research interests.
( ) = Number of respondents.

Actions Taken

Most (76%) institutions have taken action to accommodate the shift. Hiring adjunct faculty and full time faculty are the most common steps that have been taken.

Academics

Has your institution taken any of the following actions in light of this shift in the past ten years?*
(49 Respondents)**



Other responses include: Add non-tenure-track full-time faculty with research interests in engineering education (1), Hired adjunct faculty to teach courses related to materials, nuclear chemistry, and brewing (1), Hired adjuncts for other courses (1), My university initiated cluster hiring in sustainability, energy, and bioengineering (1), New faculty with specific research areas, with not much thought how they fit into teaching (1), and Seeking role (1).

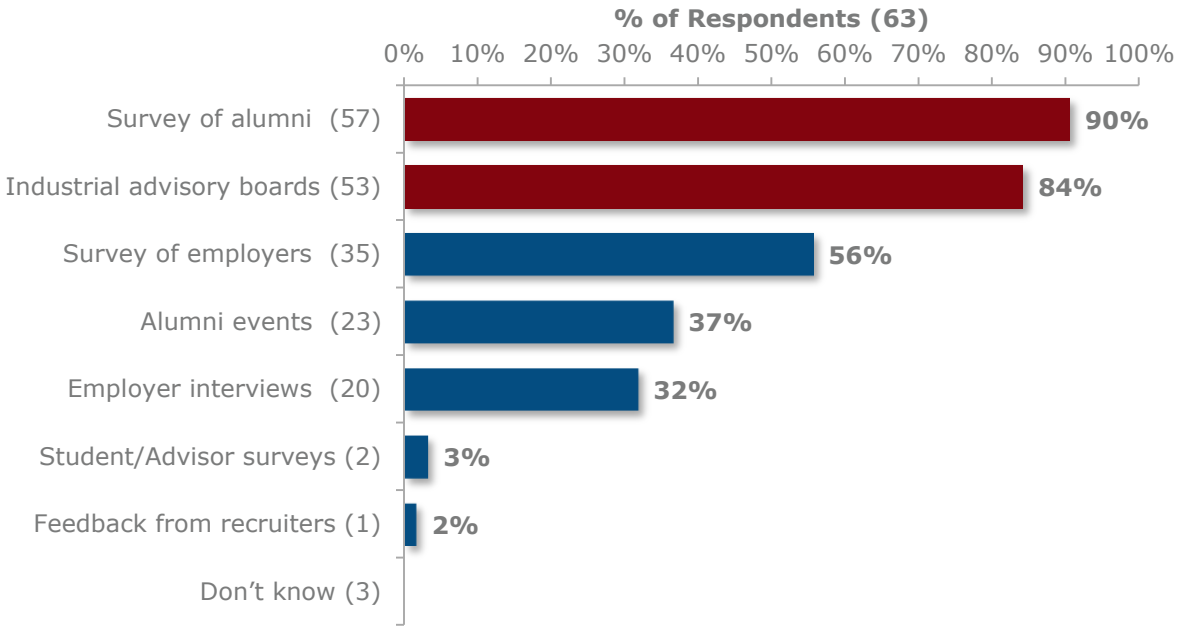
*Actions were shortened to fit in the chart. Please refer to the questionnaire to see full action.
**Questions asked only to respondents who acknowledge a shift in research interests.
( ) = Number of respondents. Multiple responses accepted.

Actions Taken

Almost all institutions either survey alumni or use industrial advisory boards to obtain ABET-process feedback.

Academics

How do you obtain ABET-process feedback from stakeholders about how prepared students are at graduation?
(66 Respondents)



( ) = Number of respondents. Multiple responses accepted.

Subject Area Importance

Academics

All subject areas have some degree of importance – no respondents rated any of them a "1" or not at all important. All subject areas investigated can be classified as extremely, very or somewhat important.

Please rate how important the following subject areas are in terms of career importance. Please use a 5 point scale where 5 = Extremely Important and 1 = Not at All Important.
(66 Respondents)

	Areas*	Importance Ratings 5	4	3	2	1	Average Importance
Extremely Important	Core chemical engineering sciences	80%	18%	2%	-	-	4.78
	Engineering and process knowledge	71%	23%	6%	-	-	4.65
Very Important	Math and chemical, physical, and biological sciences	52%	33%	14%	2%	-	4.35
	Co-ops, internships, and/or faculty-supervised research	51%	34%	11%	5%	-	4.31
	Business, leadership, and project management	26%	53%	18%	3%	-	4.02
Somewhat Important	Advanced chemical engineering	15%	48%	31%	6%	-	3.72

*Subject areas were shortened to fit in the chart. Please refer to the questionnaire to see full text.
( ) = Number of respondents.

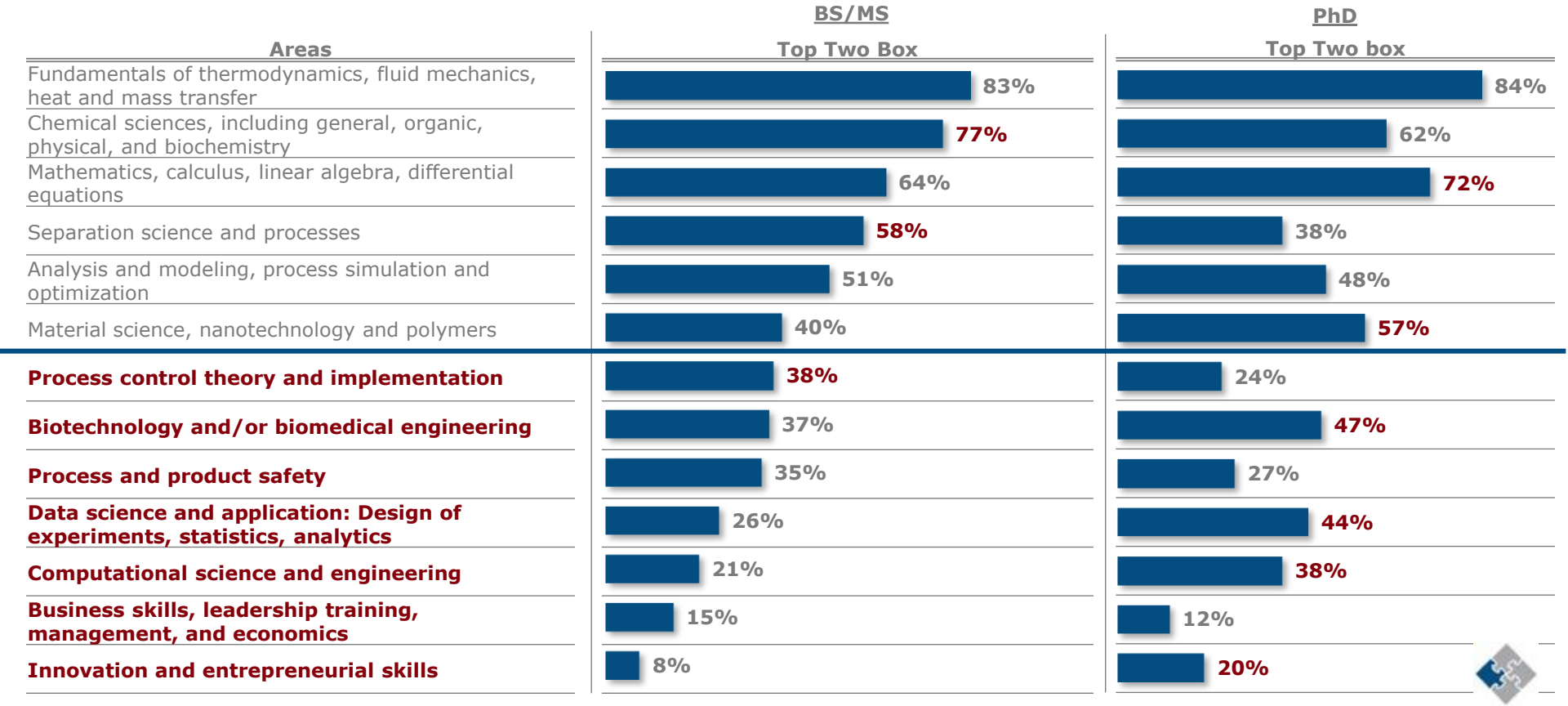
Academic Preparation Opinions

Academics

Less than 50% of respondents feel that many of the current subject areas covered in Chemical Engineering programs prepare students for employment. It is obvious that those in academics feel that some subjects are covered better depending on the level of degree that is being obtained.

How strongly do you agree that present academic preparation for _____ programs addresses the following subject areas relative to employment need? Please use a 5 point scale where 5 = Strongly Agree and 1 = Strongly Disagree.

(66 Respondents)



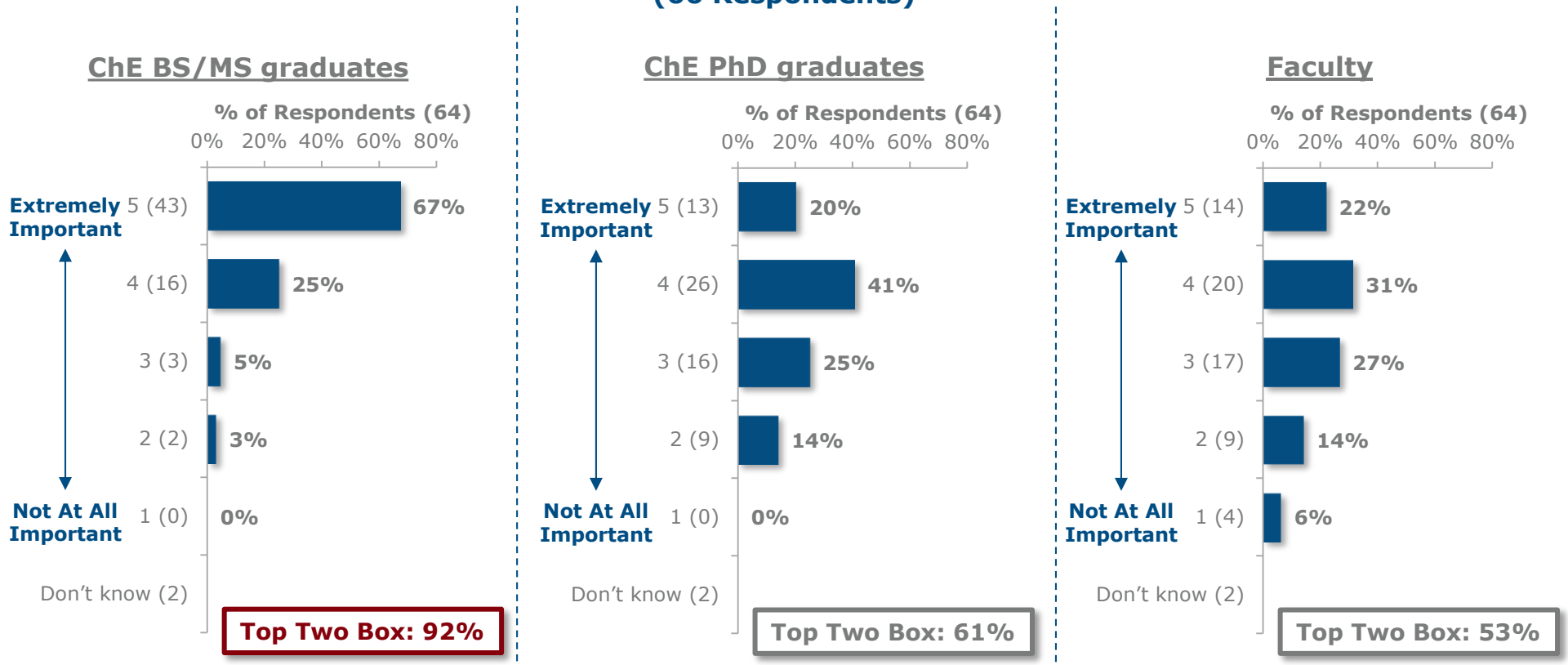
Practical Experience Importance

Practical experience is viewed as being most important for bachelors/masters students.

