Industry Trends in Engineering Offshoring

-- A Duke University, Pratt School of Engineering Research Summary

Presented at the National Academy of Engineering Workshop on the Offshoring of Engineering: Facts, Myths, Unknowns and Implications

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Abstract

Engineering jobs are being offshored to countries like India and China, and this trend seems to be gaining momentum. It is not clear whether this will erode U.S competitiveness or provide long term benefit. What is clear is that there is insufficient independent research on this topic. Here, we delve into some of the offshoring experiences of leading American corporations. This report summarizes data collected from 78 division representatives at 58 U.S. based companies involved in engineering offshoring. We discuss their experiences in hiring engineers, the perception of the productivity and quality differences between U.S. engineers and those in China and India, and future trends in offshoring.

Study Introduction

The effect of engineering offshoring on the global economy is a discussion of keen interest in business, policy and academic circles. Over the past few years, there has been mounting public concern over the offshoring of engineering jobs by American corporations. This concern stems from the economic and competitive impact of the relocation of specialized engineering jobs to countries like India and China. In the absence of sufficient independent research, the debate often focuses on statistics such as the graduation rates of engineers in the U.S. vs. China and India. Such numbers are often cited as a measure of global competitiveness. The statistics that have been most frequently cited by the media, government officials and academics suggested that China and India graduate 12 times the number of engineers as the U.S. In December 2005, research from Duke University's Masters of Engineering Management Program showed these statistics to be incorrect. This research suggested that the U.S. is producing a competitive number of engineering graduates (http://www.memp.duke.edu/outsourcing/).

In preparation for this paper, researchers from Duke University's Masters of Engineering Management Program approached U.S. based firms which are actively engaged in offshoring engineering jobs. The objective was to learn more about their hiring practices, experiences, offshoring initiatives and future plans.

Methodology

In April of 2006 an interdisciplinary team of researchers at Duke University created a detailed industry questionnaire to identify current and future trends in engineering offshoring. Over the subsequent six months, this questionnaire was submitted to presidents, division heads, managers and senior HR representatives within selected U.S. based companies. The initial list of companies was derived from CNN anchor Lou Dobbs' list of companies that are supposedly "Exporting America." These are U.S. firms that Lou Dobbs says "are either sending American jobs overseas, or choosing to employ cheap overseas labor, instead of American workers". The questionnaire was delivered via phone, fax and e-mail requests, and completed responses were stored in a secure, online database. Our research team ultimately received 95 survey responses. In the event that we received multiple questionnaire responses from different individuals in a single division, we utilized only the response of the most senior individual with the greatest years of work experience at a given company. Anonymous and incomplete questionnaire responses were discarded. This left our group with usable responses from 78 unique divisions within 58 different corporations. A breakdown of the responding companies' Fortune 1000 rankings and employee bases are present in Figures 1 and 2 below. The majority of the respondents are from Fortune 1000 companies with significant employee bases. The identities of respondents in addition to their divisions and companies will remain anonymous.

