INCENTIVES FOR INNOVATIVE COOPERATION BETWEEN INDUSTRY AND ACADEMIA.

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Abstract.

New partnerships are developing between industry and Alabama A&M University as two new engineering programs are brought up on-line in Huntsville, Alabama, a highly focused region dedicated to world class advanced space systems, communications and manufacturing technologies.
This paper describes examples of collaboration between Alabama A&M University and industry. Collaborative efforts have aimed at: accreditation issues under the ABET criteria 2000, technical information exchange, promotion of internships, company tours, student scholarships, engineering laboratory development, implementation of industry best practices for project development, research contracts and grants.
Industry and Government Agencies seek partnerships and alliances with universities and research institutes to benefit from key know-how expertise found in university's researchers and to promote technical expertise for the long term.
The Boeing Executive on Loan Program and the NASA Administrator's Fellowship Program, have sponsored engineers and scientist on loan to the university which provide an avenue for universities to export /import industry know how, industrial practices and a different approach to both everyday operations and long term infrastructure development.

The collaboration of Boeing with the School of Engineering and Technology provided substantial support towards program preparation for the fall of 2000 accreditation visit for the civil, electrical and mechanical engineering programs. The NASA Administrator's Fellowship Program provided support for the development of the High Performance Computing Facility in the ME Department. The authors provide an insight of how corporate culture and academia can resolve differences in procedures and address issues of mutual interest.

The authors infer that highlighting the benefits of industry and academia collaboration provides incentives to sustain for sustaining long term industry involvement with academic programs.

I. Introduction

Before discussing possible new incentives for Industry/Academia cooperation, it may prove useful to review typical past and prevailing typical expectations of both Industry and Academia, i.e., what Industry wants from Academia and, in turn, what Academia expects from Industry from both from the industry perspective and from the academic perspective.

II. Partnerships and Collaboration: Part I.

In the past Industry has given relatively small amounts of money in the form of matching grants to just about any academic institution that was advocated by some internal alumni. Larger amounts were given to those academic institutions identified for some reason or another as focus institutions. Grants, student scholarships and in kind donations were given to academic institutions that were geographically co-located with corporate facilities as part of "corporate good citizenship" efforts. There was, to be sure, focused giving in the form of capital funding, research contracts, support for minority academic institutions and such, but little of this giving was done as a consequence of an internally coordinated effort and even less according to some general corporate strategy tied to business interests. As a consequence, corporate dollars were spread around the academic landscape in a way that created little lasting impact for either the academic institution or for the corporate donor.

On the other side of the coin, Academia would receive from Industry sporadic gifts of money and material, academic scholarships, internships, co-op positions for students and then, unless they were fortunate enough to receive long term commitments in the form of research contracts, would lose contact with the corporate donor. There was no institutional continuity in the relationship. This was partially because of the dilution of funds caused by unfocused or non-strategic giving by corporations, but was also because of the lack of any coherent strategy on the part of Academia for developing lasting relationships with the corporate donor. In effect, academic institutions viewed corporate giving as a unilateral source for money, equipment and student jobs and corporate donors felt that their sporadic gifts satisfied their philanthropic goals without the need for follow-up. Little effort was given to establishing a continuous and mutually beneficial, quid-pro-quo relationship.

But, times have changed. In this new era of belt tightening and limited discretionary funding, Industry is looking for more bang for its buck(s) and is trying to refocus its attention on institutions that best meet its business and philanthropic giving needs. Academia is looking for ways to ensure continued funding streams. The problem for both then, is to establish a mutually beneficial relationship, one that allows both parties to achieve their goals.

Well, what does Industry want from Academia?

First, and most obvious, Industry needs a steady supply new engineers; and more to the point, entry-level engineers who are appropriately trained in needed skill areas, who have the characteristics desired by Industry and who are motivated to do the things required to ensure the success of the industrial endeavor and whose education meets generally recognized standards.