Academics

How important is practical experience (e.g., internships, co-ops, prior technical jobs) for chemical engineering BS/MS graduates, PhD graduates, and faculty? Please use a 5 point scale where 5 = Extremely Important and 1 = Not At All Important.

(66 Respondents)



( ) = Number of respondents.

Reasons for Practical Experience Importance

Some respondents do not feel practical experience is necessary because graduates will get on the job training.

Academics

Why do you feel practical experience is not important for BS/MS graduates, PhD graduates, and faculty?*

ChE BS/MS graduates (2)

- *Companies will train entry-level engineers and teach them everything else they need to know…*
- *Practical experience from observation seems to be limited to learning the operational culture of each company. Students never return with improved thinking, lab skills, or knowledge. Research internships should be limited to students that will pursue R&D careers, and should be determined through individual interviews and discussion…*

ChE PhD graduates (9)

- *Important for BS/MS. Not so much for PhD who will be trained by their employers….*
- *They'll get once they start work…*
- *They are already adequately prepared for on-the-job education.*
- *Most of the research at the PhD level is supported by NSF, NIH and DOE. Although there are programs that involve industrial partnerships and experience, it is not necessary for all students…Practical experience is important to some, but those will likely work on a project with this aspect.*
- *People who pursued a PhD should focus on R&D careers. Internships may be more useful for these, as long as they occur in R&D oriented environments…*
- *PhD graduates may be hired based on specific expertise rather than on industrial or other practical experience. Practical experience is a bonus, not a requirement in many cases.*
- *Purpose of PhD is to generate new knowledge while training for fundamental research. Industrial experience can impose a paradigm on the student's approach…*

Faculty (13)

- *For faculty it is not important…They can learn on the job…*
- *Given the country-wide reduction in course hours for a BS degree, the academic focus appears to be on the core science and engineering skills for BS graduates…*
- *It is less important for faculty and PhD graduates than for BS/MS graduates.*
- *It is useful for faculty, but should not be mandatory*
- *…The one area that may be improved by industrial experience would be to expose the instructors charged with process safety education to many short mini-internships…*
- *Modern ChE research is increasingly less industrially focused and more fundamental, oftentimes overlapping with chemistry and physics departments…*
- *Most faculty have not held industry jobs prior to faculty jobs…Since many are only interested in their research area for teaching, they have no desire to teach or have skills in the process design area.*
- *It's not the fundamental underpinnings of what they do.*
- *Research productivity and creativity are most important.*

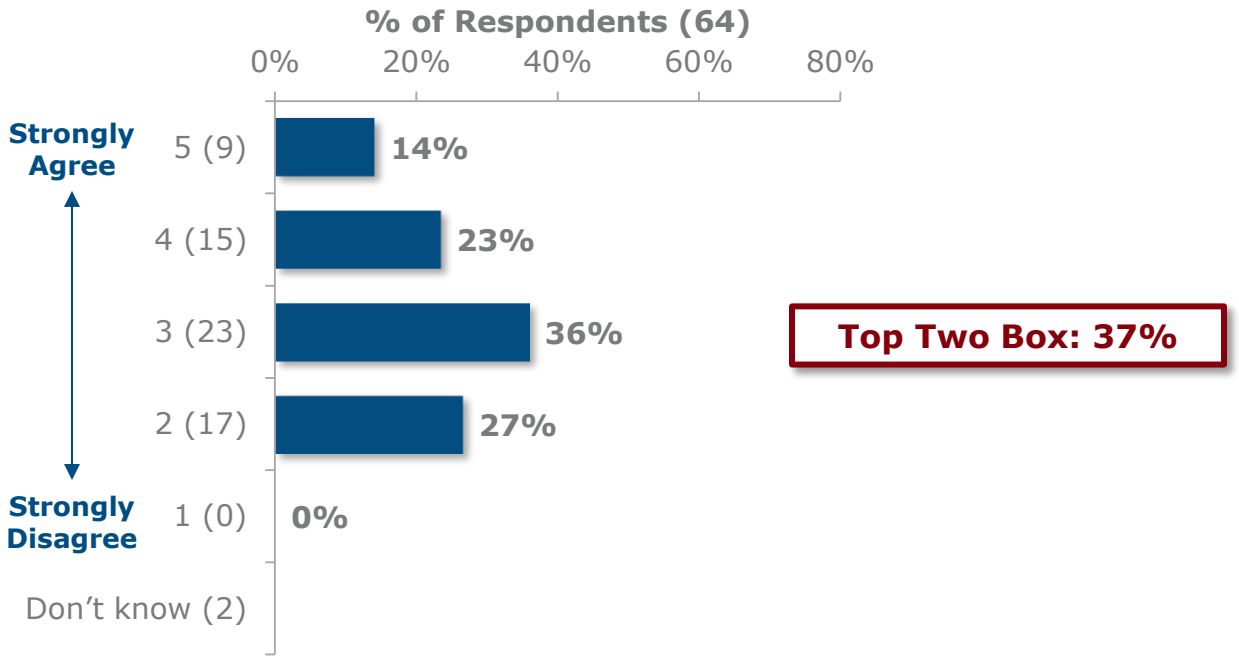
*Question asked only to respondents who rated practical experience importance a "2" or "1". ( ) = Number of respondents.

Academic Preparedness Opinions

There is not a huge push for more workplace preparation for BS/MS students; only about a third of respondents feel this is necessary.

How strongly do you agree with the following statements?
Please use a 5 point scale where 5 = Strongly Agree and 1 = Strongly Disagree.
(66 Respondents)

The BS students graduating from your institution need more workplace preparation.



( ) = Number of respondents.

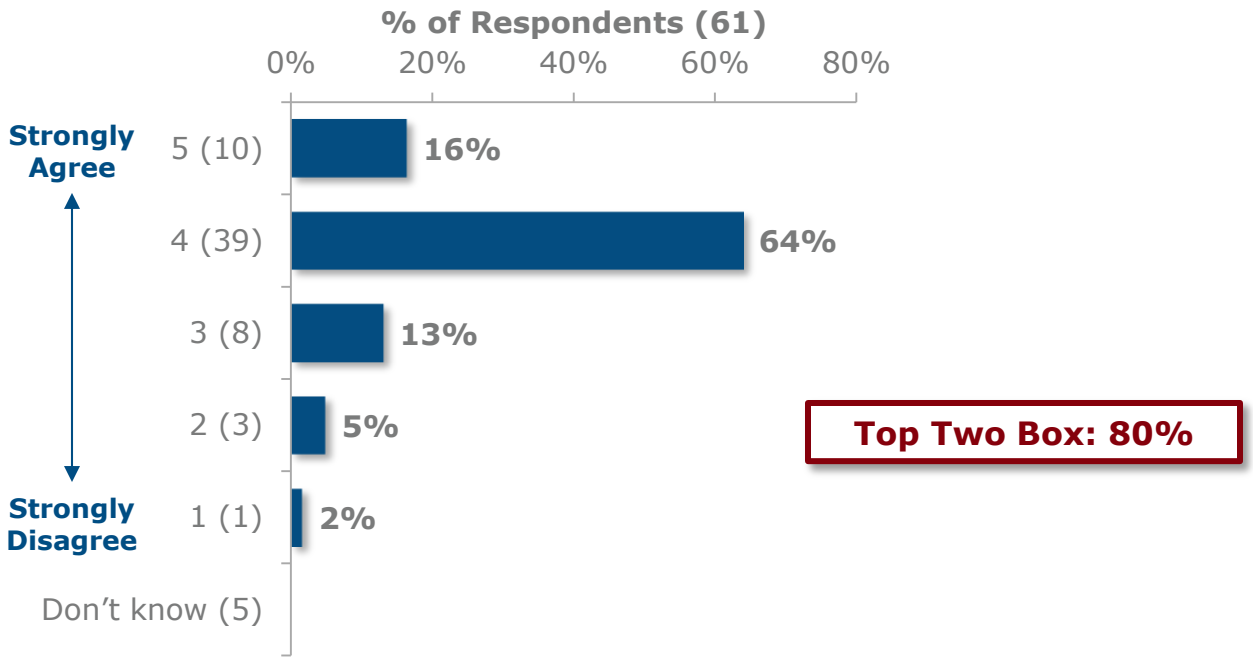
Academic Preparedness Opinions

A large majority of respondents feel that PhD graduates are prepared for the positions they are hired for.

Academics

How strongly do you agree with the following statements?
Please use a 5 point scale where 5 = Strongly Agree and 1 = Strongly Disagree.
(66 Respondents)

Your institution's PhD graduates are prepared to meet the needs of the positions they are hired for.



( ) = Number of respondents.