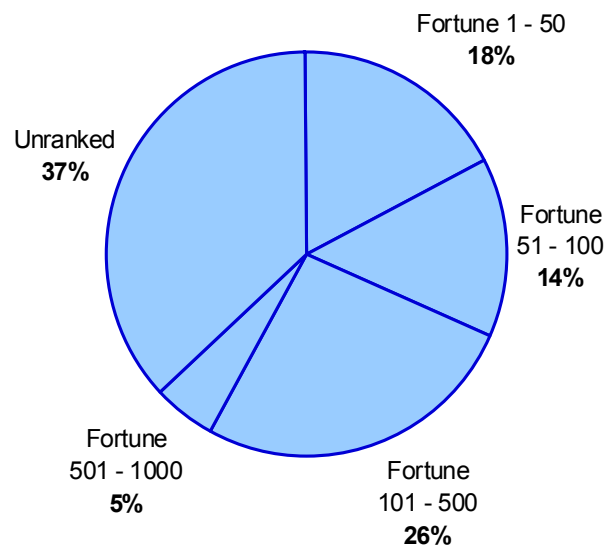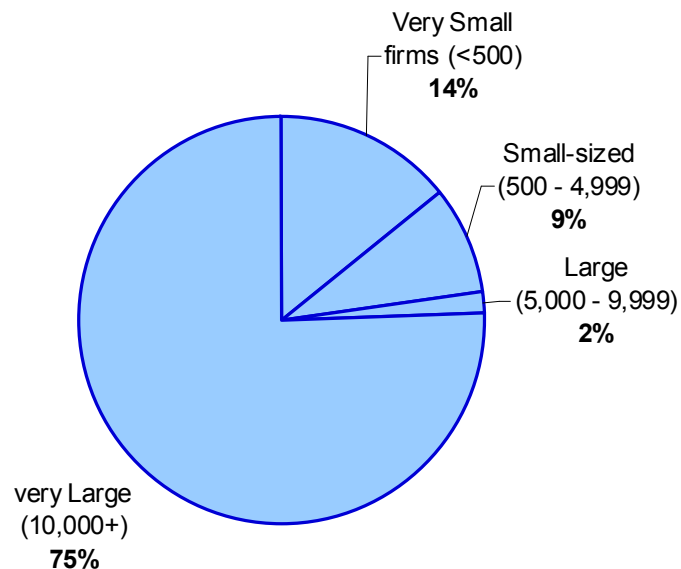**Figure 1: Fortune 1000 rankings of respondent companies**

Figure 2: Respondent companies rated by number of employees

Very Small
firms (<500)
14%

Small-sized
(500 - 4,999)
9%

Large
(5,000 - 9,999)
2%

very Large
(10,000+)
75%

For this questionnaire we adopted a broad definition of the terms "offshoring" and "engineer". Here offshoring is defined as the relocation of business processes to another country. This can include any business process such as production, manufacturing, or services. We asked respondents to take into consideration all engineers whether employed directly by a firm or through an external service provider. We defined an engineer as an individual who uses scientific knowledge to solve practical problems. Engineers work in a technical capacity and usually posses a formal college-level education. For the purpose of this research, we included computer science and computer technology related jobs under the category of engineering.

Part I: Current Engineering Hiring in the United States

In December 2005, we released the results of a study called "Framing the Engineering Outsourcing Debate: Placing the United States on a Level Playing Field with China and India". This study attempted to provide an "apples to apples" comparison of the graduation rates of engineers between the U.S., India and China. Until recently, the most commonly cited statistics were that the U.S. graduates 70,000 engineers a year vs. 600,000 in China and 350,000 in India. Our research showed that if you counted total bachelors and

subbaccalaureate engineering, computer science and information technology degrees a more accurate set of numbers for the year 2004 were: U.S -- 222,335, China -- 644,106, and India -- 215,000. Counting only such 4 year degrees, the numbers were U.S -- 137,437, China -- 351,537, and India -- 112,000.

It was not clear whether subbaccalaureate degree holders should be included in such estimates as there was uncertainty about whether such two and three year degree/diploma holders would play a significant role in the global engineering workforce and receive employment offers by firms offshoring engineering jobs.

In this survey, we asked the question, "do you hire two or three-year degrees/diploma holders for engineering jobs within your company?". 40% responded with an unqualified "yes" and an additional 17% said "depends on additional training experience". 37% said they did not.

To learn more about the supply of engineering and technology skills in the United States, we asked several questions about hiring polices.

One measure of skill supply is "acceptance rate". A company typically interviews several candidates for an open position and makes a job offer to one or more of these. Candidates typically interview for jobs at multiple companies. In a competitive market, candidates may receive more than one job offer and have the opportunity to select from these. Acceptance rate provides an indication of the level of such competition.

The majority of companies we surveyed had acceptance rates greater than 40%. Of the companies that could provide this data, 21% reported acceptance rates of 80-100%, while another 26% reported 60-79% acceptance rates.

We asked how acceptance rates have changed over the past three to five years. 80% of respondents reported that acceptance rates had stayed constant or increased (see Figure 3 below).