Within this statement of need there are hints for Academia concerning the characteristics and training of the graduates that Industry desires.
The Boeing Company, among others to be sure, goes further. On their public web-site (www.boeing.com) they list their "Desired Attributes of an Engineer". The list of desired traits includes not only "a good understanding of engineering science fundamentals" but also such highly desired traits as: "a good understanding of design and manufacturing processes", "a multi-disciplinary, systems perspective", "a basic understanding of the context in which engineering is practiced" (i.e. concurrent engineering), "good communication skills; written, oral, graphic and listening", "high ethical standards", "a profound understanding of the importance of teamwork", "curiosity and a desire for lifelong learning", "flexibility and an ability to think critically and creatively". Many of these attributes require training beyond that which has been historically provided in the classical engineering curriculum. In addition, Boeing adds a note to this list of Desired Attributes:

*"Note: This is a list of basic, durable attributes into which can be mapped specific skills reflecting the diversity of the overall engineering environment in which we in professional practice operate. In specifying desired attributes (i.e. desired outcomes of the educational process), we avoid specifying how a given University goes about meeting Industry needs. Curriculum development is viewed as a University task to be done in cooperation with their "customers", and in recognition of their own local resources and constraints***. *Industry, as an important customer, must be an active partner in this process."*** (Emphasis added)

Industry needs training for its people and flexibility in course work to fill immediate needs. Continuing education is the major recipient of corporate education funds; however, Industry wants continuing education that is focused on its requirements. This means not only classical engineering undergraduate and graduate course work, but also course work that meets business unit immediate needs, e.g. specialized training in new technology or concentrated work in high demand skill areas, e.g. systems engineering.

Industry needs new ideas, Industry needs research and Industry needs diversity, both in people and in approach, in its workforce.

What does Industry perceive to be Academia needs?

Academia needs money. Academia needs equipment. Academia needs scholarships, internships and co-op positions for students. And, Academia needs research contracts and consulting positions for faculty. Academia needs continuous sources of funding. Academia needs continuity in its relationships with Industry. And, Academia needs input from industry on the construction and relevance of its programs.
At this point, Academia seems to have much the same perception with perhaps a little less focus on continuity and input. Both seem, only now, to be investigating the concept of partnership.

But in the same way that Industry has, in the past, diluted its effort through unfocused giving, Academia must avoid trying to be "all things to all industry" and must focus on those industries that provide a "best" match with the universities educational philosophy.

What then are the incentives for Industry/Academia cooperation?

It is clear that both need each other. The key is in the establishment of a **mutually** beneficial relationship. The problem lies in developing attainable, mutually agreed-on goals. One of the best first steps, after the mutual analysis that suggests that a partnership might be a good match, is to establish personal contact, form a committee to explore areas of possible cooperation. The committee must be populated with persons who might be expected to stick around, i.e. to provide the necessary continuity to develop a relationship based on mutual respect. A good area for interaction is through industry advisory boards. These have a formal structure but allow for continuous personal contact. Other good areas for interaction include industry sponsored student projects (as long as the outcomes and deliverables are clearly understood by both parties), guest classroom lectures, and getting-to-know-you days. To be effective there should be interaction on all levels, from institution president/senior industry management to Dean/Chief Engineer to student/engineer. There must also be an agreed on extraction process so that if things don't work out as expected one party or the other can gracefully withdraw without creating hard feelings.

III. Partnering with Academia: Part II

Industry and governmental organizations have partnered with academic institutions in various fashions and for various reasons as stated earlier. In some instances the partnerships have been strongly linked to the war/defense efforts, the space race and the fight against the spread of diseases to mention a specific few areas. In these cases the activities have been intense and focused for the period of relevance. In other cases the partnerships have taken a more steady / longer term form. When industry and governmental agencies support not only four year colleges but also two year colleges, these organizations face a challenge trying to work with more than 2400 U.S. institutions of higher learning. This challenge is goes beyond dealing with the number of schools but also it is important to note that the academia culture is not a homogeneous one among all schools. In addition the various way that schools handle contracts and how school administration supports researchers adds more complexity to the partnerships. A simple differentiation among universities is that of being a private school and being a state university. That is being a for-profit or a non-for profit organization.

Partnering among universities and private industry has not been always free from "bruises" and there are a few large corporation s that have seen fit to create their own universities. However time has shown that industry and government organizations can benefit from key know-how expertise found in university's researchers and at the same time use their partnerships to promote technical expertise development for the long term for the future generations of graduating engineers.