SENIOR NON-ACADEMIC (Bachelor's before 2001)

(267 Respondents)

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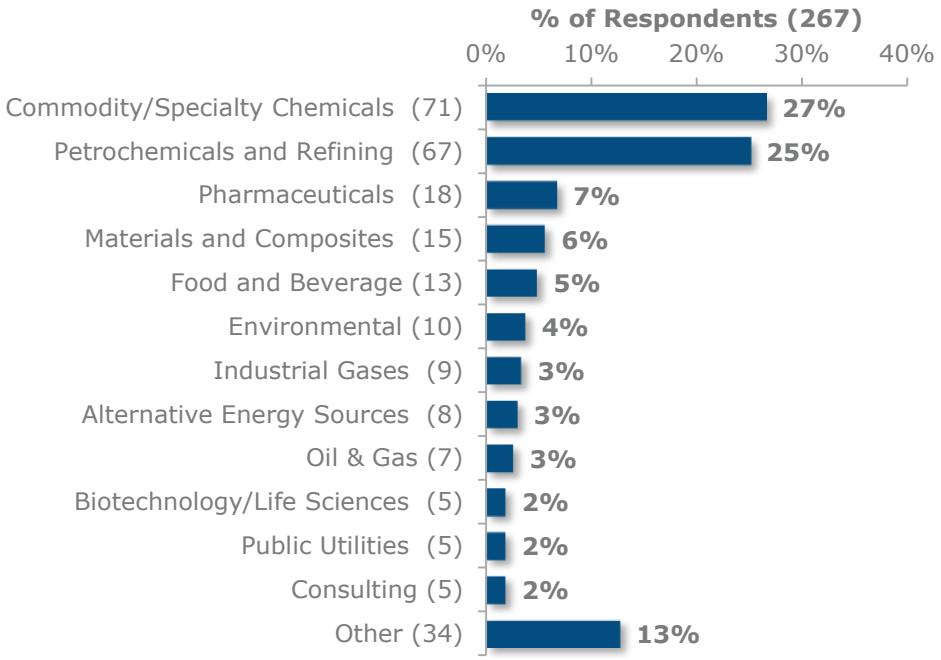
Sectors

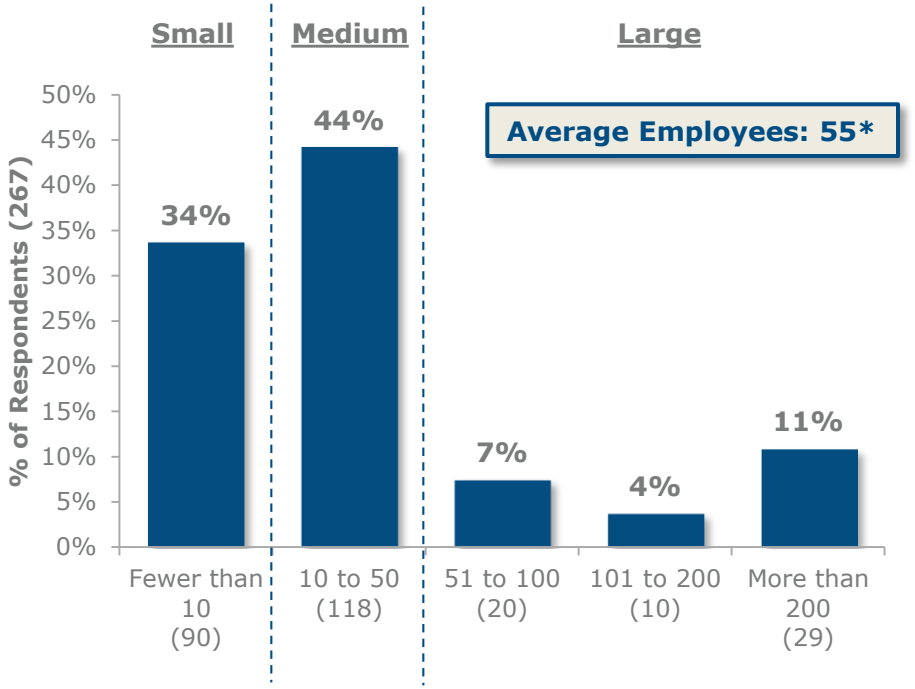
Those in industry cover a wide variety of sectors. Most work in small- to medium-sized engineering departments.

Sr Non-Academic

Which of the following best describes the sector you work in?
(267 Respondents)



Approximately how many employees make up your department's engineering staff?
(267 Respondents)



Others include: Equipment (4), Multiple (4), Energy (3), Agribusiness (2), Consumer Products (2), Engineering (2), Government (2), Medical Device (2), Semiconductors (2), Biomaterials (1), Electronics (1), Flooring (1), Insurance (1), Investments (1), Materials Characterization (1), Metals (1), Nuclear waste management (1), Polysilicon (1), Research (1), and Simulation Software (1).

*Average does not include mentions of 1,000 (1), 1,200 (1), 1,500 (1), 1,800 (1), 2,000 (2), 2,300 (1), and 5,000 (1).

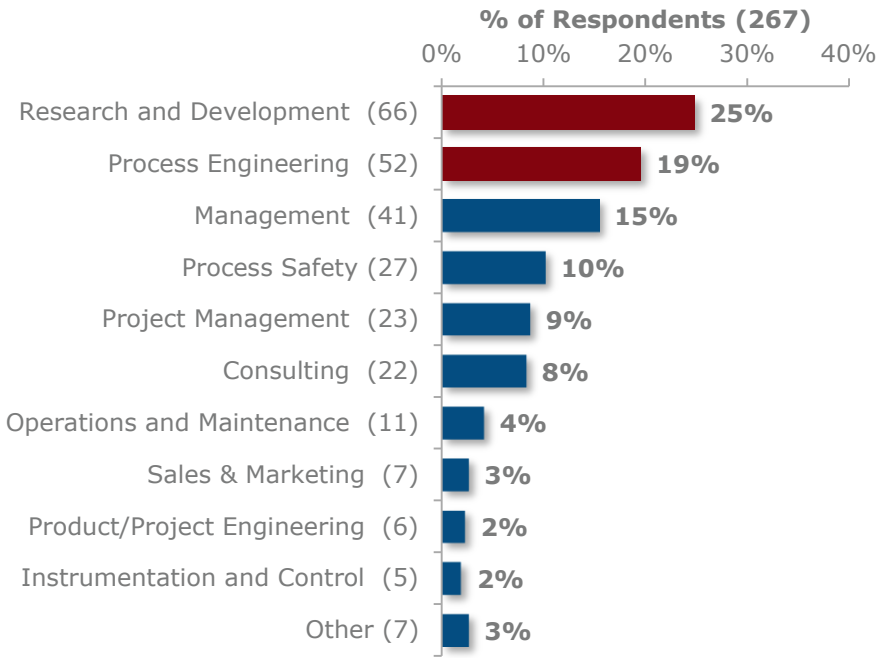
( ) = Number of respondents.

Job Function

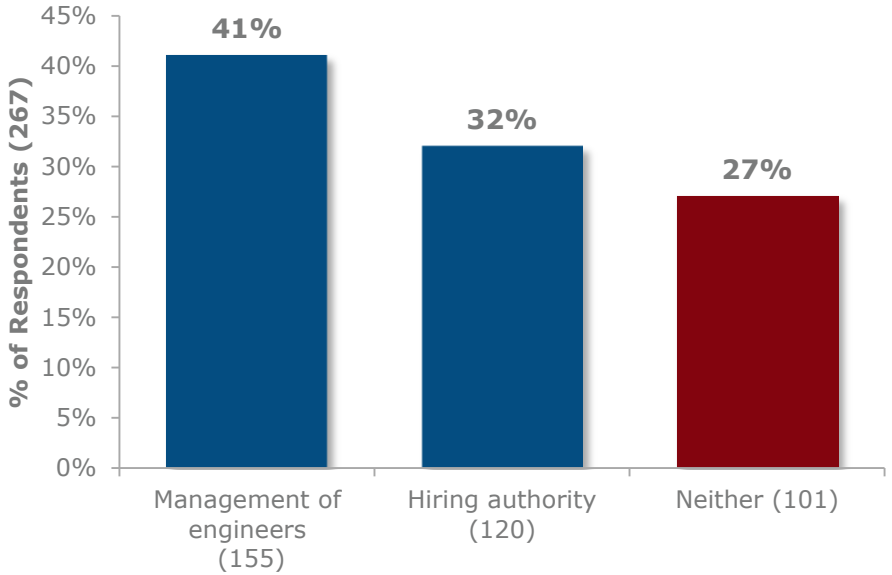
Sr Non-Academic

Research and Development and Process Engineers make up almost half of the industry people interviewed. The number of respondents who neither manage or hire engineers was limited to 100 responses.

Which of the following best describes your job title/function?
(267 Respondents)



Do your job functions include either of the following?
(267 Respondents)



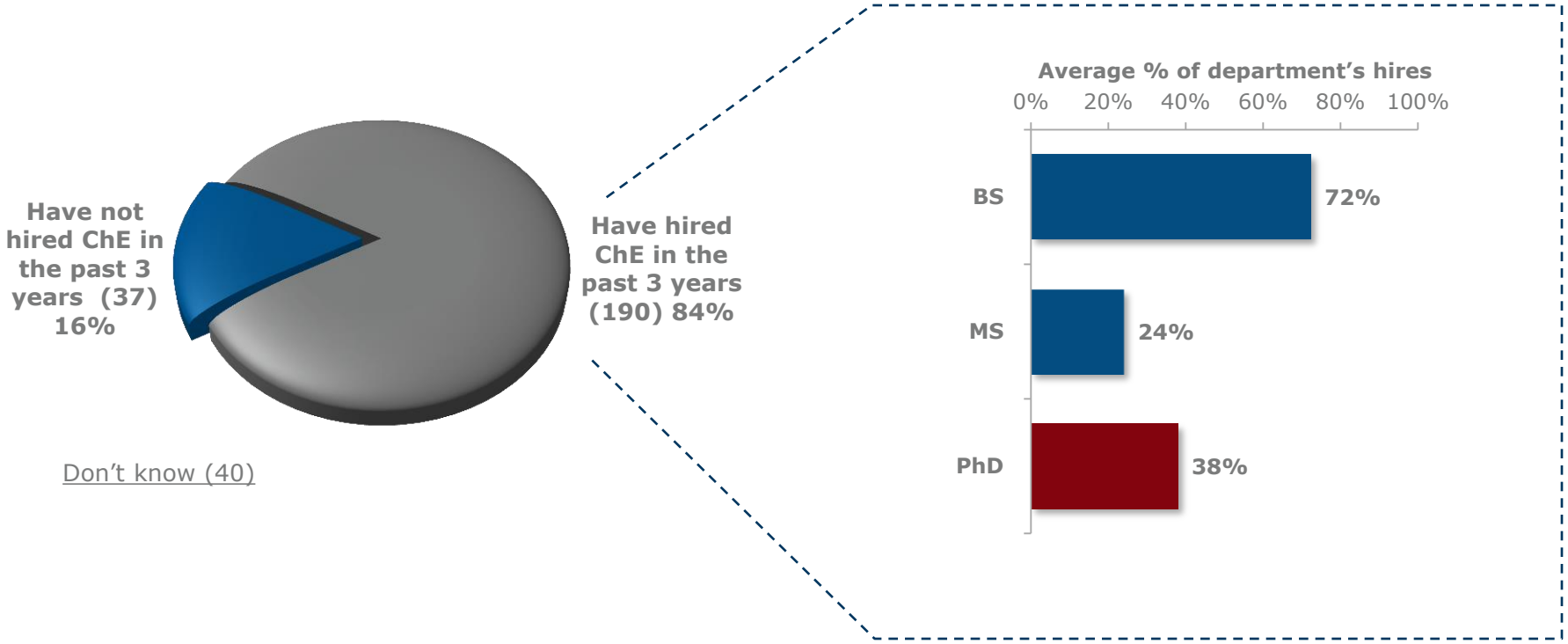
Others include: Economist (1), Systems Engineer/IT (1), Multiple (1), Patents/Intellectual Property (1), Proprietor (1), Quality Assurance (1), and Technical Specialist (1).
( ) = Number of respondents.