Figure 3: At your company, how has the acceptance rate of employment offers by U.S. engineers increased or decreased over the past 3-5 years?
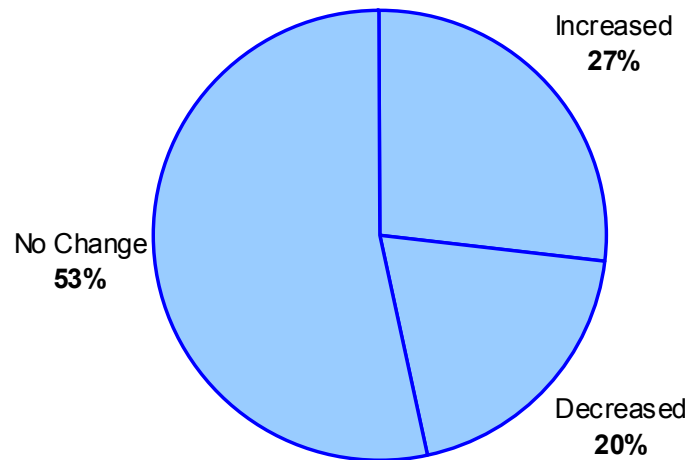

To improve acceptance rates, companies often offer signing bonuses. These are financial inducements offered to a candidate to encourage them to accept a job offer.

The majority of the respondents to our survey indicated that they did not offer signing bonuses or offered these to a small percentage of their new U.S. hires. 44% reported that their company did not offer signing bonuses and 44% stated that they offered signing bonuses to less than 20% of potential engineering employees.

Another measure of skill supply is the amount of time taken to fill a vacant position. In a competitive market, it takes longer to fill a position.

Respondents to our survey reported that 80% of the U.S. engineering jobs at their companies were filled within four months. A full breakdown of this response can be found in Figure 4 below.

Figure 4: Approximately how long do available U.S. engineering positions at your company typically stay unfilled?
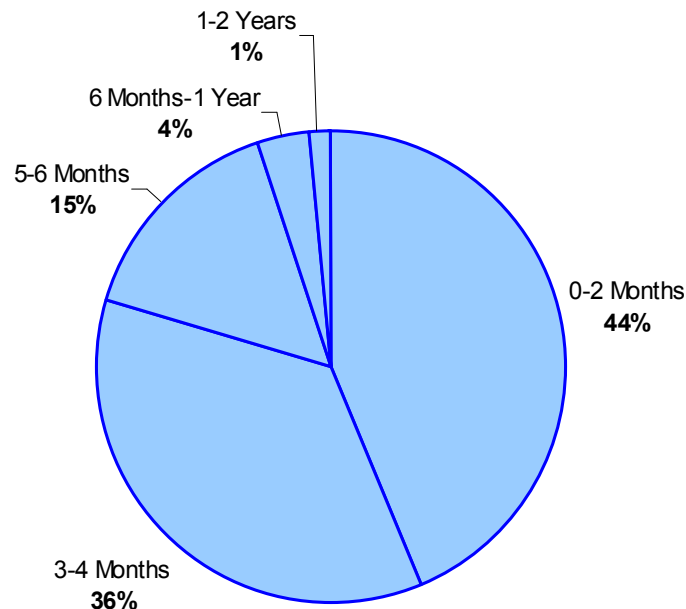
Part II: The Changing Nature of the Engineering Workforce

We asked our survey respondents a series of open-ended questions about what changes they had seen in the capabilities or skills of engineers over the last three to four years, what additional training or skills would they like to see in undergraduate engineers before they entered the workforce, and what capabilities their U.S. engineers had which would make it advantageous to keep their jobs in the U.S.

On the question "what changes have you seen in the capabilities or skills of engineers that you have recently hired from those that you hired 3-5 years ago?", the top response was that graduates had better technology and programming skills. Some reported better communication and team skills and a broader global outlook. 18% of the respondents reported no change.

We asked "what additional training (or skills development) you would like undergraduate engineers to receive before they enter the workforce?". Respondents wanted better communication and presentation skills, internships and practical experience, computer

related skills including 3-d modeling, programming and simulation, project management, leadership, business skills such as the ability to read financial statements and write proposals.

