A LINK BETWEEN INDUSTRY AND ENGINEERING AND ENGINEERING TECHNOLOGY INSTITUTIONS

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Abstract
A means for training and employing the knowledgeable and skilled workforce for careers in engineering design, manufacture, testing and marketing areas has long been envisioned by the Engineering Accreditation Commission (EAC) and Technology Accreditation Commission (TAC) by requiring a connection between industry and academic institutions. Student learning and student preparedness for careers in industry was the primary intent for warranting this cooperative connection. The accreditation criteria require that students acquire mastery of knowledge in engineering and design principles and apply this knowledge to solve technical problems of significance to industry.

This paper examines the current practice and life cycle evaluation of interaction between academic institutions and industry. The roles of Industrial Advisory Councils (IACs) and their effective use by the academic institutions are explained here in the context of institutions meeting the accreditation criteria. Although this link between industry and academic institutions seems to be working well in the US system of engineering education, its effectiveness is not guaranteed in the impending economic downturn and global competition. This paper discusses a few concerns in the industry and academia relationship and indicates the extended scope of collaboration.

1. Accountability in Engineering and Technology Education: A Preamble

Undoubtedly, the United States' college-level science, engineering, and technology education and training is superior to many others in the world and it's due to the checks and balances embedded in articulation and implementation methods to continuously improve student learning. The stakeholders to making the engineering and technology education success are: students, faculty, society, and industry, each group with its constraints, privileges, and responsibilities. Students will learn to develop skills and knowledge for employability, faculty members will instruct students to impart mastery of technical and humanities knowledge, industries will employ graduates and use their skills to create economic and technological wealth, and society including professional societies and accreditation agencies will benefit from the economic growth and will provide support and guidance to the educational system. This interdependent engineering and technology educational system requires each stakeholder to play a distinct role in the design of holistic curricula, mode of instruction, and method of assessment and accountability. The curricula and academic activities of engineering and technology degree programs are thus designed to generate knowledge and engage with industry and community. Thus there is a natural connection or link between academia, industry, and society, and this link is to be fostered and strengthened.

This paper analyzes the nature of linkage between the academia and industry, especially the role of industry in affecting students' acquisition of technical and soft skills to benefit industry and society. The industry and society expect engineering and technology programs to acquire mastery of technical knowledge through integrated holistic curricula and solving technical problems. Students are also expected to gain skills in communications, team dynamics, and develop appreciation for diversity and professional ethics. But the design of integrated holistic technology curricula is often prone to errors and pitfalls. Industry as a user of technical graduates is better suited to defining a balance between the technical and humanities courses and is considered an effective link between practical engineering and academic programs.

2. Linkage Validation by the Accreditation Board for Engineering and Technology (ABET)

TAC and EAC [1, 2] of ABET, and the Association of Technology, Management, and Applied Engineering, the new name for the National Association for Industrial Technologies [2] are the regulatory bodies that emphasize the integrated learning experiences to students with the active involvement and support from all stakeholders. The requirements elucidated through criteria (a) through (k) require that the engineering and technology programs at the associate and baccalaureate level provide evidence to continuously assessing and evaluating student learning for receiving initial and continued accreditation. Criterion 7 of TAC/ABET [3] requires that the engineering and technology programs establish IACs to advise and assist degree programs in the design, assessment, and evaluation of curricula with focus on student learning.

3. Roles and Obligations of IACs

It's noted that all accredited engineering and technology programs in the US have met accreditation criteria by maintaining IACs. The roles of industry and academic institutions in this cooperative partnership are indicated in the Table 1 below, and only a few programs excel in achieving all the collaborative elements.