Department Hire Degrees

Over a third of those recently hired in industry have a doctorate degree.

Sr Non-Academic

Approximately, what percent of the following degree levels make up your department's hires of chemical engineers in the past 3 years?
(267 Respondents)



( ) = Number of respondents.

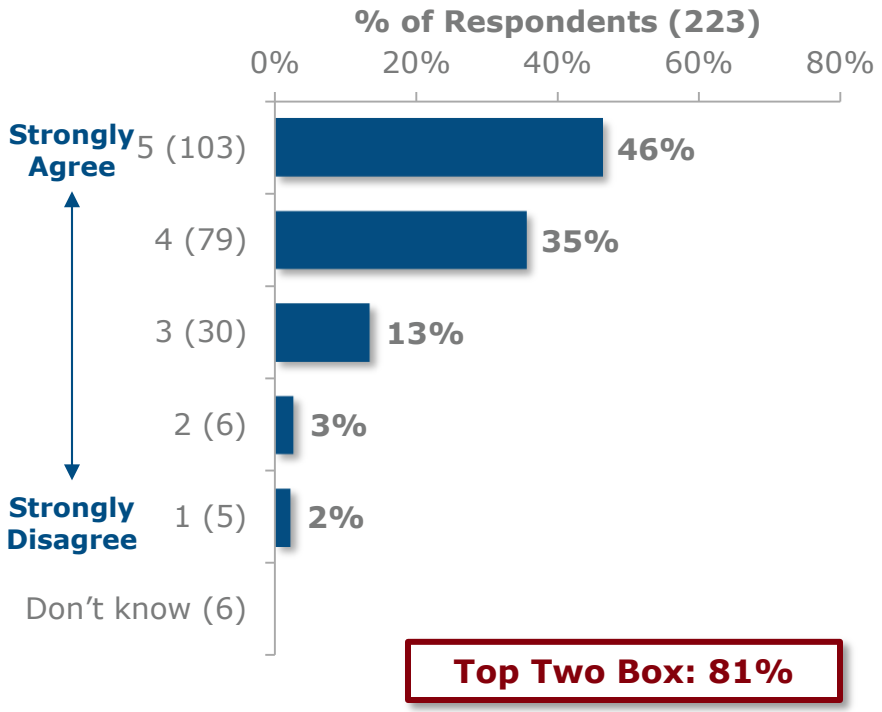
Academic Preparedness Opinions

Having practical experience gives candidates an edge when applying for a job in Chemical Engineering.

Sr Non-Academic

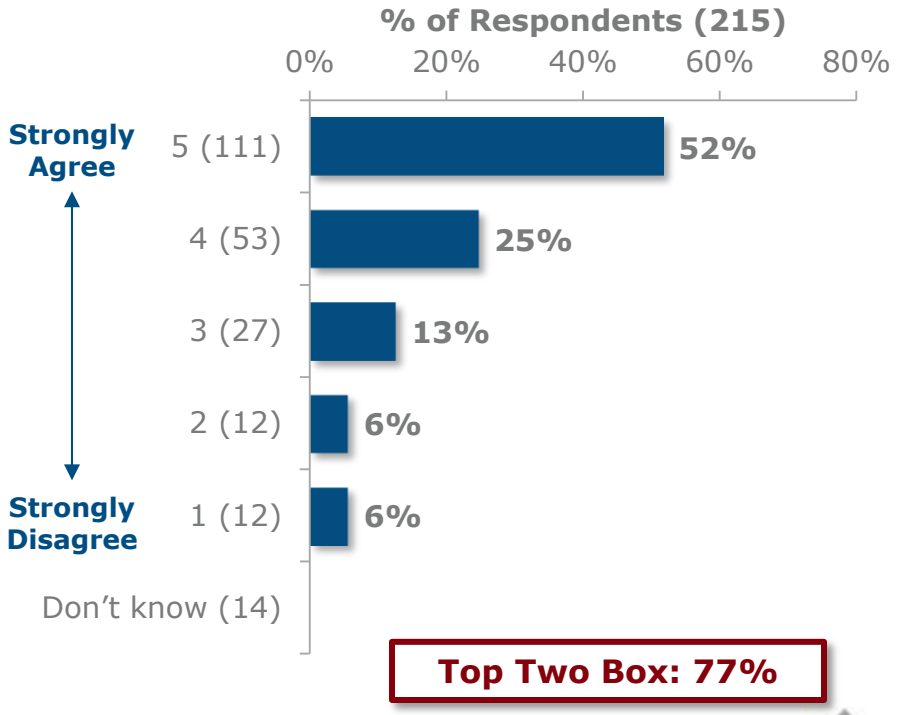
How strongly do you agree with the following statements?
Please use a 5 point scale where 5 = Strongly Agree and 1 = Strongly Disagree.
(229 Respondents)*

We are more likely to hire chemical engineers who have completed internships, co-ops, or other technical jobs.



Top Two Box: 81%

We are more likely to hire chemical engineers who have completed internships, co-ops, or other technical jobs inside our company.



Top Two Box: 77%

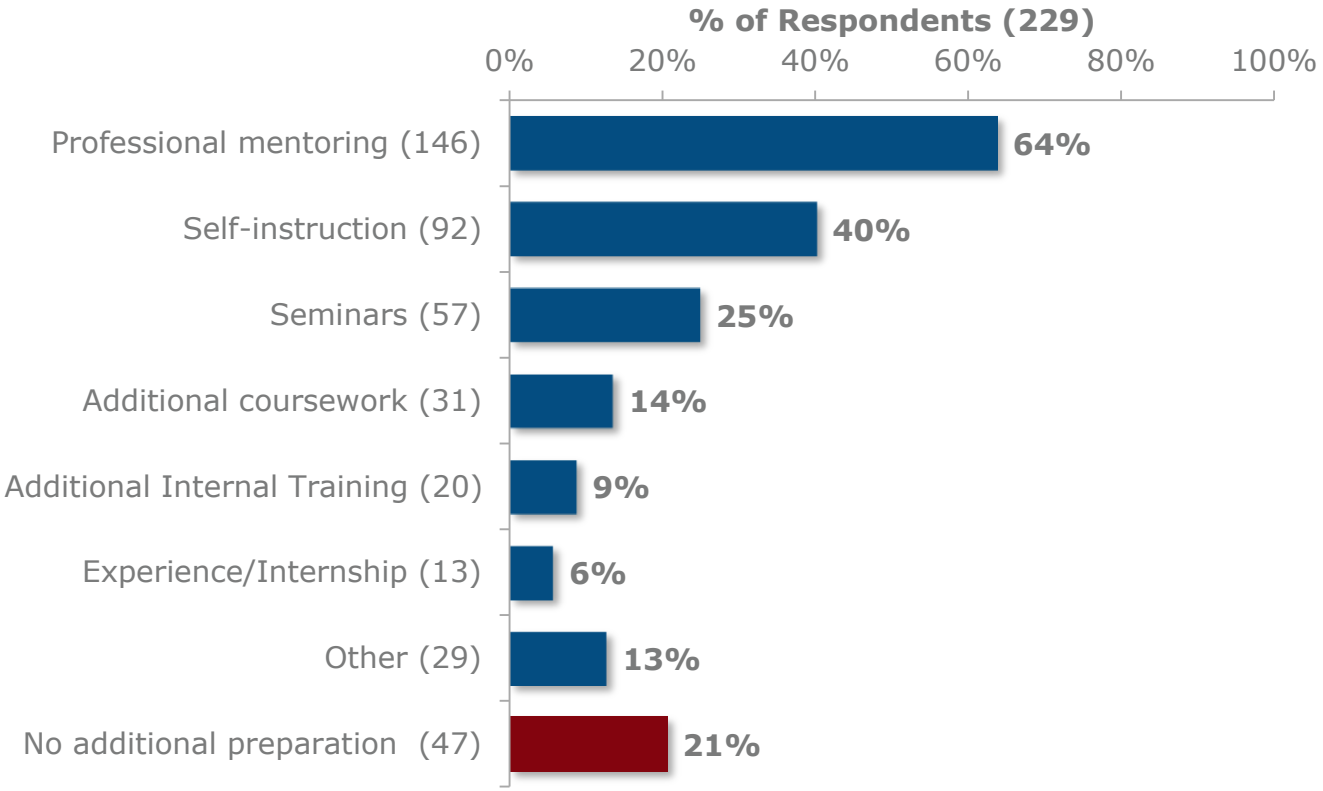
*Question asked only to non-academic respondents who have hired chemical engineers in the past three years.
( ) = Number of respondents. Multiple responses accepted.

Additional Preparation Needed

About 80% of new hires needed some type of additional workplace preparation. Professional mentoring and self-instruction are the two most common types.

Sr Non-Academic

What types of additional workplace preparation, if any, did your new hires (past 3 years) need?
(229 Respondents)*



*Question asked only to non-academic respondents who have hired chemical engineers in the past three years.
( ) = Number of respondents.

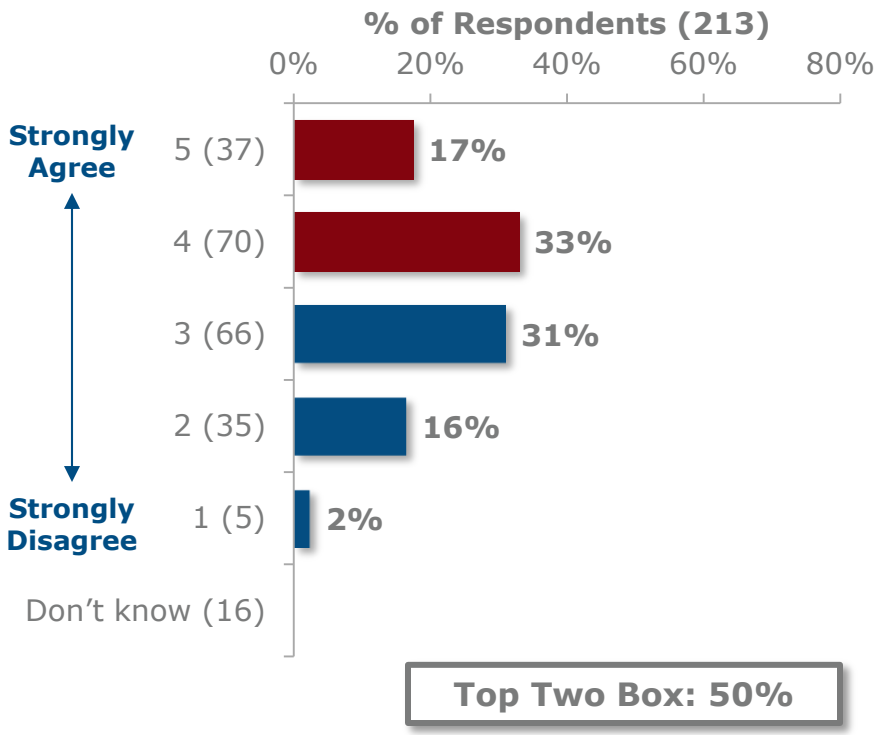
Academic Preparedness Opinions

While PhD graduates are viewed as being more prepared than BS/MS grads, there is still a number of respondents who feel they need more preparation.

