Corporate Connections: Developing Programs and Relationships; Phase III

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Abstract – **Partnering on the development of a state-of-the-art manufacturing facility has provided the opportunity to examine and report on collaboration between Youngstown State University and Summer Garden Food Manufacturing. In retrospect, the authors take the opportunity to explore the connections that were established or strengthened through this collaboration. The viewpoints of the Industrial & Systems Engineering faculty, the students, and the corporate participants are considered in the introductory discussion and in the case study that follows. This is the third ASEE paper in a series by the primary author exploring three elements of academic/industrial partnering including: service learning, student professional practice, and faculty involvement in technology transfer. While the two previous works, in turn, focused on the characterization and impacts of course-embedded service learning assignments and formal student professional practice assignments, this paper pursues the characterization and impact of the faculty involvement. The discussion begins with retracing the well known, traditional paths of cooperation and moves on to the less defined aspects of the various relationships among the faculty members, the students and the institutions involved. These relationships outside of the classroom, however imperfect they may appear to some, are examined as valuable seeds for continued relationship-building and the long-term benefits that those relationships can offer. Educational program activities made possible primarily by faculty involvement outside of the classroom are described in brief. The YSU/Summer Garden collaboration is presented as a case study. Finally, readers are encouraged to pursue "externships," or outside activities by any name, so that the benefits may one day be well understood, clearly defined, and properly valued.**

Index Terms – industry/university partnership, professional development, industry outreach.

INTRODUCTION

In the past, the primary author with others has explored three specific avenues for partnering; curriculum (service-learning based education), professional practice (internships), and faculty-based technology transfer arrangements (externships). First, as supplemental to the curriculum, service-learning based education was explored and reported on in 2002 [1]. Next, the impact of an intensive service learning component in the curriculum on internship opportunities and experiences was reported on in 2003 [2]. Finally, an effort to understand and report on the formalization of externship activities was reported on in 2004 [3]. In retrospect, increased service learning activities did lead to increased and higher quality internships and improvement in the internship network did lead to improved relations between faculty and employers. However, the development of externships or at least the identification of externship-like activities has been difficult. In the final collaboration cited above it was possible to observe and report on the externship-like activities associated with an industrially funded, campus-based research center. This paper focuses on the activities at a partner's site as full partners in its inception, design and implementation. The development of a new, state-of-the-art, LEED (Leadership in Energy and Environmental Design) certified food processing plant has opened doors for a unique collaboration between Youngstown State University and the SGFM (Summer Garden Food Manufacturing) division of the John Zidian Company. The professional development opportunities in the context of externship activities are explored from the perspective of both organizations. Also, with the creation of funded GA/I (Graduate Assistantship/Internship) opportunities at Youngstown State University, it is possible to explore and understand the integration of students, faculty, and local company engineers in the context of externship activity. The nature and scope of this collaborative approach is presented in this paper with the specific learning and technology transfer benefits cited. The faculty advisors have found avenues to keep abreast of the latest industry innovations. The research assistants and faculty have gained access to industrial equipment and research opportunities. The faculty members have been able to bring real-world connections to the classroom and students have begun to learn about the needs of actual employers. Finally, the employers have learned how to better utilize the university as a resource at various levels. SGFM has hired YSU interns from Industrial, Mechanical, Chemical and Civil engineering. Providing students from all areas with more specific preparation for careers with the corporate partner helps the company to significantly shorten the training period at its facilities. Finally, this collaborative approach provides opportunities

to support the local community through industry outreach and to showcase, to both companies and prospective students, the quality of YSU engineering programs.

TRADITIONAL PATHS OF COOPERATION

Engineering faculty and students traditionally interact with industry through a variety of mechanisms. These mechanisms have evolved under a paradigm where professional development activities of stakeholders occur largely independent of one another. Opportunities for cooperation differ substantially based on the type of interaction, and opportunities are not integrated. Typical paths of interaction are depicted in Figure 1 below.

