COLLABORATION BETWEEN INDUSTRY AND ENGINEERING EDUCATION

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Abstract-- **At present the industry needs an engineer to master cross-disciplinary competencies and general skills in terms of outcome based education, basis for continuing education and development. Every engineer does not have to master all of these skills and competencies, since sharing knowledge and networking are ways to both deepen and widen personal knowledge into a competent team or network. The educational factors for the student studying engineering technologies lie in the practical R&D processes. The students were assigned to the on job training in the actual R&D in the practical industrial sides. The frameworks that can be deployed across various institutes foe fostering creativity and innovation. The framework envisages various path ways such as research, corporate, socio managerial and entrepreneurial. The frame work would have the facility to develop a network of various educational institutes especially to share the learning in this area. Education is always a relevant issue for those of us in the electronics industry. It affects not only our technological status in the world but also the availability and competency of qualified graduates to fill job openings. If you aren't paying attention to education, now is the time to give it some time. The industry and academia both support the creation of more industry-college partnerships, internships, and industry participation. Meanwhile, STEM (science, technology, engineering and math) education in the K through 16 grades is ongoing, but more needs to be done to attract more students to fill the pipeline to employment in engineering.**

Keywords-- Indian Engineering education, Creativity and Innovation Competency Development, Framework, Career development, engineers, work-based learning, competence, skill, company collaboration.

I INTRODUCTION

The framework mandates that the students think of real life problems and create innovative solutions and deploy them to deliver value, right from the early years. All such projects are expected to culminate into worthwhile an industry quality capstone projects. The redesign will require the faculty members learn and develop state of the art pedagogical techniques. The institutes may have to

undertake the change in a phased manner. All these can synergize into developing creative and innovative Indian engineers. That will not only facilitate the students to become 'industry ready engineers' but also give them confidence needed to transform their visions into realities. The paper proposes appropriate ongoing measurements and commensurate activities with expected outcomes starting right from the third to last semester.

Many developed countries are looking up to India to fulfil their requirements of engineering graduates to a good extent. This requires serious review and action on war footing. The outcomes of an educational system largely depend on the faculty and they have to act. The faculty is involved in teaching, assessing, researching, mentoring as well as developing academic processes and infrastructure as well as establishing collaborations with academia, industry and alumni. Unfortunately, currently the education system is facing shortage of good faculty resulting in shortcomings in all the areas mentioned above. The shortage results in their engaging in age old lecturing method and not paying attention to and assimilating the leading edge research in the area. This has to change. There have to be initiatives – coming from faculty members themselves - to develop the competencies required of the 21st century engineers and increase their students' employability.

A K–16 engineering "conversation" has been initiated and is picking up steam. This involves establishing longterm and skill-building relationships between engineering colleges and K–12 schools and exploiting *engineering as a vehicle for the integration of science and math* in ways that connect youngsters to the joys, challenges, and relevance of a future in engineering. Such experiences helpstudents recognize the pervasiveness of engineering in their everyday lives and enable them to internalize engineering as a helping profession. Furthermore, early and extensive engineering experiences can prepare children and young adults to thrive in a technologically driven society—helping them to recognize the complexities of contemporary issues, engage intelligently in the discourse of our times, and make informed choices that take future generations into consideration.

The current Indian engineering education system appears to inhibit the competency. Till the recent past, the Indian industry, especially the manufacturing sector, was driven by imports and offered mainly production, support and maintenance jobs. The academia was playing to the requirement and not nurturing problem solvers and knowledge creators and neglected both application-oriented and fundamental research. This is reflected in producing just 1000 PhDs per year as against 3500 in the US – even when the US has only 10% of engineering graduates as that of India. Another reflection is in dismal number of patents. India ranks 17th with 5170 patents while Japan and US are well above 200,000 mark (Patents, 2013). China is not far behind them and South Korea is touching the 100,000 mark. Indian education system has to do a lot of catching up so that India can leverage their demographic dividend and not face demographic disaster.

In the long run, making universities and engineering schools exciting, creative, adventurous, rigorous, demanding, and empowering milieus is more important than specifying curricular details. This paper proposes a framework that can help to integrate development of innovation competencies with regular engineering curriculum. There have been many organizations and individuals who are working to develop the competencies.

The next section covers literature survey and is followed by articulation of the proposed framework and ends with concluding remarks. The main contribution of the paper is explaining the need of a framework and detailing out its design.