On the question "what capabilities do your US engineers have that make it advantageous to keep their jobs in the US", the response was that U.S. engineers have a very good understanding of U.S. consumer needs, culture, business, and better communication and interpersonal skills. Respondents also stated that U.S. engineers were more creative, excelled in problem solving, risk taking, networking and had strong analytical skills. Plus they could work on high security applications and had the advantage of proximity to resources.

Part III: Engineering Offshoring

We asked a series of questions regarding which countries work was being offshored to, the type of work being done there, how technical these jobs were compared to those in the U.S., how productivity and quality compared, and what advantages offshoring provided.

Our respondents indicated that India and China remain the top offshoring destinations, with Mexico in third place. The types of engineering work sent to these destinations varied greatly and spanned the following job types:

- Engineering design
- Development
- Analysis
- Manufacturing / Industrial
- Documentation
- Testing and quality assurance
- Maintenance and support
- Software development
- Computer programming
- IT
- Drafting, drawings and finite element analysis

We asked "how similar or different are the types of engineering jobs that your company performs in the U.S. from those that your company has offshored?".   44% said that their company's U.S. engineering jobs are more technical in nature vs. 1% that said that their offshore engineering jobs are more technical in nature. 33% said that jobs were equivalent.

When asked to compare the productivity of the engineering workforce between their U.S and offshore facilities, 37% of respondents stated that U.S. engineering employees are more productive, while 24% stated that U.S. and offshore engineering teams are equivalent in terms of productivity. See Figure 6 below.

We also asked companies to compare the quality of engineering work between their U.S. and offshore facilities. 38% said their U.S. engineering employees produced higher quality work and 40% reported that work quality was equivalent between U.S. and offshore facilities. 1% reported that their company's offshore engineering employees produce higher quality work. A full breakdown of these statistics can be found in Figure 6 below.

Figure 6: Productivity and Work Quality Comparisons between U.S. and Offshore Facilities

Are Engineering Employees at your U.S. or Offshore Facilities More Productive?

No opinion, Don't know
29%

U.S. engineering employees
37%

Equivalent
24%

Offshore engineering employees
9%
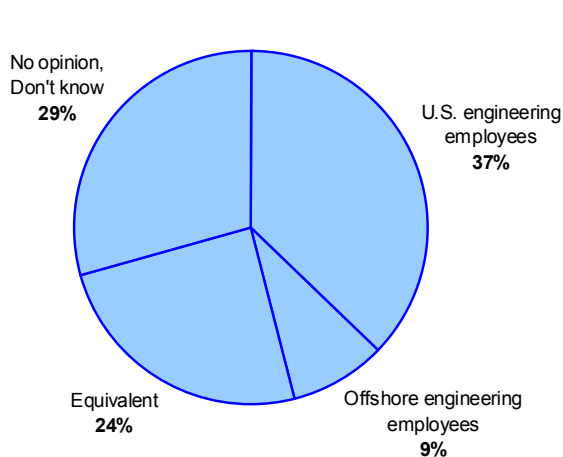
Do Engineering Employees at your U.S. or Offshore Facilities Produce Higher Quality Work?

No opinion, Don't know
21%

U.S. engineering employees
38%

Equivalent
40%

Offshore engineering employees
1%
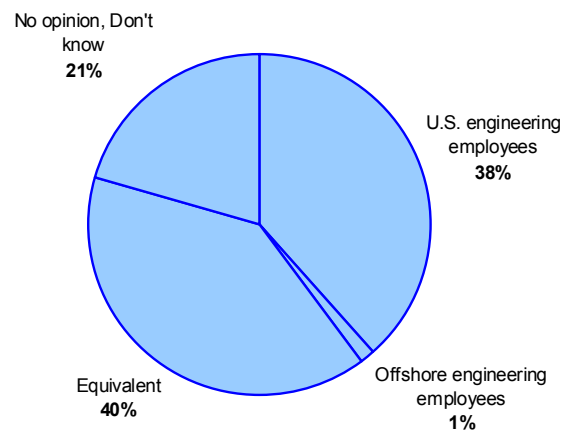
We then asked respondents to numerically rate the business advantage they received, if any, from access to new markets, cultural and geographic proximity, co-location of design and production facilities, 24/7 development cycles, salary or personnel savings, tax/government incentives, and overhead savings. Figure 7 contains the resulting average scores.

