Securing an internship in the Engineering Disciplines: Response from the Industry

Abstract

Engineering is a rapidly growing field that embraces novel ideas. The rapid advancement of technology is currently offering several possibilities for tomorrow’s engineers and is facilitating the successful conception of new designs and models. This in turn presented new challenges to the engineering educators in preparing the students by varying the degree and type of attention, help, advice, information and encouragement that he/she provides to each individual. Current students are not prepared to be productive in a company from the very first day, due to many reasons such as adaptation to work environment, self efficacy, team skills, and ability to learn independently etc.

Internship or Co-op is an ideal solution for this challenge. A limitation that prevails even today is the precise knowledge of what skills are necessary in the industry for engineering discipline. Having information at hand helps the engineering educators to update their experience with the requirements of the real world, while providing them feedback to improve their course material accordingly. On the other hand, by providing this information to universities, industries could benefit by having to spend less time preparing the individual, and thus utilize their time effectively.

The basic skills each student posses of their respective discipline remain the same. Based on this presumption, a survey was conducted by contacting several companies to seek the information regarding the skills a student employed by the company should possess. It is the presumption of the authors that his information is vital to preparing the global citizen in answering tomorrow’s challenge today.

Keywords – internship, industry

Introduction

With the unprecedented advancement in the technical fields, universities are still posed with a daunting task of training engineers ready to join the work force without undergoing prior real-time training. Although the curriculum offered by engineering schools helps in developing a robust foundation in basic engineering sciences, it lacks the application and design based approach that would deliver a graduate ready to work in the industry without prior training. When knowledge obtained through dogmatic class based learning is to be applied in an industry environment, the student experiences a new wave of learning that encompasses many facets of engineering education that are not prevalent in the classroom. A co-op or an internship fills this void by providing a platform for the student to reinforce his or her theoretical knowledge with design and practical application based experience. Not only does an internship act as a bridge between the traditional academic structure of class learning and the world of real application, but it also gives the students an opportunity to hone his or her personality, communication, management skills etc.
An internship challenges students with open ended problems which affect the student’s intellectual development promoting long life learning. Long life learning includes nontraditional, experimental academic programs often emphasizing open ended, self directed and/or socially and culturally embedded research experiences. An internship emulates a learning atmosphere conducive for the development of long life learning. School coupled along with an internship drives students to be “methodical/disciplined, reflective/self aware, venturesome creative, independent/interpersonally competent” as a person. Apart from the above mentioned attitudes a student develops his/her basic communication skills, learning how to deal with information, evaluating integrated information and critical thinking.

The industries hiring interns also play a critical role. Students are hired with an intention of retaining a majority of the interns into their workforce thereby cutting down on the costs spent on training new hires. Many of the companies require the student interns to handle multiple tasks that include technical, management as well as documentation. This nurtures the overall development of the interns. Meeting deadlines, reporting to superiors, adapting to the corporate culture, working in a team are some of the important attributes imbibed through an internship experience that the classroom does not offer. The different stages of a product life cycle that includes the conceptualization, design and production, testing and marketing can be seen only in an industry.

Academic research and industry are two different entities, the first gives more importance to research and analysis where as the later gives more emphasis to application and design. The product delivered by the industry is entirely driven by the consumer market where as academic research is aimed towards advancement in one particular field without a major emphasis on the consumer market. Cutting edge research being conducted in many universities does not have to materialize into a product. This leads to the big question whether the curriculum designed should be research oriented or design oriented?

An internship experience has a psychological effect on the student, instilling confidence, open minded approach towards real world problems. Hence it is essential for a student studying in an engineering school to have experienced an internship.

Academia and industry

Engineering curriculum is of utmost importance to all universities as it defines the standard that the school sets for its students. The designed curriculum should include coordinated opportunities for application and hands-on experience, thereby erasing the traditional boundaries between lecture and laboratory, academia and industrial practice. It is extremely important that there is a linkage between design based learning and classical lecture based learning. Having mentioned the above we can say that the designed curriculum should have a strong foundation in the fundamentals of engineering sciences, it should be well versed in the design processes and application based hands-on activities, it should integrate current technology trends and tools and should incorporate introductory research based courses. Moreover the curriculum should provide the student with ample opportunity to decide where his/her interests lie in and build on it, thereby increasing in the knowledge base as he/she goes deeper into the program.
University Industry collaboration enhances the visibility of the university to the industry and paves a path for the university to meet industry’s education and training goals\textsuperscript{3}. Although college education aims at long life learning and industry focuses on generating a workforce with specific skills for their immediate use, collaboration between the both should be thought of in a way where both work towards a common goal. This can be implemented efficiently by having a prior plan in place and having a clear channel of communication between both the fractions so that all the interests are served\textsuperscript{3}.