II Related Work

The need for sharing knowledge between research institutions and industry has become increasingly evident in recent years . In parallel, it has become clear that research institutions need to play a more active role in their relationship with industry in order to maximize the use of the research results. It provides an international platform to the youth to showcase their talents and skill sets in fierce competitions, display cutting edge technology and research from all over the globe. We believe that there is a need to plough back learning's from all these efforts and develop a robust framework that can facilitate the integration. The framework posits four pathways for engineering students – entrepreneurial, socio-managerial, and corporate and research. It uses various personality assessment techniques in their second year to identify right pathway for each student and provides flexibility to change that as they proceed to the final year. The framework hinges on project based learning that is supplemented by two theory courses – one in the third and one in the sixth semester. It proposes four projects along with competition at different levels to cross pollinate learning and encourage better performers. At least some of the projects can be merged with the current curriculum and be executed.

There is also a need for existing resources to be made more accessible. This can be partially achieved through co-ordination. At present, certain research institutions have staff who actively pursue links with industry, but who do not interact amongst themselves. By pooling their knowledge transfer competencies, they can ensure that such skills are made more widely available throughout the research institutions. Furthermore, significant benefits may arise by outsourcing certain specialised functions or by pooling resources or R&D results (and associated IP rights) between several research institutions.

For the next generation of engineering students, the most exciting period in human history for science and engineering are the Exponential advances in knowledge, instrumentation, communication, and computational capabilities have created mind-boggling possibilities, and students are cutting across traditional disciplinary boundaries in unprecedented ways. Indeed, the distinction between science and engineering in some domains has been blurred to extinction, which raises some serious issues for engineering education. As we think about the challenges ahead, it is important to remember that students are driven by passion, curiosity, engagement, and dreams. Although we cannot know exactly what they should be taught, we can focus on the environment in which they learn and the forces, ideas, inspirations, and empowering situations to which they are exposed. Despite our best efforts to plan their education, however, to a large extent we simply wind them up, step back, and watch the amazing things they do.

At the universities, research and publication are the primary concerns. Students seem to be lower on the priority list. An overwhelming internal focus keeps students from getting the attention they pay for. A key issue at most schools is student retention. Actual graduation rates are only in the 22% to 56% range. Colleges are attracting students to engineering, but most of them are not completing an engineering degree. Many switch majors because of the heavy math and analysis that engineering requires. Financial issues play a role too. It almost appears that we could meet the needs of the industry if we could find a way to hold on to the students that colleges do recruit.

THE OUTCOME IMPACT GAP BETWEEN INDUSTRY AND UNIVERSITY

About half of the 106 projects studied resulted in what were seen as major outcomes (i.e., they produced new ideas or solutions to problems, developed new methods of analysis or generated new intellectual property of potential benefit for the company). But only about 20% of the projects led to major impacts on the company that participated in the collaboration process for a biotechnology product. The company contacted a faculty member with the relevant expertise and set up a two-year project. The company project manager disclosed the specific company needs, but did not explain how the project fit into the company's related strategy. The project manager told us that this was an explicit choice; the company, he said, "is really reserved when it comes to revealing its technology strategy." The result was that the solution delivered by the university researcher met the need in a way that was not consistent with other strategic considerations. It consequently had no subsequent value to the company.

III INDUSTRY AND RESEARCH INSTITUTION – WORKING TOGETHER TOWARDS A KNOWLEDGE ECONOMY

The main theme of the paper is that there have been many organizations and individuals who are working to develop the competencies.

Design of Framework

The salient features of the proposed innovation competency development framework are displayed

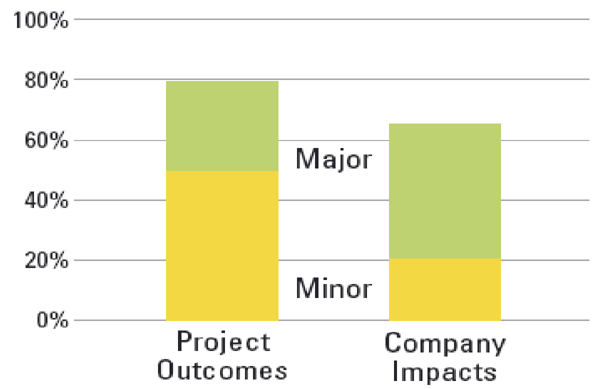

Fig1: Outcome Impact gap for Industry-University

in Fig.2. It has four poles – Project Based Learning, psychometric assessment, benchmarking and varied career options. The framework is broadly divided into three stages – Inception, Elaboration and Transformation (Figure 3) and follows spiral approach. The inception introduces the innovation, its criticality and expects students to work on their first project – P0. The Elaboration phase consists of a project P1 from students' chosen discipline and a project P2 of interdisciplinary nature and a theory course. All of them will provide elaborate idea about their pathways. The last stage primarily consists of their capstone project and helps the students to transform into innovative and employable individuals.

The figure 4 elaborates the framework, is based on the principles of project based learning, psychometric assessment to choose appropriate pathways and competitions at different levels to enhance cross pollination of ideas and sharing of solutions. It offers various pathways and opportunities to switch them as students learn more about themselves. The framework would transform the engineering students into effective employable professionals.