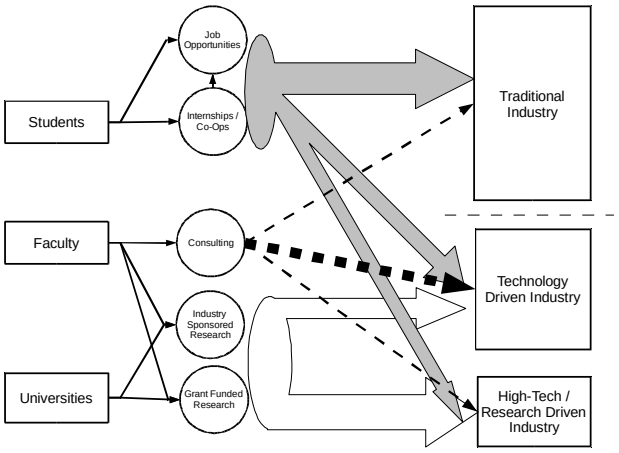

Figure 1
Typical paths of industry-university cooperation

Student-Industry Relationship

Following traditional paths, students gain practical industry experience through a combination of internship, co-op and capstone experiences. The scope of these experiences varies, but is generally limited to tasks that are within the skill set of the student or group of students. Internship experiences also vary widely in terms of experiential value, depending greatly upon the type of activities the student is allowed to perform, the length of the internship, and the level of mentorship provided to the students.

Faculty involvement in these activities may include some degree of oversight, but frequently does not include collaboration. For capstone projects students are typically given projects of a narrow scope for which they may have a reasonable likelihood of task completion within the allotted time period.

For students in internship and co-op positions faculty involvement is typically very limited. The nature of the interaction with industry is controlled by the partner company. In some cases, students will work closely with engineers within the company. In other cases the company itself may lack engineering strength and may rely upon engineering interns to supplement limited internal resources. In those cases the internship provides a taste of the realities of industry practice but offers little in terms of enrichment.

Faculty-Industry Relationships

In engineering, where many of the faculty have interests in both practical application and academic research, the interactions of faculty and industry typically take two distinct forms. In what has come to be the broadly accepted academic role faculty partner with industry as a mechanism for supporting academic research. In the role of a practicing engineer with a high degree of technical expertise the faculty may also work with industry as an independent consultant.

In the university-affiliated research role the nature of the work must be consistent with institutional expectations for scholarly merit and research funding. In this capacity many of the industry partners that are considered well-suited for student internships do not offer suitable project opportunities to support the faculty's needs for scholarly professional development. Companies that support this need must offer some combination of high technology, research and development presence, and a need for collaboration with academia.

In their capacity as private consultants, faculty members serve a vital role in technology transfer to traditional industries. Though these industries typically do not have problems or interests that are well suited to the research funding model of academia, they do benefit greatly from having access to the specialized talents of university faculty. Faculty members are valued industrial consultants because they possess a high degree of expertise coupled with access to the latest innovations of both industrial practice and scientific innovation. They are able to assist companies in addressing practical problems with a level of sophistication that may exceed what is available within the company or even within the industry. These problems, however, are typically addressed through technology transfer, rather than technology discovery, and have therefore been pushed outside the established research agenda of the university.

Industry-University Relationship

The nature of the industry/university relationship often depends on the nature of the company involved. For companies that operate within mature industries, universities primarily offer a pool engineering graduates as prospective hires. For these companies, interns offer an effective way to recruit and hire the most desirable graduates. In some cases, they also offer an opportunity to hire technically skilled temporary personnel at low cost. Companies of this sort are frequently not interested in developing R&D partnerships with universities as there is a justifiable perception that: 1.) the university's research priorities are generally not focused at a level that is relevant to these industries, 2.) the university's IP policies and pricing structure are incompatible with traditional industry, and 3.) the narrowly focused research priorities of many faculty tend to be incompatible with the economic pragmatism of these companies. In cases where these companies identify

suitable faculty, they will frequently pursue them as consultants.

For companies of suitable size or technological sophistication universities offer the prospect of research partnerships in addition to recruiting opportunities. Companies of this sort are typically either large enough in size to support dedicated R&D facilities or they are based on emerging technologies for which university partnerships provide access to expertise and resources that are not readily available otherwise. The resources that these companies seek may include not only technical resources, but also access to elusive grant funding to subsidize product development. In this capacity, the relationship between such companies and their university partners is a symbiotic relationship based on sponsored research, IP agreements, and the pursuit of grant funding.

STAKEHOLDER NEEDS AND INTERACTIONS

Literature suggests that there is an increasing need for integration of industry and university activities [4, 5, 6]. However, the typical models of industry-university cooperation do not foster synergistic interactions at multiple levels.

The vast majority of engineering graduates will not pursue graduate education or research [7]. Most of them will assume jobs that are consistent with the requirements of an undergraduate level of education. These students benefit from a perspective on engineering that emphasizes practice and application. Generally speaking, most of the companies that will hire these students perceive practice and application as the principal role of engineering, and expect that this is the goal of engineering education [8].