IAC Members	Academic Programs
1. Advise and direct curriculum design	1. Receive advice on technologically relevant curricula
2. Have expeditious access to students for internships, jobs, co-ops	2. Play a major role in the design of technologically relevant curricula
3. Access to specialized equipment/facilities at the university	3. Incorporate student competency gaps in curricula
4. Partner with faculty on research/design projects	4. Stay current with emerging trends in engineering practices
5. Interact with other industry representatives of IAC	5. Work with practicing engineers to develop new solutions for industry

6. Have access to patents from the university and programs 7. Promote technology transfer 8. Evaluate employee performance in jobs 9. Work with faculty to develop applied research/workforce development grants and proposals 10. Co-develop professional development courses/topics of mutual interest 11. Play a role as evaluators in accreditation process 12. Provide student scholarships, financial and other support, and 13. Champion engineering and technology programs and students with industry, legislature, and community.	6. Help place students in jobs/internships 7. Develop continuous improvement strategies for program development 8. Develop questionnaire to assess student learning and curriculum effectiveness 9. Acquire and analyze assessment and evaluation data/validation data 10. Collaborate with industry to develop industry oriented research grant proposals 11. Develop, promote industry relevant professional development courses 12. Work with TAC/EAC to receiving accreditation to degree programs.

Table 1. Academic Programs and Industry Partnership

4. Issues in the Roles, Framework, and Structure of IACs

Accreditation commissions make specific references to IACs' relationship with academic programs. Some common characteristics of IACs are: academic administrator and faculty members of the concerned programs select IAC members; members provide volunteer service for a period; IACs have a mission statement; members play an advisory role on curriculum design; members champion the degree programs and graduates, and members provide financial and other support to programs.

The following paragraphs describe, in brief, current practices and potential concerns in the industry-academic institutions' partnership.

4.1 Membership

How an IAC is constituted depends on the institution. Purdue [4] suggests as many as 15-16 members to serve on IAC. Faculty members and knowledgeable senior executives from a variety of industries constitute this group. In addition, this author recommends inclusion of representatives from state government agencies, especially from the department of higher education, administrators from two year colleges, high school principals and counselors, member of the state PE Board, student chapters' representative, university co-op, career, and development offices' representatives, and a representative from Dean's office in this group of advisors. Invitation to participate can vary to emphasize the purpose of the meeting.

A note of caution here is about the Dean's representative. Deans often attempt to influence the agenda of the program, especially fund raising. The chair can structure the program/department agenda to include or exclude Dean's presence at meetings but has an obligation to report the deliberations.

4.2 Curriculum Design

Academic programs have the primary responsibility of curriculum. Faculty members often tend to maintain status quo while industry members would tend to promote courses that are closely related to their employer's needs. These conflicting interests may burden the curriculum with new topics and additional hours. Industry's desire to influence curriculum focus and research direction is more pronounced if large sums of monies are pumped in to academic institutions [5]. Less than the optimal understanding of the intent of curriculum to give integrated learning experiences to students often leads to skewed relationship between industry and academia.

To avert this situation, a curriculum committee consisting of discipline-specific faculty members and knowledgeable, experienced industry representatives should meet once a year *separately* to evaluate the effectiveness of curriculum meeting industry needs as well as ABET criteria. This advisory committee can also undertake other activities such as generating a list of industry design projects, and evaluating student performance in executing capstone design projects, on voluntary basis.

4.3 Program and Student Development

Industry members with experience should be assigned to take leadership role in generating financial support for student scholarships and program development. Their activities can also encompass identifying internships for students and faculty, identifying research areas for collaboration, and promoting technology transfer. A unique activity instituted by this author was to implement the "Industry Shadow Program" sponsored by industries in Arkansas. This program has yielded many beneficial results to students but it required significant participation and support from industry. The committee on program development should meet once a year *separately* to explore ideas and assess their performance.

4.4 Assessment, Evaluation and Accreditation

This committee consisting of the program chair, faculty members, and a select group of industry representatives should become well acquainted with various elements of ABET criteria and continuous improvement. The committee should develop the educational objectives of the program, a questionnaire to assess graduates' job satisfaction, methods to measure employer's satisfaction with graduates, and provide feedback on how the program is achieving the written outcomes. This direct involvement in the assessment process by members enables them to identify competency gaps in student knowledge and skills. The chair and faculty would then incorporate IAC findings for program improvement. Some industry representatives should be encouraged to become ABET evaluators, eventually.