The Outcome-Impact Gap

The main observation that drives this discussion is that industry-university collaboration often produce interesting outcomes — for example, an insightful technical paper, a proposed process or a new computer code — but those outcomes have minor or no impact on company productivity or competitiveness. Roughly 50% of the examined projects resulted in what were seen as major outcomes (i.e., produced new ideas or solutions to problems, developed new methods of analysis or generated new intellectual property of methods

Fig 2: The salient features of the proposed innovation competency development framework

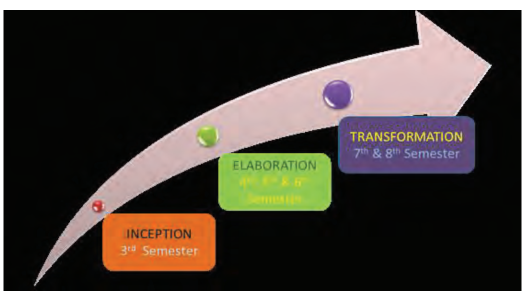

Fig 3: The Transition Stages

of analysis or generated new intellectual property of potential benefit for the company).Given the risks in research funding, that is an impressive batting average. The fact that almost half the projects had successful and consequential outcomes suggests that these companies are effective in their selection of university research projects. That's the good news. The bad news is that only 40% of the projects with major research outcomes were exploited in ways that led to major impact, defined as an observable and generally agreed-upon positive effect on the company's competitiveness or productivity. The other 60% of the projects underachieved, at least from a business standpoint: The outcomes did not make their way into products or processes or influence company decisions. This study aims to determine and address the conditions that lead to such reflections. The "outcome-impact gap" is not unique to industry-university collaboration.

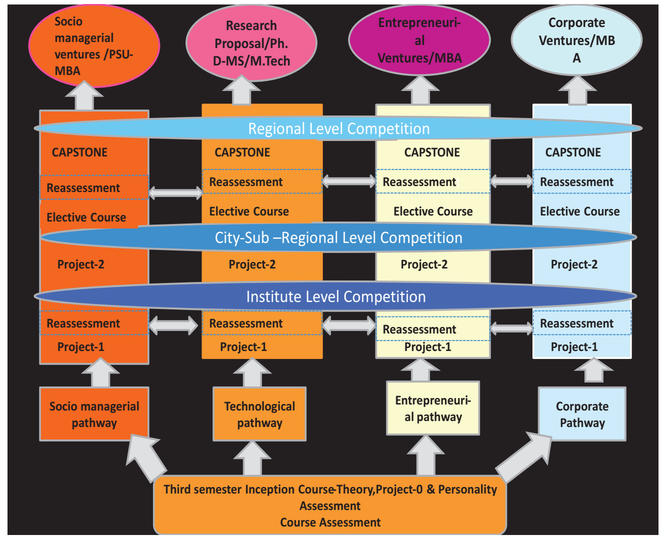

Fig 4: The Framework showing four pathways.

University projects with links to internal company interests create a strong continuing basis for collaboration when the research complements the company's own R&D or when the project is considered important for the company's technological leadership. Further, when company personnel work on areas linked to the university project, the knowledge flows connected with the collaboration are heightened, providing additional pathways for uptake of the results. These additional linkages broaden and diversify the communications channels that are key to maintaining project alignment, and in some cases even can enable a realignment of the research goals with changing company strategy.

Industry-university collaborations must be aligned with the company's research and development strategy and address a tangible need of the company. If not, there is high risk of investing in projects that have little or no impact. Our companies already know this, but it often seems that the public and the body politic are still largely in denial of this reality—a very dangerous situation. If we continue to deny the realities of globalization or, worse yet, retreat into protectionism, then we won't do the very things that will enable us to lead and benefit from this brave new world. Meeting these challenges will require an accelerated commitment to engineering research and education. Research universities and their engineering schools will have to do many things simultaneously: advance the frontiers of fundamental science and technology; advance interdisciplinary work and learning; develop a new, broad approach to engineering systems; focus on technologies that address the most important problems facing the world; and recognize the global nature of all things technological.

KNOWLEDGE EXCHANGE PATHS IN INDUSTRY-UNIVERSITY COLLABORATION

An effective communications framework can help bridge the gap between outcome and impact. It is important to have two-way knowledge transfer between the university researchers and the company's project manager (green arrows), as well as between the project manager and others in the company (blue arrows) shown in Figure 5. In addition, the project manager should keep groups inside the company abreast of progress on the research collaboration, and inform the university team of ideas from the company regarding potential linkages to other company activities (orange arrows).