To prepare students to work in an engineering environment of practice and application engineering faculty are well served by activities in which they, themselves, actively practice and apply engineering skills. Because such activities are not generally acknowledged as professional development under current academic paradigms, engineering faculty must maintain their ability to work with industry through outreach activities, including consulting. These activities typically differ from and are practiced in isolation from research activities. They are also frequently divorced from any formal connection to the university.

Faculty research activities, of the sort that are prized for their likelihood of funding through traditional grant mechanisms, are heavily predicated upon a foundation in engineering science and the application of engineering principles at a level far above undergraduate education. Accordingly, the relevance of these activities to the training of well-prepared undergraduate engineering practitioners is often limited. Similarly, the companies for which most engineering undergraduates will be well-suited as employees do not have a direct interest in research at this level. The disconnect between the type of work that most undergraduates will be expected to perform in their first jobs, as compared to the research priorities emphasized within the university, creates a wide gap that the faculty are theoretically expected to bridge. In practice, however, this gap is frequently not bridged, as those who choose academia as a profession generally gravitate toward theory rather than practice.

Under ideal conditions, the priorities of all stakeholders could be met simultaneously. The activities that are included in the industry/university partnership would provide a cohesive theme of work for collaboration at all levels. The result of that collaboration would enhance the professional development and competitiveness of students, faculty, universities, and industries who participated in the process. In order for such a collaboration to be successful, a variety of expectations that have been established as norms must be reconsidered. The case study that follows presents the character and nature of a unique collaboration between The Industrial and Systems Engineering program at YSU and an innovative local food manufacturer, Summer Garden Food Manufacturing. The integration of this relationship at many levels illustrates the possibilities for establishing industry/university partnerships that span the continuum of interactions.

IMPACTS AND BENEFITS OF INTERACTIONS

Faculty research interests partnered with industrial relationships can be combined to achieve pedagogical advancements. There are multiple levels of engagement in this partnership, which range from freshman year courses, to integrated practice labs, to cooperative education experiences, to the capstone for undergraduates, to the graduate projects. Learning outcomes of curricular innovation stemming from such partnerships include increased exposure to emerging technologies, multi-disciplined activities, team learning, communications, and project management. There also exist many beneficial institutional outcomes including faculty development in research interests, improved industrial partnerships, improved aesthetic to curriculum both undergraduate and graduate programs, and graduate placement among industrial partners.

At an applied level, the proposed model integrates field activities for students, through internships, and faculty, through externships. This integrated relationship extends through a range of companies, from traditional industry to high technology. In the process, students gain industry experience and faculty mentorship. Industries gain technology transfer and impetus to explore innovation.

The case study that follows this discussion of curricular impact describes just one of many industrial-academic relationships that have demonstrated the potential for curricular innovation. Three benefits that have been observed in this and much other collaboration with industry are:

1. Faculty research interests are aligned with emerging technologies, and course content can thus be matched to these technologies and brought to the classroom, lab or field experience.

2. Potential pedagogical innovations are brought to light in a way that is both that is both relevant and measurable.

3. Institutional resources such as specialized centers become viable partners in curriculum development, in connecting programs to partners and in assessment activities.

Furthermore, curricular innovation helps in meeting the ABET "soft" criteria that industry is now asking for; communication skills, project management skills, working in teams, etc. [9] while impacting quality and relevance of the curriculum at all levels of the undergraduate and graduate experiences.

Impact on Faculty Research Interests

Faculty research interests have always been a source for and motivator of curricular innovation. Innovation driven by research interests presents new learning outcomes related to skill sets within the faculty. This is a chance for improved learning outcomes that come ready for assessment. When faculty research is conducted either with industrial partners or for industrial partners in emerging technology areas of interest the improvement in the curriculum is not only innovative but is now relevant. This leads one to suppose that emerging technologies belong at the forefront of curricular innovation. To wit, emerging technologies are the very reason for much continued training and development of their engineers. Early introduction to these emerging technologies puts students at an advantage once they enter the work field.