Sr Non-Academic

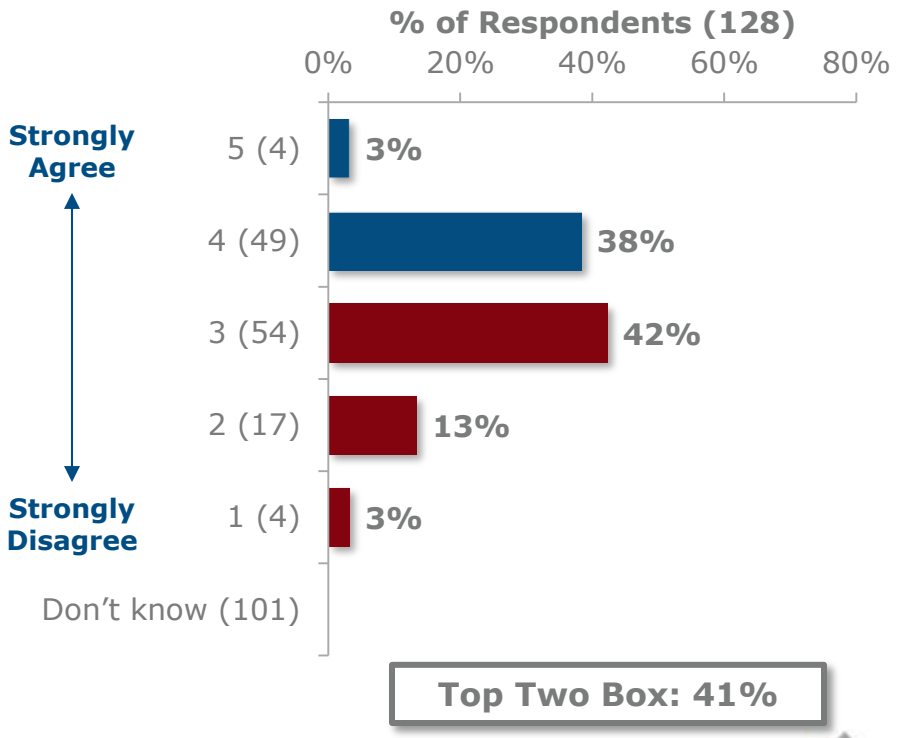
How strongly do you agree with the following statements?
Please use a 5 point scale where 5 = Strongly Agree and 1 = Strongly Disagree.
(229 Respondents)*

Recently hired BS/MS graduates need more workplace preparation.



Top Two Box: 50%

Recently hired PhD graduates are prepared to meet the needs of the positions they are hired for.



Top Two Box: 41%

*Question asked only to non-academic respondents who have not hired chemical engineers in the past three years.
( ) = Number of respondents.

Position Skill Importance

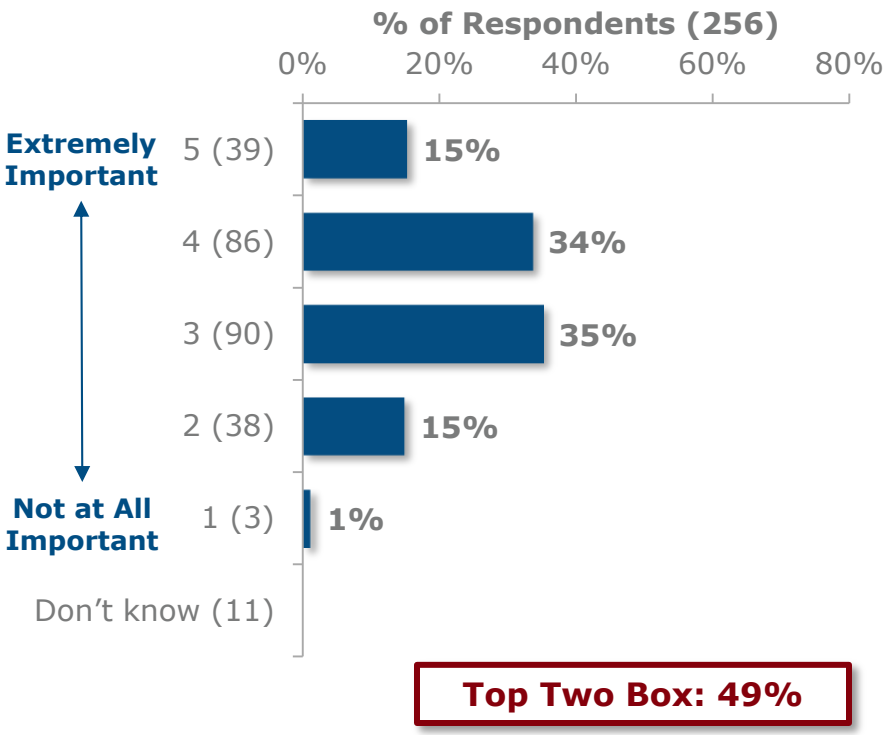
As would be expected, expectations are slightly higher for PhD graduates.

Sr Non-Academic

For each degree level, please indicate how important you believe it is for job candidates to possess the skills that directly match the position description. Please use a 5 point scale where 5 = Extremely Important and 1 = Not At All Important.

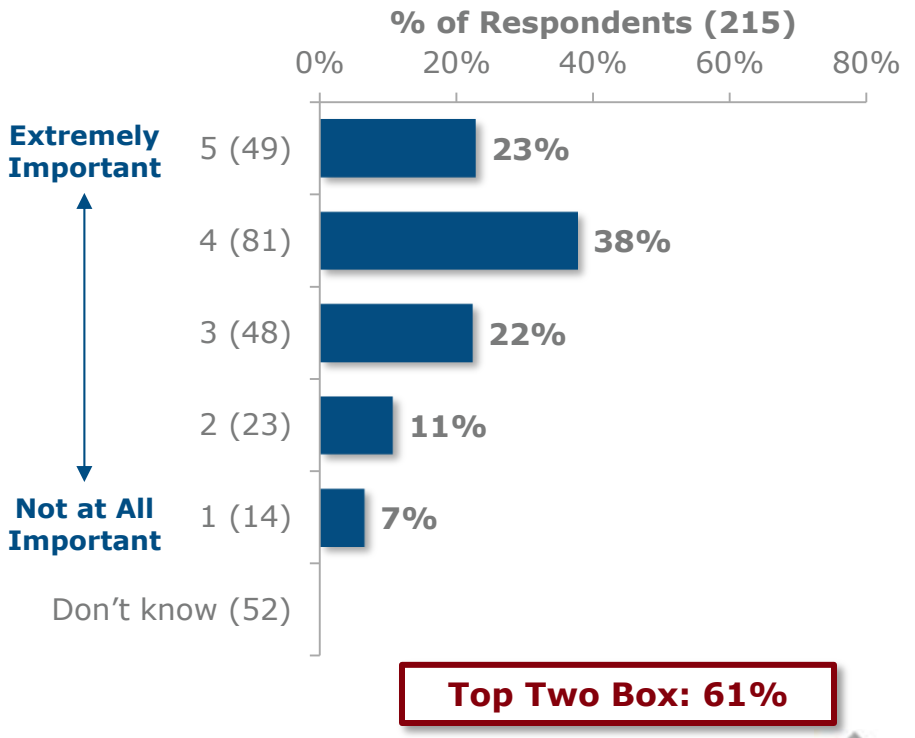
(267 Respondents)

ChE BS/MS graduates



Top Two Box: 49%

ChE PhD graduates



Top Two Box: 61%

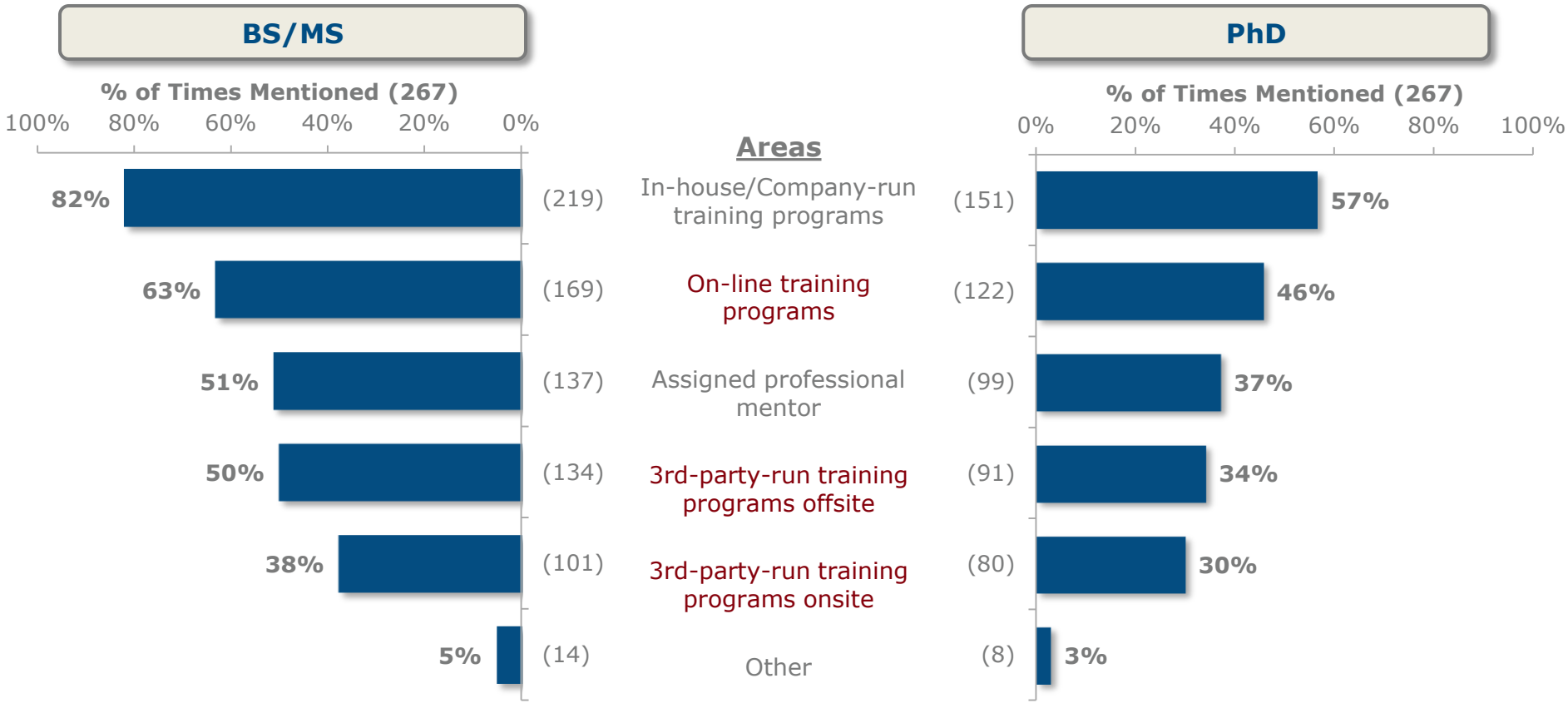
( ) = Number of respondents.