Collaborations can also take the shape of an alliance where the industry partners enter into a contract with a university which has active ongoing research with an explicit mission to advance new technology. A popular mechanism for establishing such a relationship is when a firm contracts with a university researcher to conduct research and development on its behalf\textsuperscript{5}. Partnerships of this kind involve the universities carrying out applied research on behalf of the company, where the university benefits by obtaining monetary benefits for its students conducting research and the industry benefits by obtaining valuable knowledge and ideas which it could commercialize into a product. Alliances such as these are governed by industry partners as well as representatives from the university. By doing so the benchmarks put forward by the committee are neither biased towards the firm nor the university. Although the students play an active part in experiencing what it is to carry out industry research in a university environment, they lose out on the exposure to the corporate culture that most internships would offer. By carrying out research for a firm, the chances of a student being hired on a full time job are higher compared to a student who has done one or two internships in that firm. It is extremely hard to mention what a firm would be working on a year from now because of the rapid rate at which technology is advancing. With this perspective, it is of utmost importance for students to understand that the approach and swiftness in grasping the concepts of a particular technology is the key to being successful in the industry.

Collaborations and alliances have their advantages as well as disadvantages. Some of the benefits arising out of collaboration between a university and the industry are listed below:

1. It provides students with more opportunities to obtain an internship, cooperative study and chances of securing a full time job on graduating.
2. Allows university to obtain vital information from the industry regarding product life cycle, marketing, corporate issues, technology prevalent in the industry, upcoming technological upgrades etc.
3. Floating a committee overlooking the internship process, curriculum development etc.; that has representatives from universities as well as the industry, hence creating a knowledge bank that has both academic as well as industry related ideas.
4. In the case of a research based organizations, it provides the faculty with an opportunity of a sabbatical, thereby increasing the research base of the school.
5. It has monetary benefits for both the school as well as the industry. The school may benefit by obtaining funds to carry out industry related research, where as the industry benefits by hiring interns at a lower cost instead of hiring full time employees.
6. The partnership between the school and local industries leads to the economic development and betterment of the society in that particular region.
Several dilemmas make the university-industry alliances difficult to create and maintain in a manner that benefits both parties. Reinforcing their belief that knowledge should be disseminated to the general public, many universities keep the patent rights of new discoveries to themselves than granting it to a particular organization. Although both university and the industry have fundamentally different cultures, both when in an alliance work with a direction to increase their revenue, earn a competitive edge over their competitors thereby enhancing their recognition. A university offers a stable environment compared to the industry where mergers, acquisitions, reorganizations and market variations occurs on a regular basis. As mentioned earlier, many of these unexpected changes may have a detrimental effect on a university-industry alliance. There have been many instances when a company has gone through major changes due to change in administration. The new administration may feel that funds spent on conducting research and development is not viable, may decide to terminate the project, and hence with it goes the university industry alliance. Patent policies, licensing agreements, market trends, the economy etc. play a vital role in an industry university relationship.

The university industry partnership can be instrumental and advantageous in many instances, but can also get complicated based on many factors stated earlier. Hence, we can say that a coalition between a university and the industry is successful with good governance, a strong set of goals, dedicated researchers with strong work ethics, cooperation between both parties with mutual respect for each other.

**Classroom lectures integrated with a design based approach**

Through industry experience an individual gains invaluable hands on design skills which many classroom lectures do not offer. It is essential that engineering faculty integrate classical class lecture with an approach towards application development in order to increase student lifelong learning among students.