Impact on Institutional Positioning

Institutional offices of outreach are constantly striving to position themselves for interplay with the maximum number of players providing the highest quality of interaction with each. When faculty members are engaged in industry, the game of catch up is replaced with mutual complimentary roles. For example, The Office of Grants and Sponsored Programs maintains contract integrity for deliverables working with R&D while The Professional Practice Office provides the framework for supplying service learning contracts working with HR and these are usually seen as separate relationships. When teaching faculty are responsible for the deliverables they are more likely to go back to the drawing board on curricular initiatives that satisfy the needs of industrial partners, faculty and students. In the case that follows are examples of opportunities to impact the curriculum to support an emerging regional industry.

Impact on the Curriculum Delivery Modes

The curricular innovations stemming from faculty research interests and industry/university partnerships are as much innovations in delivery as they are the obvious innovations in content. The convergence of broad areas of practical interest creates an opportunity to address the needs of a diverse student body; those preparing to enter industry as product developers and process designers and those as members of multidisciplinary teams in the lab environment. Faculty members engaged in partnerships are more keenly aware of the value of service learning experiences for students and are more likely to seek opportunities.

In addition to service learning, other alternatives to lectures and institutional laboratories present themselves when faculty members are engaged in externship relationships. Lectures, while necessary and valuable can be combined with field exercises. Faculty with or without connections to industry are usually reluctant to "sacrifice" lecture time with field experiences. This resistance is lessened when the field experience is with a company that is a viable research partner for faculty and students and is a potential employer for students. The preparation in the lecture can affect the success and benefits that all parties seek. Adoption of a theme related to a relevant emerging technology can transform the lecture room into a runway for engagement. Such theme courses are ideal to keep students up-to-date on new directions in industry.

Another possibility is integrated practice laboratories. Integrated practice laboratories can be inspired by the field experiences or the theme courses discussed above. They are by nature multidisciplinary and set up so that they can integrate students from various disciplines in a "control room" lab environment. When students conduct laboratories only with equipment that is housed within their discipline, without variance from year to year, many opportunities for expanding the learning process is missed. Since each discipline has specific areas of expertise, the goal of the integrated practice labs is to introduce a multidisciplinary approach to engineering lab courses. This approach not only fosters interaction between students from various engineering programs, but also simulates an actual engineering workplace where technical experts collaborate in solving engineering problems. Faculty that are engaged with industry are more used to working with those outside of their pure discipline and less resistant to supporting multidisciplinary experiences of this kind for their students.

Cooperative education experiences are obviously influential in training and developing students into employees that companies want. However, this 'real world experience' is as imperfect as the real world. Thus, while cooperative education can address teamwork skills, communication skills, and project management skills it probably won't do all of those things for all students. It is nearly impossible for the faculty advisor to intervene to the extent that would be required to ensure the multitude of experiences that would be desirable. Team co-op experiences, however, are more controllable by the advisor because it is possible to direct the students toward each other to these ends. Team experiences do sometimes occur naturally in co-op experiences but in the majority of cases, these are not multidisciplinary. Co-op teams can allow for collaboration of students from various disciplines with experts in the real world. Traditional cooperative education

experiences are important and necessary for companies requiring one or two students to fulfill their needs. However, the arrangement of co-op teams would give a significant number of students a superior experience. The ability to arrange such experiences is limited by the number of faculty that are appropriately familiar with a given company. The case study that follows is an example of both undergraduate and graduate students working together with faculty and company experts.

The pedagogical concepts presented here of incorporating emerging technologies, faculty research interests, and industry-university partnerships, gives momentum to curriculum innovation that many parties can get behind. In the case study that follows can be seen a multitude of opportunities to connect the needs of industrial partners to the curriculum. Taking the examples of the case presented many benefits as described above can be reaped, not the least of which is the improved learning outcomes and more motivated and confident practicing engineers.

CASE STUDY

In 2006 the John Zidian Company sought to expand its small manufacturing facility. Recognizing that this expansion would require substantial use of automation, management at SGFM sought the help of faculty at YSU as advisors on the project. As initially conceived, the project was a relatively simple expansion project aimed at increasing the production capacity of the facility. However, as the scope of the project grew, the mission became to develop a first of its kind, world-class food manufacturing facility.

In the initial phases of development, a number of student interns were hired from YSU to assist in various phases of the planning. Interns from the civil engineering department worked with civil engineering contractors on site planning, while students from the industrial and systems engineering department contributed to initial discussions of facility layout. YSU faculty participated in the same design team meetings and contributed to higher-level discussions of the facility. Those higher-level discussions included strategic and managerial discussions about techniques for creating effective cross functional design teams. Faculty also actively participated in the selection of production equipment for the facility.