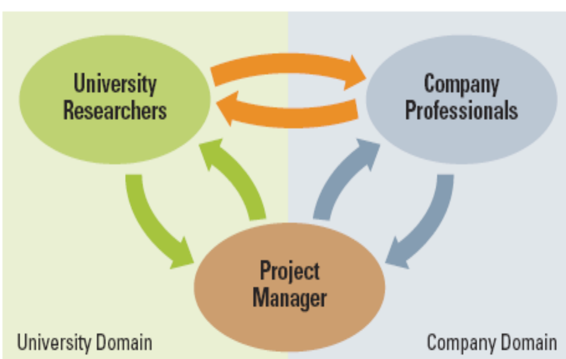

Fig 5: Communication Framework

This paper, thus designed to investigate whether the channels for knowledge exchange were active both during and after project completion, as well as to examine the quality of the relationships.

THE SEVEN KEYS TO COLLABORATION SUCCESS

1. Define the project's strategic context as part of the selection process.

- Use your company research portfolio to determine collaboration opportunities.
- Define specific collaboration outputs that can provide value to the company.
- Identify internal users of this output at the working level; executive champions are not a substitute for this requirement.

2. Select boundary-spanning project managers with three key attributes:

- In-depth knowledge of the technology needs in the field
- The inclination to network across functional and organizational boundaries
- The ability to make connections between research and opportunities for product applications

3. Share with the university team the vision of how the collaboration can help the company.

- Select researchers who will understand company practices and technology goals.
- Ensure that the university team appreciates the project's strategic context.

4. Invest in long-term relationships.

- Plan multiyear collaboration time frames.
- Cultivate relationships with target university researchers, even if research is not directly supported.

5. Establish strong communication linkage with the university team.

- Conduct face-to-face meetings on a regular basis.
- Develop an overall communication routine to supplement the meetings.
- Encourage extended personnel exchange, both company to university and university to company.

6. Build broad awareness of the project within the company.

- Promote university team interactions with different functional areas within the company.

• Promote feedback to the university team on project alignment with company needs.

*7. Support the work internally both during the contract and after, until the research can be exploited***.**

• Provide appropriate internal support for technical and management oversight.

• Include accountability for company uptake of research results as part of the project Manager role.

In addition, one of the most effective methods of developing such skills and sharing knowledge is the movement of staff between research institutions and industry. It is therefore important that the appraisal criteria also take into account other activities such as patenting, licensing, mobility and collaboration with industry**.** Firstly, a governing board representing both business and academia will provide strategic guidance on the selection, evaluation and coordination of *Knowledge and Innovation Communities* (KICs). Secondly, a set of autonomous KICs will be selected to carry out the work. They will fully integrate and perform innovation, research and education activities on designated themes. They will be joint-ventures of partner organisations representing universities, research organisations and business.

The message from this study thus goes beyond identifying the seven practices. Merely talking a good game is not sufficient. What is needed is execution and follow-up of the actions: longer-term projects, continuing relationships, assigning project managers who make the contract feel like a partnership and enabling these managers to invest the time and effort to generate effective knowledge flows between the university and the company. We understand the difficulties. The professionals who perform this function well are almost always needed for other jobs, the cost of their time is high and there is difficulty in capturing and defining the benefits for a given project. However, implementation collaborations that create and deliver substantial value for a company of these seven practices can lead to.

FIVE THINGS THAT DON'T AFFECT COLLABORATION'S IMPACT

Several factors widely thought to be important to industry-university collaborations in fact had little effect on the projects' business impact.

Presence of an executive "champion.":

Although a powerful ally in the executive suite can help obtain support for a project, we did not find a correlation between the existence of such a champion and project impact. To deliver value, the key is whether the project addresses a real need, as perceived by working engineers in the company

Geographic proximity

Companies scouted for collaborators worldwide and were able to bridge geographic distance through visits, personnel exchanges and student internships. The important factor is not proximity but personal interaction between the academic research team and the company.

Overall project cost

The time frame of the project, not the amount of funding, is important.

Type of Research, basic applied or advance development

There was no statistically significant difference in terms of impact between projects with different missions. What is important is that the projects address a tangible need for the company.

Location of project manager

We found no evidence that the location of the project manager, whether at a central laboratory or a business unit, affects project impact. What is important is that the project manager is able to span these organizational.

IV CONCLUSION

In this paper, we provided a new method of creativity education in engineering as well as introducing a possible way to create a flexible curricula strategy for generating creative products. We have tried to keep the framework simple to increase the chances of success. There is a serious paucity of qualified engineers in the developed world and is expected to become worse .Revamping of system is required to fulfil the requirements of the globe and to grow in both economical and technological dimensions. As of now the system is criticized for its poor performance on the employability of its graduates. If the revamping is not done expeditiously and appropriately, there is a danger of losing on opportunities of serving the globe. This paper concludes that in industry environment, the company managers are aware of the above practices, they paid little or no attention for implementing them. All the interviewees stress the importance of informal technical communications and personal relationships, but the company briefing on managing University research made almost no reference to activities to develop such relationships.

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