This raises the question of whether it is important to integrate the classical classroom lecture with an application based approach rather than emphasizing on research. Establishing a perfect blend between both application oriented learning and fundamental classroom lecture entirely depends on the faculty member. It is here where a faculty member with prior work experience in the industry makes a difference compared to a faculty member with no industry experience. In order achieve the main goal of incorporating design into the curricula, there is a need to bring about reforms to the faculty culture enhancing the values placed by faculties and administrators on teaching. To work in this approach, it is required by the faculty to give more importance to activities with emphasis on design, practical application and real world problems.

Design based learning can be implemented effectively and easily in class by faculty members with prior experience in the industry. Although many senior faculty members experience the industry as a sabbatical, many of their junior colleagues are less likely to have had any form of work experience. Faculty working in teaching oriented institutions with no prior industrial experience show more desire to do research, whereas on the other hand new faculty with less experience in teaching would spend most of their time teaching. Faculty who have experience in the industry are more likely to spend a greater percentage of their time on instruction than their counterparts without experience in the industry.
A strong link between faculty with industry experience and those exceptional in classroom teaching can be achieved by having a seminar series where in each of them present their ideas and perceptions about developing a curricula with strong linkage between application and classroom based learning. Summarizing the best of the ideas, the administration can decide on implementing curricula with the consensus of all the faculty members. Not only does it help in building a rapport among faculty members from different departments, but it also creates an environment suitable for the development of new ideas. It is also important to help nurture present graduates students transform into future faculty. Efforts should be made to educate them about the benefits not only of teaching, but also of industrial experience. A faculty member with conceptual, experimental knowledge and experience will know what it takes for students to get a grasp of both practical as well as theoretical concepts.

By bringing forth reforms into student experience in the form of application oriented design we are preparing them for their future profession in engineering. Giving greater value to new faculty with industrial experience during hiring, it should be ensured that their talent should be consistent with a commitment to teaching and focus towards reforming the cultures of engineering and science education.

Co-op Student performance assessment

In order to bridge the gap between application oriented learning and traditional classroom learning it is imperative that we assess the response relevant to interns from their employers. A performance assessment of the students participating in internships would be essential in providing information regarding their attitudes and skills. Moreover this information can be reviewed to catalyze the process of bringing about reforms implementing hands on design approach into the engineering curricula. With intent to evaluate the performance of students participating in an internship and obtain valuable feedback from employers an appraisal form containing several questions was developed.

The performance evaluation of interns completed by employers focuses on three attributes being work habits and attitudes, job competencies and overall performance. It is important to analyze the work habits and attitudes of students as interns in order to better understand the mind frame, reasoning ability, approach of students towards application related problems. The approach with which an individual deals with a problem is of utmost importance when he/she enters into the world of application development. Attributes like mind frame, reasoning ability etc. help the reviewer decide how much the courses contribute towards the scientific/engineering maturity and lifelong learning process in a student. The section on work habits and attitudes contain responses from the employers about the quality of work, adaptation to work environment attitudes/application to work/ initiative, judgment, relations with other employees, dependability, punctuality and attendance of the participating interns from science and engineering backgrounds. From the above we can clearly state that the university experience does not only comprise of students gaining engineering knowledge but also contains added attributes that contribute towards the intellectual maturity and the overall development of an individual.
The second section of the questionnaire contains feedback regarding job competencies of the interns. The timeframe within which a fresh graduate of an engineering school adapts to the industry is very important for both the employer and the employee. Although this factor may vary with the knowledge grasping ability of the individual, it will give us an approximate of how quickly engineering students adapt to the industry environment. The motivation with which a student works towards completing his/her assignment in order to get a good grade in an educational environment is directed towards producing a finished product in the industry. The transition period from the time a student graduates from school to the time where he/she starts designing applications in the industry is very important. The inclusion of application oriented approach and design based classes in the university helps in reducing this period required by students. The section on job competencies contain feedback regarding the math skills, fundamental knowledge of sciences, ability to solve engineering problems, ability to design and conduct experiment, analyze and interpret data, ability to design applications in order to meet particular needs, ability to use software or hardware tools for engineering design, ability to function as a member of a project team, professional and ethical attitude toward job responsibilities, ability to give oral progress reports, ability to provide written reports, memos or letters and the ability to learn independently. The above attributes help the reviewer interpret to what extent the classroom learning help the students in gaining knowledge and how they put it to use when confronted with real word problems in a different environment. All the above collaboratively help us in getting an insight as to how competent a graduate student or an intern is for an engineering job posted in the industry.