As the scope of the project grew, the company owner, Tom Zidian, wanted to create a facility that would have unprecedented flexibility and the ability to create the finest quality foods in its category. He also wanted the facility to be environmentally friendly, and to meet the demanding standards of the US Green Building Council's Leadership in Energy and Environmental Design or LEED certification. Though these additional requirements did not push into the level of "science," they didn't push the envelope of what is traditionally done in industry. To achieve these goals, SGFM had to rely increasingly on support from high-level technical visors, including faculty from YSU. Through this process, undergraduate students working with the project were able to observe project evolution and to appreciate the role that experienced engineers could play in the development of such a project.

Based upon their advanced technical perspectives, the faculty externs were able to consider options that went beyond what is traditionally done within the industry. They worked with contractors and equipment vendors to challenge conventional wisdom and push for innovations. On this particular project, those innovations included a systems level integration of several large pieces of equipment that would ordinarily work autonomously. This integration and optimization, though contrary to conventional practice within the industry, was able to yield substantial energy savings. Predicted savings, based on a one shift operation, exceed $40,000 per year. The cost for implementing these particular changes was approximately $50,000, thereby yielding a very attractive return on investment.

The methodologies that were employed to create the effect of cross functional design team caught the attention of SGFM management. Based in part on the success of the team's organization, the company became interested in possibilities for applying systems engineering principles for optimizing other portions of their operation. This led them to consider supporting research activities being conducted by a graduate student in the industrial engineering program. SGFM purchased software licenses, to support that student's research in hopes that it might yield innovative ways for them to be more competitive. Without the positive experience with YSU at the practical level, they would not have had the insight or inclination to sponsor any sort of basic research.

Similarly, several of the innovations that were developed in the process of integrating SGFM equipment required equipment suppliers to consider new ways of designing their equipment. The analyses performed on those machines, identified very low cost modifications that were able to yield double-digit efficiency savings for the operation of those machines. The significance of those findings has opened the dialogue between YSU and several of the equipment suppliers for the project. Those discussions have yielded opportunities on a variety of levels including the possibility for high-level, industrially appropriate research funded through either industry or grants.

The significance of expanding the interaction to include partner companies is manifold. First, for a small, predominantly regional engineering program, the ability to catch the attention of prospective industrial partners from outside the region is extremely valuable. It opens new internship opportunities, provides potential job opportunities for our students, and generally enhances the reputation and visibility of our programs. It also serves as a starting point, to engage companies with increasingly technology-based interests. It is anticipated that through those relationships effective and successful research opportunities will emerge. At present, one of the major equipment suppliers on the

project, a company headquartered in Wisconsin is actively engaged in discussions of how to build a research partnership with Youngstown State University. Those discussions are a direct outgrowth of their experience working with consulting faculty on the SGFM project.

CHALLENGES AND FUTURE WORK

The proposed method of interaction with industry requires that universities build credibility with prospective partners from traditional industries. Many of these companies have preconceived notions about the viability of industry/university cooperation and remain unaware of the many interactions that do take place. University partners must demonstrate acute business acumen as part of their interactions with these companies. Failure to respond in a timely and profit-sensitive manner will doom cooperation.

In the process of developing these partnerships, universities must embrace aspects of engineering professional development that go beyond publications and research. Faculty members adept at working with industry as engineering practitioners offer great value as industry liaisons in the proposed model. Those who are not able to balance their research interests with the practical needs of the companies will not be successful at building those relationships. They will also not offer the sort of student mentorship for industry practice that is a benefit of more externship-like activities.

CONCLUSIONS

Defining and achieving a true faculty externship agreement remains elusive. The partnership established between Youngstown State University and Summer Garden Food Manufacturing affords a look at a possible starting point. At a minimum it serves as a touchstone for many aspects of classroom study, bridges the gap between classroom theory and professional practice, and creates faculty/mentors within a practice-based environment while simultaneously engaging the sponsor company at a high level of practical engineering application. That interaction ensures that the faculty member's practical skills remain relevant and that the company benefits from the inclusion of advanced technologies and methodologies within their operation. In the process of working actively with the company on large-scale projects, the faculty member has the opportunity to observe industrially relevant problems for which there may be a need for high-level exploratory research. While it may remain a question as to what is consulting and what is a true externship, it is apparent that faculty involvement with major industrial projects of any kind is something that should be pursued whole heartedly by both the faculty and the institution.

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