Figure 7: In your offshoring endeavors, how much of an advantage, if any, has your company gained from the following? (1: No Advantage; 2: Slight Advantage; 3: Moderate Advantage; 4: Strong Advantage; 5: Significant Advantage)

| Category	Score
Access to new markets	2.89
Cultural or geographic proximity to customer	2.86
Co-location of design and production	2.32
24/7 continuous development cycle	2.97
Salary or Personnel savings	3.83
Tax incentives & host government assistance	2.52
Overhead savings	3.06
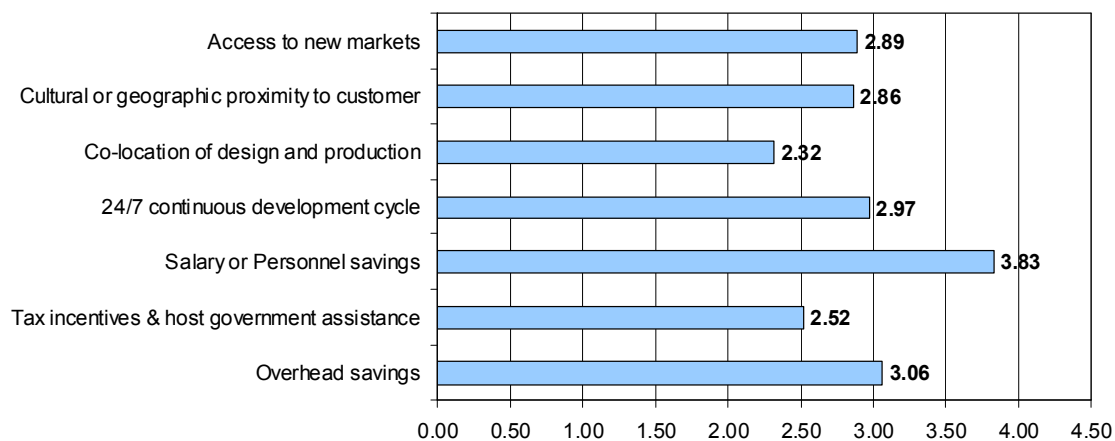
Part IV: Comparisons of the U.S., Chinese and Indian Engineering Workforce

We asked companies to evaluate the abilities of their U.S., Chinese and Indian engineering workers to meet their business needs and to discuss the strengths and weaknesses of entry-level engineers in each.

We asked if the current U.S. engineering workforce met their business needs for entry-level engineers. 75% of companies who expressed an opinion said that India had between an adequate and large supply of well-qualified entry-level engineers vs. 59% for the U.S and 54% for China (see Figure 8).