Offered Training Programs

More training is offered to BS/MS graduates than PhD graduates. Many locations take advantage of outsourcing some of this training to third parties or online sources.

Sr Non-Academic

For each degree level, what technical training programs, if any, do you offer for newly graduated hires?
(267 Respondents)



( ) = Number of respondents. Multiple responses accepted.

Subject Area Importance

Those in industry would rank the main chemical engineering subject areas as most important, followed by the business oriented subject areas, and lastly advanced chemical engineering, which has pretty low importance.

Sr Non-Academic

Please rate how important the following subject areas are in terms of career importance. Please use a 5 point scale where 5 = Extremely Important and 1 = Not at All Important.
(267 Respondents)

Subject Areas	Importance Ratings 5	4	3	2	1	Average Importance
Core chemical engineering sciences	62%	28%	8%	1%	1%	4.48
Engineering and process knowledge	53%	35%	9%	2%	-	4.39
Math and chemical, physical, and biological sciences	45%	38%	15%	2%	-	4.27
Business, leadership, and project management	30%	42%	22%	5%	1%	3.96
Co-ops, internships, and/or faculty-supervised research	22%	38%	32%	7%	2%	3.72
Advanced chemical engineering	12%	25%	40%	18%	5%	3.23

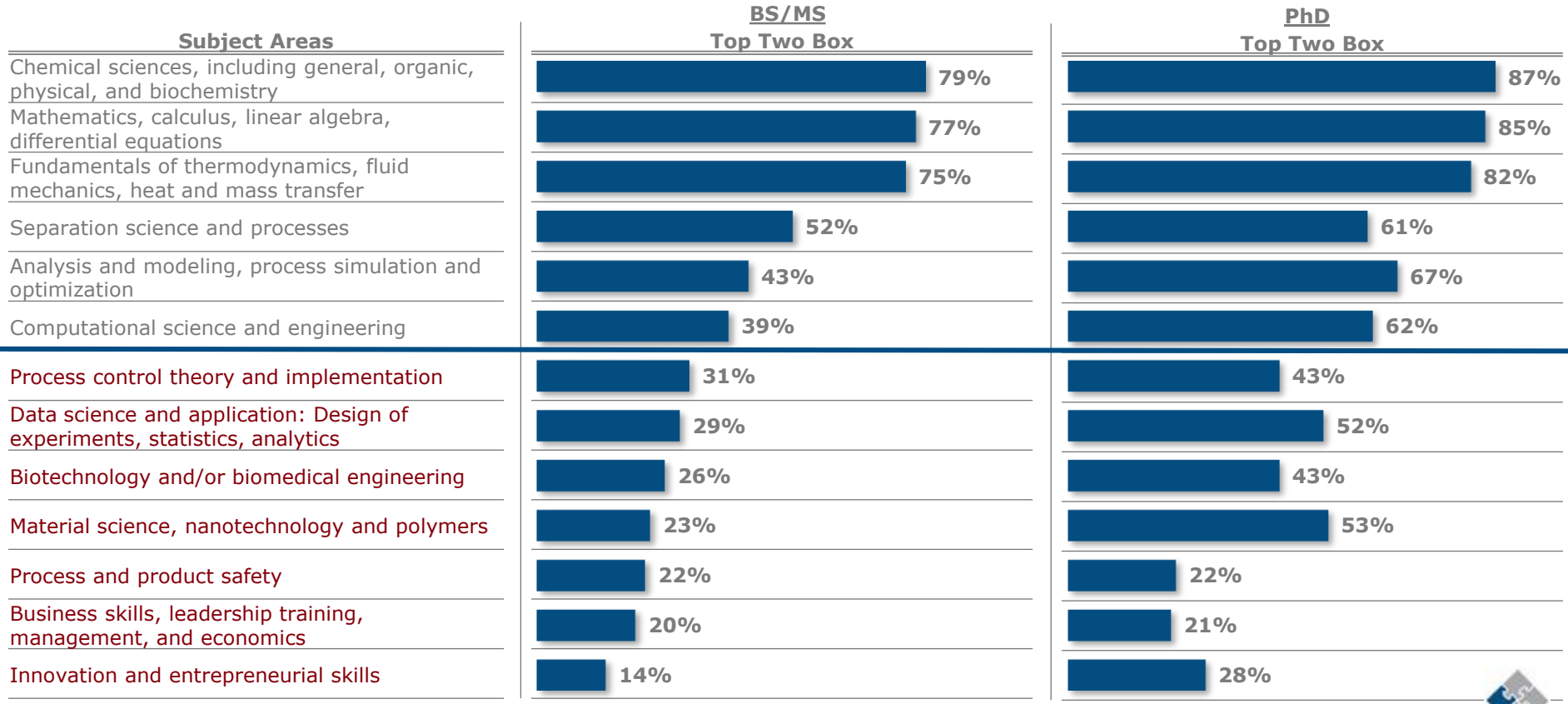
*Subject areas were shortened to fit in the chart. Please refer to the questionnaire to see full text.

Academic Preparation PhD Opinions

Sr Non-Academic

Those in industry feel that PhD programs address all subject areas better than BS/MS programs do. Less than 50% of respondents feel that many of the current subject areas covered in Chemical Engineering programs prepare students for employment.

How strongly do you agree that present academic preparation for _____ programs addresses the following subject areas relative to employment need? Please use a 5 point scale where 5 = Strongly Agree and 1 = Strongly Disagree.
(267 Respondents)

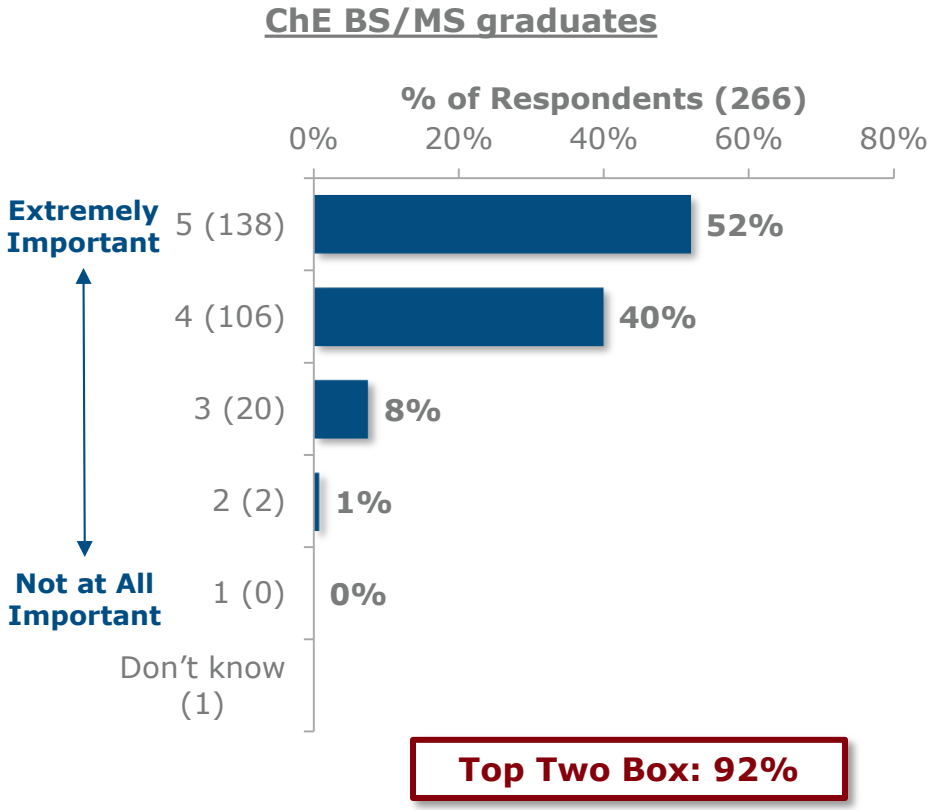


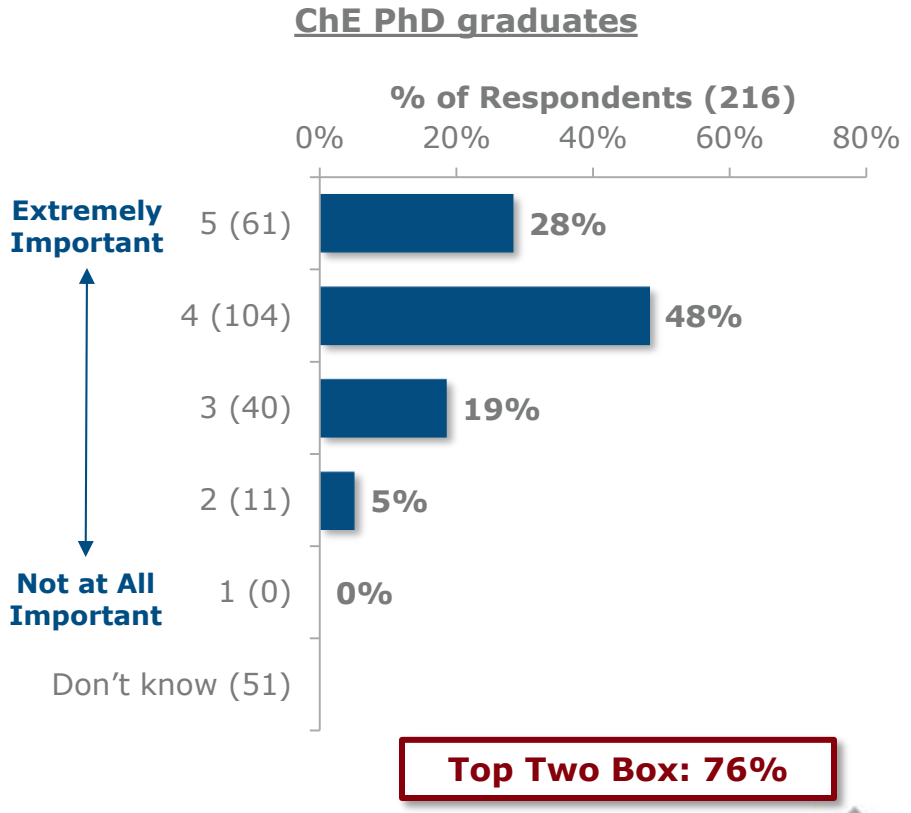
Practical Experience Importance

Practical experience is viewed as being more important for BS/MS graduates than PhD graduates.