The third section contains feedback in regard with the overall performance of the student intern as viewed by the employer. This section also contains specific feedback/comments/suggestions from the employers that would help the interns and the universities realize what needs be done in order to bridge the void between the industry and university. The appraisal form contains feedback for undergraduate, graduate and as well as doctorate students who attend an internship. This being the preliminary process of reviewing the feedbacks, there was no differentiation of the results depending on whether the student was an undergraduate, graduate or doctorate student. Participating students were segregated according to the department to which they belong. A total of 353 student feedbacks were reviewed with the highest number of students from the mechanical department and the least number of students from the department of engineering production.

The student distribution according to their respective departments is as follows; 15 students biomedical engineering, 17 students Computer Engineering, 35 students computer science, 104 students electrical engineering, 2 students engineering production, 7 students human factors engineering, 6 students information science, 21 students mathematics department, 132 students mechanical engineering and 14 students from doctorate programs. A total of 18 questions were framed to record the employer’s feedback reviewing various characteristics of the student interns. The feedback obtained is divided into three sections being work habits and attitudes, job competencies and overall performance. All the graphs posted below give a visual representation of the detailed analysis of participating intern attributes.
Work habits and attitudes of participating interns

This section contains the employer’s feedback regarding 8 characteristics of the participating interns, them being quality if work, adaptation to work environment, attitudes and application to work initiative, judgment, relation with others, dependability, attendance, and punctuality. All the above mentioned attributes relate to the work habits and attitude of the participating intern and helps the reviewer in obtaining insight into a behavior pattern showcased by an intern in the form of inclination towards work, rapport the intern maintains with his/ her fellow colleagues, approach towards problems, dependability .etc. Having known these facets of the student’s character, we can anticipate what would be the best fit characters a student should possess for her/him to excel in an industry environment.

In figure 1 we can clearly notice the number of students whose QOW (quality of work) is “excellent” and the number of students whose QOW is “very good” is very close in the mechanical department and the electrical department. We can also notice that the number of students whose QOW is “very good” in the mathematics department is high. The rest of the departments have a feedback that either has QOW as “excellent” or “very good”. We can infer from the results obtained that the quality of work executed by engineering student interns is appreciated by industry employers.

In figure 2 we analyze the adaptability of the students to their work environment. From the figure we can notice that the number of interns in the electrical, mechanical and computer science department fall under the category of “learn very quickly” whereas other departments have their numbers distributed between “learns very quickly” and “adapts readily”. This question helps us as reviewers to conclude that engineering students adapt to the industry environment very quickly. Students in the university environment are required to take multiple courses in a single semester/quarter hence putting them under the pressure of mastering more than one subject in a span of 3 - 4 months. In the industry the student intern will be working on one particular topic or multiple interrelated topics which all belong to the life cycle of a particular product. Without the stress of having to write exams, the student will definitely be more productive in an industry environment gaining as well as applying the knowledge he/she has.
This may be one of reasons why a student adapts to the industry in a small span of time. Figure 2
is displays results in line with above mentioned ideology.

Figure 2

Figure 3 below shows the feedback of the employers based on the interns attitudes
towards work. We can notice from the figure below that most of the employers feel that the
students are full of enthusiasm and are very industrious and hardworking. Every
student/individual is filled with the zeal to succeed in life and one path in getting there is to be
industrious and be the best in what he or she does and the graph clearly indicates this.

Figure 3.
The figure 4 shows the feedback related to the judgement of the student interns. In the industry, interns are faced with many situations where in their decision making skills are put to task unlike in a classical academic setup. The decisions taken by interns directly affect the working of the company and hence judgement is a very sought after skill that all interns must possess. Decisions regarding the approach to be adopted to solve a problem, judgement regarding when to market the product, decisions regarding the division of work among team members etc. are few important instances where in the decision and judgemental skills of an individual are put into practice. Taking decisions and judging helps in instilling responsibility and self confidence among interns. If responsibility is given to students when they are interns, it is easier for them to take decisions when they become full time employees. Looking through figure 4 we can notice that the most of the interns have judgement skills that are above average. Hence we can say that the judgement skills of an individual is an attribute that he/she can develop over a period of time depending on the position which he or she is working in and the responsibility bestowed on that individual.