Figure 8: Does the current Chinese/U.S./Indian engineering workforce meet your business' needs for entry-level engineers? (1: Limited supply of well-qualified candidates, 3: Adequate supply of well-qualified candidates, 5: Large supply of well-qualified candidates)
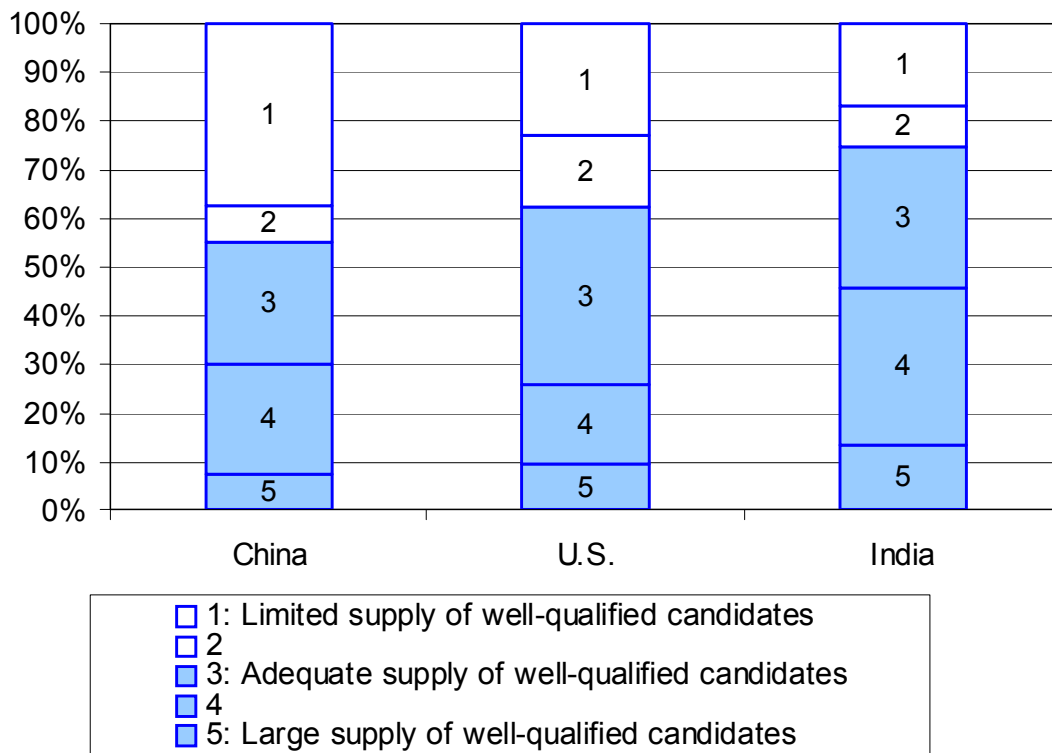
We asked a series of open ended questions on the relative strengths and weaknesses of entry-level engineers in each of these countries.

To the question, "What are the key reasons why either the U.S., Indian or Chinese entry-level engineers might not be able to meet your needs?", the responses were as follows:

US: Respondents cited salary demands as a key issue, limited supply of available people, and lack of industry experience. Some respondents stated that there were no issues. A small minority of respondents raised issue with inclination towards non-technical work, an unwillingness to relocate and poor work ethics.

China: The top response was that Chinese engineers lacked communication skills. Other

issues included visa restrictions, a lack of proximity, and inadequate experience. A few respondents also cited lack of loyalty, cultural differences, intellectual property concerns and a limited "big picture" mindset.

India: Inadequate communication skills, a lack of specific industry knowledge, and proximity/visa restrictions were the top responses. Other issues raised were lack of domain experience, limited project management skills, high turnover and cultural differences.

We asked, "what are the relative strengths or advantages of U.S, Indian or Chinese entry-level engineers when compared to each other?". The responses were as follows:

U.S.: Strong communication skills, an understanding of U.S. industry, superior business acumen, strong education/training, and a sense of creativity and desire to challenge the status quo. A few respondents cited strong technical skills, proximity to work centers, and a lack of cultural issues as advantages.

China: Many respondents stated that the key advantage of hiring Chinese entry-level engineers was cost. A few respondents cited strong education/training, work ethics and a willingness to work long hours.

India: Similar to China, many respondents said that cost savings was a major advantage of hiring Indian entry-level engineers. Other advantages were technical knowledge, English language skills, education/training, ability to learn quickly and a strong work ethic.

Part V: The Future of Engineering Offshoring

The final section of our questionnaire was designed to gauge opinions on the future of engineering outsourcing. We asked a series of open ended questions about what changes the respondents expected in their offshore operations and engineering jobs over the next three to five years.

When asked "what changes do you expect in your offshore operations over the next three to five years?", the vast majority of respondents indicated the offshoring trend would continue and that their overseas operations would expand. Only 5% of respondents indicated a stabilization or contraction of offshore operations.