Sr Non-Academic

How important is practical experience (e.g., internships, co-ops, international experience, prior technical jobs) for chemical-engineering BS/MS graduates and PhD graduates? Please use a 5 point scale where 5 = Extremely Important and 1 = Not At All Important.
(267 Respondents)





( ) = Number of respondents.

Reasons for Practical Experience Importance

Sr Non-Academic

Some reasons respondents do not think practical experience is important are: they will already have these skills based on their education, they will learn what they need to on the job and it will depend on the position they are hired for.

Why do you feel practical experience is not important for _____?*

ChE BS/MS graduates (2)

- *The most important skills gained through practical experience include time management and working in teams. Students learn these skills through their rigorous education/research.*
- *You get lots of on the job experience the first 5 years of your career.*

ChE PhD graduates (11)

- *Need for practical experience will vary greatly depending on career path. It is not as important for research/academic positions. Training associated with getting a PhD…should provide basics and knowledge of how to develop skills.*
- *PhDs should be experts in an area and hired for their expertise. Practical experience helps to establish this expertise, but is not required…*
- *Practical experience in the form of an internship is a 'nice to have', but not a 'need to have' for our PhD hires. The qualities that we are looking for in our PhD hires are technical leadership, deep understanding of Chemical Engineering fundamentals, ability to work independently, and demonstrated ability to solve a difficult technical problem.*
- *Specificity in a position.*
- *The most important skills gained through practical experience include time management and working in teams…*
- *The PhD program should give them strong skills already.*
- *The PhD research they do should be the practical experience they need since it takes 3-4 years to graduate adding to that would be difficult…*
- *They learn on the job.*
- *This role is more slanted towards creation of new products and processes. The creative element takes priority in the hiring decision and inherent technical abilities along with soft social skills and team work skills over "practical experience" as is defined here.*

*Question asked only to respondents who rated practical experience importance a "2" or "1".
( ) = Number of respondents.

Most Potential Growth Opportunities

A wide variety of areas were mentioned, none with an overwhelming number of responses. Energy is the area where the most growth is predicted.

Sr Non-Academic

In what areas of work do you see the most potential growth of career opportunities for students graduating with chemical engineering degrees?
(267 Respondents)

- **Energy (24)**
- Oil & gas (24)
- Environmental (19)
- Nanotechnology (15)
- Process safety (15)
- Biotechnology (14)
- Pharmaceuticals (13)
- Process design (13)
- **Alternative energy (12)**
- Petrochemical (11)
- Process engineering (10)
- Water/Wastewater (9)
- Materials science (8)
- Sustainability (8)
- Optimization (6)
- **Renewable energy (6)**
- Biochemistry (5)
- Business (5)
- New materials (5)
- Bioengineering (4)
- Data analysis (4)
- Food and beverage (4)
- Innovation (4)
- Management (4)
- Manufacturing (4)
- Petroleum (4)
- Project engineering (4)
- Separations (4)
- Specialty chemicals (4)
- Supervision (4)
- Biomedical (3)
- Green jobs (3)
- Project management (3)
- R&D (3)
- Reaction engineering (3)
- Technology management (3)
- Bio fields (2)
- Co-op work (2)
- Data simulation (2)
- Downstream chemicals (2)
- Field support (2)
- Lean manufacturing (2)
- Operations (2)
- Sales & marketing (2)
- Solids handling (2)
- Traditional chemical engineering roles (2)
- Advanced process (1)
- Applied materials (1)
- Biofuels (1)
- Biomechanical (1)
- Catalysts (1)
- Emerging technology (1)
- Lab technician (1)
- Life sciences (1)
- Natural gas processing (1)
- Practical implementation (1)
- Process development (1)
- Process integration (1)
- Process lead (1)
- Process operations (1)
- Process reliability (1)
- Production management (1)
- Scientific computing (1)
- Semiconductor (1)
- Six Sigma (1)
- Subsea flow assurance (1)
- Transport (1)
- All areas (3)
- Don't know (4)
- None (1)

( ) = Number of respondents. Multiple responses accepted.

JUNIOR NON-ACADEMIC (Bachelor's after 2000)

(237 Respondents)

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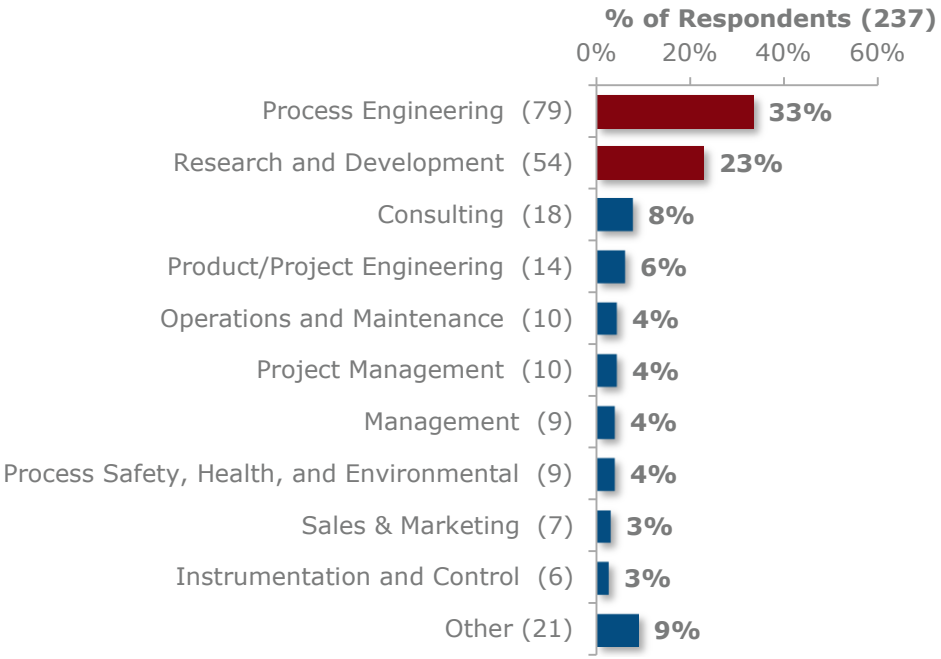
Job Function

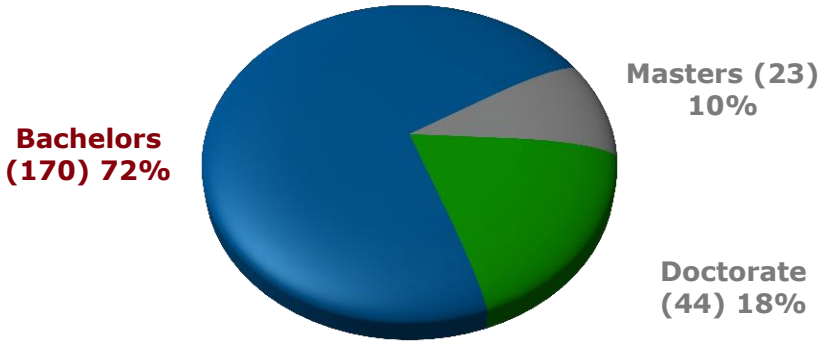
Jr Non-Academic

Similar to the seasoned professionals, Process Engineering and Research and Development make up the majority of the respondents. Almost three-fourths of respondents held only a bachelors degree when starting their jobs.

Which of the following best describes your job title/function?
(237 Respondents)



What degree did you hold when you began your job?
(237 Respondents)



Others include: Unemployed (3), Job Searching (2), Manufacturing (2), Process Simulation & Optimization (2), Quality Management (2), Analysis (1), Business Analyst (1), Facilities Engineer (1), Federal Safety Oversight (1), Government (1), Reservoir Engineer (1), Small business owner (1), Software (1), Technical Service (1), and Technology Training (1).

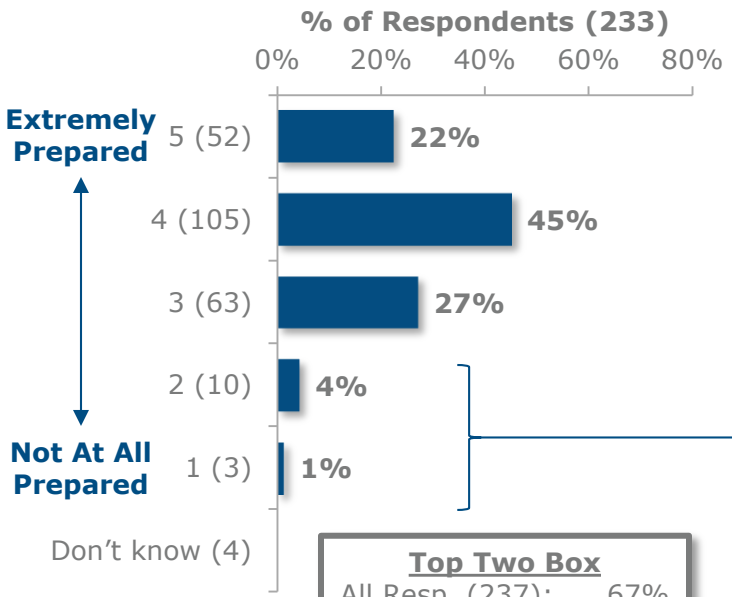
( ) = Number of respondents.

Education Value

Most respondents felt at least somewhat prepared for the jobs they were hired for. Many of those who did not feel prepared said it was due to lack of industry exposure/experience.

Jr Non-Academic

How well do you believe your education to that point had prepared you for the position you were hired into?
(237 Respondents)



Top Two Box	
All Resp. (237):	67%
Bachelors (170)	67%
Masters (23)	65%
Doctorate (44)	70%

Describe how you were ill-prepared.