![Judgement Chart](image)

**Figure 4.**

The next attribute of an intern that is discussed is his/her relation with other employees and colleagues. Although there are many instances in an educational setup where in students have to work in groups, but many times a student will have to work all by himself. In the industry although employees have to complete the work assigned to them independently, the results obtained by one employee is integrated into the work of another employee. It is of utmost importance that all the departments integrate their efforts and work closely to develop a product. Thus communication skills and maintaining a good rapport with colleagues and fellow employees is an essential attribute in an industry setup. Looking at figure 5 we can say that most of the interns are exceptionally well accepted and work well with others. This attribute helps in honing the communication skills and the personality of an individual hence making it important and a characteristic which companies see as a must have in potential employees.
Figure 5.

Dependability is a form of accolade that interns have to earn from their superiors. Only if the superior feels that an individual is dependable enough will he hand him/her the responsibility of a particular task. We can notice from figure 6 that the employers feel that most of the students in all the departments are completely dependable. To a great extent this depends on how comfortable the intern is with the job handed to him. If he/she is inclined and motivated to complete the job assigned to the best of his/her ability, then that individual automatically becomes dependable. This attribute is closely related to how competent an individual is in executing a particular task briskly.

Figure 6.
Figure 7 and figure 8 show the feedback obtained from the employers about the attendance and punctuality of the interns. Being punctual is very important as every minute is important in an industry environment. With companies trying hard to keep ahead of their competitors, they are always working in a time crunch to release new products and outmatch their competitors. Hence it becomes important for the company and its employees to work efficiently in the allotted time.
Job competencies

In this category we analyze the job competencies of participating interns. The feedback obtained contains replies to questions directed towards student abilities, skill sets and knowledge of fundamentals of sciences. The interns were judged on their skill in mathematics, fundamental knowledge of sciences, ability to solve engineering problems, ability to design, conduct experiments and analyze data, ability to use software and hardware, ability to work as a team member, professional and ethical attitude towards job responsibilities, ability to give presentations, give oral reports and ability to learn independently.

![Skills in mathematics](image)

**Figure 9.**

![Fundamental knowledge of sciences](image)

**Figure 10.**
Shown above in figure 9 and figure 10 we see the industry feedback relating the student’s skill in mathematics and their fundamental knowledge of sciences. The evaluation was based off 5 different categories, them being outstanding, adequate, inadequate, not observed and not applicable (N/A). A basic knowledge of mathematics and sciences is a requirement for every individual on this planet. When we consider engineers in particular, it is imperative that they have a sound background in the field of science and mathematics as every product developed has complex designs of mathematics and science integrated into it. Taking into account the feedback obtained we can notice that many employers feel that the skills in mathematics and fundamentals in sciences of most of the interns are either outstanding or adequate for the job they are assigned. We can also notice a large number of students that fall under the not observed category. Having a strong background in mathematics and science gives the student an edge in developing a much efficient approach towards analyzing the real world problems.

![Ability to solve engineering problems](image)

Figure 11.

All interns should possess the ability to design, implement, analyze, and interpret data. They should adapt quickly to the software and hardware tools they utilize to build their design. To a large extent the ability of the intern to analyze system functionalities depends on his/her familiarity with the system. If the individual has worked on a similar system on a prior occasion, it will not take him/her much time to get accustomed to the system again. There should be a balance between the knowledge an individual has and the approach he/she utilizes to solve a problem. When prior knowledge goes hand in hand with approach and innovative thinking, new inventions are given rise to. The ability of an intern to design and analyze systems is something that he/she can develop over a period of time, and the approach with which he/she implements it is what importance should be given to. Figure 12 and figure 13 shows feedback that clearly indicates that the knowledge the students have is adequate for them carry out the above mentioned abilities. Figure 13 indicated that the ability of the interns to use application specific software and hardware is outstanding. Thus we can come to conclusion that the approach with which an intern tackles a problem helps them develop problem solving skills that will last with
them through their livelihood compared to memory which can be retained only for a limited period of time.