4.5 Commitment and Passion

Many industrial representatives readily accept the invitation from academic programs to serve as advisors and consider it as a privilege to serve. It happens that high-level executives who signed up to serve on IACs will soon delegate their assignments to junior-level engineers, and as a result academic program suffer for not having the benefit of stewardship and guidance from experienced executives. Lack of creative engagement by industry members results in waning enthusiasm for the partnership. Industries see their investment as non-rewarding with no tangible return on their involvement. As a result, IACs become lukewarm, routine and stagnant advisory councils. The success of this voluntary, collaborative partnership rests mostly on the leadership of the degree program. The chair needs to involve all IAC members by assigning faculty members and industry representatives to committees on curriculum design, student scholarships, laboratory development, student mentoring, professional development courses and lectures, and assessment and evaluation.

5. Challenges and Expanded Scope of IACs

Current challenges [6] facing several engineering and technology programs in the USA are: having to admit under-prepared students in science and mathematics to pursue baccalaureate programs in engineering and technology; high attrition rates; insufficient number of suitable jobs in industry; lack of effective mechanisms for transfer of technologies [7]; rigid curriculum structure; lack of enthusiasm on the part of industry and academia to collaborate; and lack of means to develop new solutions for the emerging needs in energy, environment, and human resources development at the global level.

The following paragraphs describe, in brief, the need for expanded roles of IAC members.
(a) Industry members can play a key role in encouraging academically talented high school graduates to pursue math, science, engineering, and technology (STEM) degrees by rewarding them with scholarships at local colleges. This activity will let colleges recruit quality students and reduce attrition. Direct involvement by industry representatives through lectures, visits, and mentoring will reduce attrition and increase graduation rates in STEM programs.

(b) Industries can consider creating career oriented training cells to help graduates get trainee jobs. Individual or collective training programs by local and regional industries with active participation by academicians will serve as workforce development banks and will help graduating students to access jobs nationwide.

(c) Industry members can involve state legislators to develop a balanced curriculum for technologists. The 4-year rigid curriculum structure is a restriction to introduce timely knowledge and skills for college students. The case in point is: lack of instructional expertise in energy, environment, transportation engineering, manufacturing and costs, and materials technologies. In state colleges, there is a heavy share of humanities courses and this issue will need to be addressed by legislators in state assemblies. Time is ripe to evaluate this issue at the national, if not at the global level.

(d) The global competition for excellence in STEM areas is real. Although the US college education and training is superior to other nations, high attrition and lack of interest by US students in STEM are a severe burden on instructors. These problems are compelling engineering and technology institutions to recruit students from abroad. Satellite programs through memorandum of agreements are transferring students at the undergraduate level. Foreign students are good learners but they have limitations: language skills, ability to function independently, practical knowledge and technological skills. These recruitment trends have put additional burden on faculty and resources in the US institutions, and

(e) An emerging challenge in solving problems facing the world is the need to work with faculty and industry at the global level. This globalization process begins with designing a compatible curriculum agreeable to all nations involved. Related issues are the protection of intellectual property and provisions for seamless industrial jobs across the globe. The task will also involve unified assessment, evaluation, and accreditation criteria and thus involving representatives from global industries. These expanded activities will involve cultural shift in engineers in other countries, especially those in Asia and Middle East where industry participation in academics is not warranted or witnessed.

6. Conclusions

This paper examines the current and future partnerships between industry and academic degree programs to design, develop, and promote an effective education and training programs with a mission to serve students, technology innovation, and society. Industry and academia must agree on the value of balanced curricula that gives holistic learning for students. Composition and structure of curriculum, balanced perspective, and knowledge and enthusiasm of IAC members are the keys for the effective link between industry and academic programs. Assessment and evaluation of student learning at the global level of new and emerging technologies such as energy, environment, health, and effective resources development will expand the roles of newly envisioned IACs.

7. References

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