- *Before I graduated, I was told that an internship was not essential to obtain work. After I graduated, every place I have applied to denied my application on the basis of lack of experience…*
- *I did not have much information about chemical reactivity hazards and also I did not find a job in the field I did my PhD.*
- *I have knowledge of most engineering concepts, but my school failed to have enough industry style courses tailored to what might happen in the private sector. We only started these projects in my senior year, which was not enough time…*
- *I was provided insufficient information on how engineering functioned in industry… Also, I was completely uninformed as to what constituted the type of tasks an engineer would do…*
- *Laboratory work, sample preparation and analysis, and paper writing do not translate to applying for research positions within industry.*
- *Most of the valuable learning was gained on the job rather than via the classroom…*
- *Never received coaching or instructions how to integrate into the work force…*
- *I've had to learn almost everything on the job…I think that the thing that would have helped most would have been some kind of internship or coop experience.*
- *Technically I am very prepared. I received a great education at the University of Puerto Rico at Mayaguez. However, the industry life is very different. The development of soft skills and business skills are needed to work at the industry…*
- *Undergrad transport and reaction design and separations classes had entirely inadequate faculty without industry experience…*
- *Very little hands on work. Very little non-research examples/experiments were done.*
- *While classes did provide a foundation of basic engineering, it felt like we were simply checking off boxes on someone's list to prove the university was able to offer the curriculum…*

( ) = Number of respondents.

Additional Workplace Preparation Needed

Jr Non-Academic

The need for additional workplace preparation does not appear to be tied to the level of education received. Mentoring and self-instruction were the most common types of additional prep needed.

What types of additional workplace preparation, if any, did you need when starting your job?
(237 Respondents)

Additional Preparation	All Respondents (237)	Degree		
		Bachelors (170)	Masters (23)	Doctorate (44)
Professional mentoring (158)	67%	68%	61%	66%
Self-instruction (152)	64%	65%	65%	59%
Seminars (64)	27%	25%	30%	32%
Additional coursework (38)	16%	16%	17%	16%
On the job training (22)	9%	11%	9%	5%
Hands on experience/Internships (16)	7%	7%	13%	2%
Other (27)	11%	8%	26%	16%
No additional preparation (23)	10%	10%	4%	11%

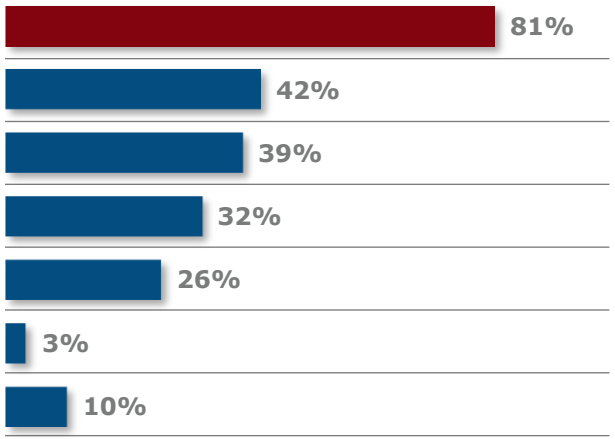
( ) = Number of respondents or times mentioned. Multiple responses were accepted.

Training Activities

A vast majority of new hires have participated in in-house company training programs. The type of training is not tied to the level of education received.

Jr Non-Academic

As a new hire, did you engage in any of the following training activities?
(237 Respondents)



Activities	All Respondents (237)	Degree		
		Bachelors (170)	Masters (23)	Doctorate (44)
In-house/Company-run training programs (192)	81%	80%	83%	84%
On-line training programs (100)	42%	43%	26%	48%
Assigned professional mentor (93)	39%	43%	30%	30%
3rd-party-run training programs offsite (77)	32%	33%	39%	27%
3rd-party-run training programs onsite (61)	26%	28%	13%	25%
Other (8)	3%	4%	-	5%
None of the above (24)	10%	11%	9%	9%

( ) = Number of respondents or times mentioned. Multiple responses were accepted.

Subject Area Importance

New hires place greater importance on subjects like product safety and business skills compared to some of the other core chemical engineering subjects.

Jr Non-Academic

Based on your experience, please rate the following subject areas in terms of career importance. Please use a 5 point scale where 5 = Extremely Important and 1 = Not At All Important.
(237 Respondents)

Areas*	Importance Ratings 5	4	3	2	1	Average Importance
Process and product safety	53%	29%	13%	4%	1%	4.30
Fundamentals of thermodynamics, fluid mechanics, heat and mass transfer	55%	23%	15%	6%	1%	4.24
Business skills, leadership training, management, and economics	47%	32%	16%	4%	-	4.22
Separation science and processes	32%	36%	19%	10%	3%	3.84
Analysis and modeling, process simulation and optimization	34%	30%	22%	11%	3%	3.82
Chemical sciences, including general, organic, physical, and biochemistry	27%	38%	22%	11%	2%	3.76
Data science and application: Design of experiments, statistics, analytics	29%	35%	19%	12%	6%	3.69
Mathematics, calculus, linear algebra, differential equations	24%	32%	29%	14%	2%	3.62
Innovation and entrepreneurial skills	25%	30%	24%	16%	6%	3.52
Process control theory and implementation	17%	35%	25%	17%	6%	3.39
Computational science and engineering	14%	22%	32%	21%	10%	3.08
Material science, nanotechnology and polymers	8%	22%	27%	30%	13%	2.81
Biotechnology and/or biomedical engineering	8%	8%	19%	28%	37%	2.24

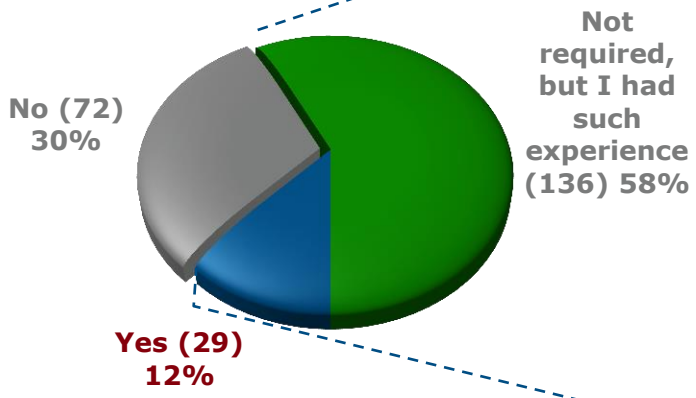
*Subject areas were shortened to fit in the chart. Please refer to the questionnaire to see full text.

Practical Experience Requirements

Very few respondents (12%) were required to complete practical experience as part of their program. Those who did complete it found it to be very or extremely valuable.

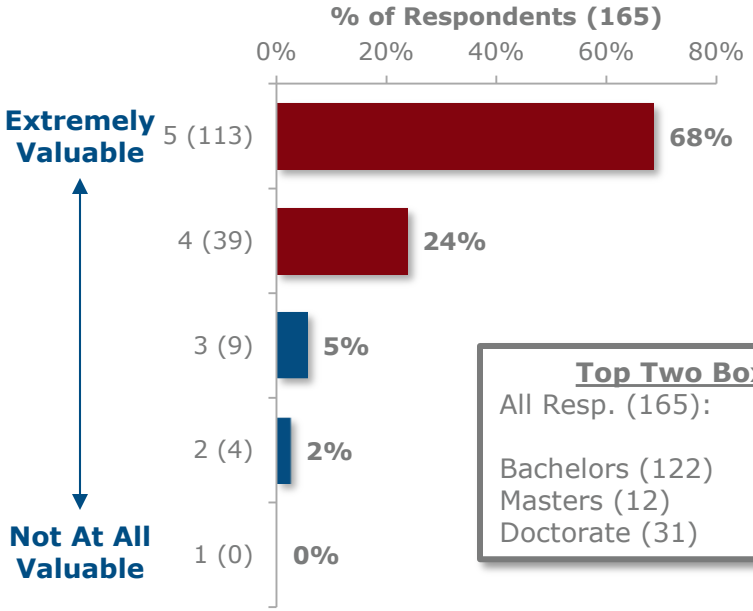
Jr Non-Academic

As a student, did your degree program require practical experience (e.g., internships, co-ops, prior technical jobs)?
(237 Respondents)



Degree	Yes	No	Not required, but I had such experience
Bachelors (170)	12%	28%	59%
Masters (23)	13%	48%	39%
Doctorate (44)	11%	30%	59%

How valuable did you consider that practical experience in preparing you for the workplace? Please use a 5-point scale where 5 = Extremely Valuable and 1 = Not At All Valuable.
(165 Respondents)



Top Two Box

All Resp. (165):	92%
Bachelors (122)	91%
Masters (12)	100%
Doctorate (31)	94%

( ) = Number of respondents.

IV. CONCLUSIONS

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Conclusions

Conclusion #1

There has been a shift in faculty's research interests in current chemical engineering programs.

Supporting Evidence

- ✓ 74% of academic respondents recognize the shift.
- ✓ 65% do not feel this is a short term trend.
- ✓ 58% feel this will cause drastic changes in the future.
- ✓ Faculty's research interests heavily affect the subjects they are willing to teach.
- ✓ Institutions are hiring adjunct faculty to cover specific courses and also offering full-time or tenure track positions to individuals with specific research interests to accommodate the shift.

Take Away

This is going to have an effect on the types of courses being taught in chemical engineering in the near future. It is also going to play a big role on institutions' hiring practices moving forward.

Conclusions (Cont.)

Conclusion #2

There is a lot value placed on having practical experience in the field of chemical engineering, yet very few institutions require it.

Supporting Evidence

- ✓ 92% of all respondents (academic, senior non-academic and junior non-academic) find practical experience to be very or extremely valuable for BS/MS graduates.
- ✓ 81% of senior non-academic respondents said they are more likely to hire someone if they have practical experience.
- ✓ Recently hired individuals who felt ill-prepared for the positions they were hired for related it to lack of industry exposure or experience.
- ✓ 88% of recently graduated respondents were not required to complete practical experience as part of their degree program.

Take Away

If institutions do not require practical experience, it could be very difficult for students to obtain, in turn making the job search more difficult.

Conclusions (Cont.)

Conclusion #3

Academic institutions do not feel there is as much need for workplace preparation as those in industry.

Supporting Evidence

- ✓ 71% of academic institutions feel that their undergraduates are extremely/very prepared for the positions they are hired for.
- ✓ And only 37% of academics feel BS students need more workplace preparation.
- ✓ Yet 50% of those in industry feel that recent BS/MS graduates need more workplace preparation.
- ✓ And 79% said that their recent hires did require some type of additional workplace prep.
- ✓ 90% of recently hired respondents said they needed some sort of additional workplace preparation when starting their current job.

Take Away

There is a discrepancy between academics and industry about how important/necessary workplace preparation is for recent graduates.