Figure 12.

Figure 13.

Figure 14 and figure 15 contains the employer’s feedback regarding the intern’s behavior as a group player and his/ her professional and ethical attitudes towards job responsibilities. Being a team player is very important in an industry environment, because different teams have to collaborate with each other to develop a marketable product. There should always be a bridge
of communication between the manager and the interns in the form of group meetings, weekly review meetings, and conferences. These events give the interns the opportunity to interact with their peers and in the process will help them improve their communication skills and personality. Displaying professional and ethical attitudes towards their job helps them set high standards for the company as well as themselves. Maintaining the privacy of company’s intellectual property entirely depends on the professional ethics its employees follow. It’s this intellectual property that develops into future products of the company and hence is closely guarded by company laws. Professional skills come into play when employees interact with representatives of various other organizations. Working with a strong sense of professionalism and ethics helps instill confidence and a sense of self respect for each other.

![Graph](image1)

**Figure 14.**

![Graph](image2)

**Figure 15.**
Figure 16 and figure 17 contains the feedback analyzing the oral and writing abilities of an intern. During an internship students will have to develop the skills of delivering oral and written reports. Oral reports can be a casual meeting between the intern and his/her manager or it can be a meeting where in strategies are laid for a project. It is essential at this juncture of time that the fellow employees and peers understand what the speaker is speaking about. Making sure that a clear channel of communication persists with his/her listeners is entirely the responsibility of the speaker. Delivering the message without being verbose, embedded with ideas is an art that each employee will have to develop in the course of his/her stay in an organization. Another challenge many interns face is writing reports. Writing is also an art that cannot come by easily
without practice and perseverance. An intern having passed the hurdle of putting his/her thoughts/ideas down on paper and voicing his/her ideas during oral presentations will have attained two attributes that are essential for his/her growth in an organization. Analyzing figure 16 and figure 17 we can notice that most of the interns have an outstanding or adequate ability of delivering oral presentations as well as written reports.

**Overall Performance of the participating students**

![Overall performance of all students](image)

Figure 18.

Figure 18 shows the overall performance of the participating students. We can clearly notice that out of a total of 338 students 189 students fall in the category of outstanding students, 118 fall in the category of very good, 26 in average, 2 in marginal and unsatisfactory and 1 in not applicable N/A. Having a large number of students fall in the first two categories is an indication that the employers are more than satisfied with the performance of the interns. This is a positive indication that graduating engineers are coping with the industry at a very fast pace. The only matter of concern here is related to the time taken by the industry to train the students to the technology they are using. Reducing the transition period taken by students to cope to the industry should be the element of focus in the years to come. Shorter this period, better it is, as it sets up a constant flow of skilled engineers into the vast pool of industries.

**Summary of observation and conclusion**

With the emphasis on research increasing in universities, efforts aimed towards bridging the void between the industry and the university is reducing. The feedback obtained from the employers gives the reviewers an idea as to how engineering graduates cope up with the fast paced industry. The feedback not only provides ample information about the attributes and qualities employers look for in potential hires but also helps reviewers develop ideas to obtain a
balance between application oriented learning and classroom based learning. An internship acts as an effective channel for students to apply the skills they accumulate in school. It also acts as a channel of recruitment where the employers access the performance of the interns and decide whether the individual is competent enough to be hired as an employee. Being beneficial to both the employer and the participating intern, internships allow students to understand the entire concept behind applying all that they studied in the classroom.

An alliance between the industry and the university can also be viewed as an effective venture to bring application based learning into school. The alliance being governed by members from both the school as well as industry will help students work on industry oriented projects in a school environment. With rapid growth and advancement in the field of engineering and sciences it is important for the universities to keep up with technology being used by the industry, and an alliance would be an effective method to achieve this.

All the above mentioned methods help in bridging the gap between the university and the industry. The feedback obtained helps us to review the characters and mindset of graduating students. It helps us in developing ideas which when incorporated in classroom based learning would make the student competent to join the engineering workforce once he/she graduates. Keeping this in mind it is utmost importance that practical, application oriented teaching is incorporated into classical classroom based education with an intention to reduce the transition time taken by fresh graduates to adapt to the industry.
References