We asked "what types of engineering jobs won't be offshored at your company within the next 3-5 years and why?". A portion of respondents believed that offshoring had no barriers and given a long enough timeframe any job could potentially be offshored. Those individuals who did list specific engineering jobs included the following:

- Research and development, conceptual front-end design
- Proprietary technical expertise and intellectual property work
- Jobs requiring deep technical, communication or business support knowledge
- Work requiring customer interactions
- Project management
- Marketing engineers and finance
- Architect level design, product roadmap creators
- Architecture and major network design
- Management staff
- Business analysts
- Design and Software
- Jobs requiring significant interaction with U.S. Local / Federal governments, jobs requiring U.S. security clearances

We also asked "what do you see as potential barriers to offshoring future engineering work at your company?" and asked respondents to select from a list. A breakdown of these responses can be found in Figure 9.

Figure 9: What do you see as potential barriers to offshoring future engineering work at your company? (Choose as many as apply)
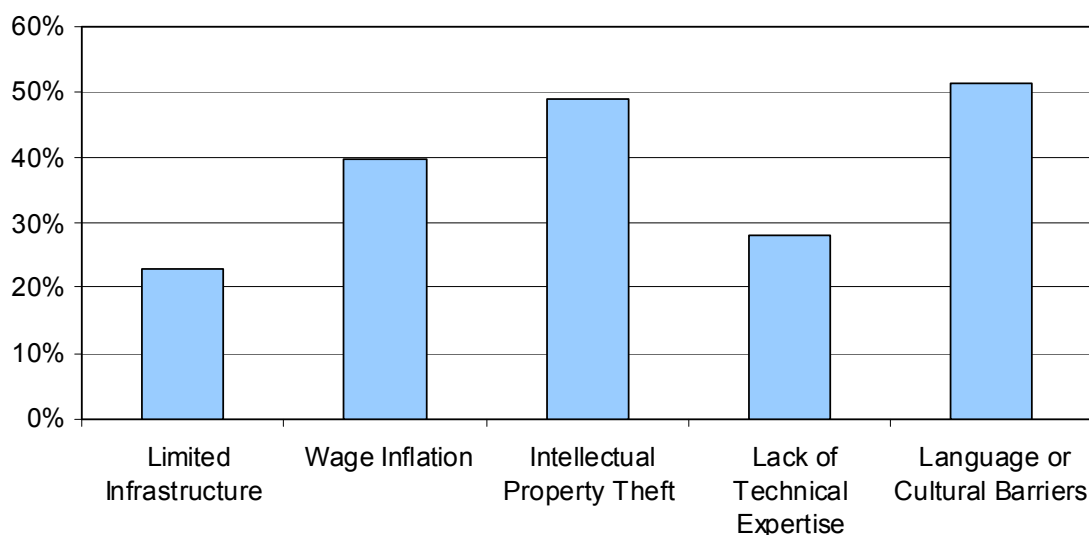
Conclusion

Companies seem to be comfortable with their outsourcing strategies and the trend is likely to continue and gain momentum. Our research shows that driving force behind offshoring decisions is not only the supply of engineering graduates; there are many other considerations. The companies we surveyed did not give us any indication that there was a significant shortage of skilled engineers in the U.S. The majority believed that there was an adequate supply of entry-level engineers with the best availability being in India, followed by the U.S. and then China.

The productivity of American engineers is almost always higher or equal to than those hired offshore. Engineering jobs in the U.S. are more technical in nature or equal. The quality of work done by U.S. workers is generally higher than or equal to what is done overseas. Business executives highlight the superior communication and business skills of American workers and their creativity and ability to challenge the status-quo.

Companies see many challenges in offshoring work, yet gain enough benefit for the trend to continue and most expect their overseas operations to expand.

There are many more questions that need to be answered and extensive independent research is needed into these issues. Corporations are reluctant to speak on the record for fear of adverse publicity. As we learned however, they will cooperate and be as helpful as they can when they believe that information will be used in a constructive manner and confidentiality can be maintained. We were able to get helpful and insightful answers to a broad set of questions.

The debate is important, and there isn't enough information available to determine whether the offshoring of engineering jobs will erode U.S. competitiveness or provide long term advantage. The more we understand about these issues, the better our chances of maintaining our competitive edge.