Partnering is more recently associated with mutual cooperation for development as opposed to "strictly business" where business partners can take legal action against contractors and subcontractors for failing to meet all contractual agreements or where business partners share in

the profitability and share dividends. In the modern view of partnering, it is expected that mentoring takes place both ways and in a less threatening environment. Both partners realize that some research is in many instances judged "high risk" and therefore industry may choose to devote more internal resources to research activities likely to provide a return on investment within three a few years.

As Industry works towards it mission in the global market, similarly universities work toward achieving their mission both in the local, national and international arena.

IV. The Local Environment

Alabama A&M University (AAMU) is a land-grant, historically black university. It is located in the northeast outreach of Huntsville, Alabama, an important world center of expertise for advanced missile, space transportation and electronic research and development. Among the leading industry and government agencies located in this area are the NASA Marshall Space Flight Center, the U.S. Army Aviation and Missile Command Center (AMCOM), Redstone Arsenal and Testing Center, The Boeing Company, Northrop Grumman, Lockheed Martin Aerospace, Thiokol and many others associated with high-tech. endeavors. These industries and government agencies require large numbers of highly trained engineers in all disciplines.

The interaction between the aforementioned organizations and academia is today leaning towards research contracts that have designated outcomes in terms of deliverables. Technical monitors and faculty members need to work closely to benchmark progress towards set goals. Time management, resource allocation, budgeting and timely evaluations of unanticipated problems, are processes that researchers must manage effectively in order to sustain a lasting interaction with industry and government agencies that, in turn, can enhance the engineering education process.

V. Corporate and Academia Culture Adjusting to Address Issues of Mutual Interest.

While Industry may expect that all changes in culture and business practices should take place in academia, on the other hand, academic institutions expect from industry, respect for their mission and the appreciation that it is because universities operate as they do, that original ideas are explored and innovation is promoted. Therefore if a partnership is to last, both industry and academia must adapt to be able to interact with each other in the benefit of both.

Industry strives to provide competitive products by reducing total cost, reduced time to market, increased quality and enhancing customer support services among other initiatives. Academia understands this and can adapt similar practices within its area of influence without loosing grasp of its educational mission.

As a consequence of the combined perspectives, we find that academia must negotiate, or determine how to better meet the needs of each member of its industry constituency and provide to them the necessary benefits to continue an industry/academia partnership for the long run.

VI. Incentives for Industry/Academia Cooperation

As an example, of incentives we can mention: how Academia could train industry personnel in shorter periods of time, perhaps via the internet. Would industry welcome universities' efforts if they were to deliver qualified engineers in three years instead of five years? Will industry welcome reduced times for internal training of new hires. While the scenario depicted may be judged "wishful thinking" it points at some of the incentives that may be reached if a successful cooperation is forged between industry and academia.

VII. RESULTS

As the new engineering programs in electrical and mechanical engineering at AAMU build-up partnerships for collaboration with industry, some results have evolved from such efforts. Some of which are listed below:

Collaborative Activities in the Department of Electrical Engineering

There are several examples of collaborative relationships in the Department of Electrical Engineering. First, representatives of local companies and organizations were invited to join the advisory board for the Department. For a new program, the Board provides not only an opportunity to comment on actions taken and plans for the future, but they also have an opportunity to shape the program by assisting with curricula development, laboratory enhancements, student internships, and accreditation issues. The involvement with the ABET process began about one year before the visit. With respect to accreditation, every document prepared and submitted with the application was examined by the Board prior to them being incorporated into the ABET document. Document oversight occurred about five months prior to the deadline for the self-study. Following the Board's review of the document, a separate "Red Team" whose mission was to compare the final self-study document with the ABET criteria was formed. For two days, the team met and read the criteria along side the self-study report. Every member had an opportunity to comment and suggest changes in the document. When all comments were received, a new document was prepared. Several weeks later, the Red Team reviewed the composite document and gave it their blessing.

LOCKHEED MARTIN

Although it was not implemented, one of the collaborative efforts with Lockheed Martin was fruitful in assisting the Department of Electrical Engineering to design a new option in Test Engineering. Lockheed Martin made representatives of their Orlando organization available for two days to outline and develop the curricula to prepare students in the new option. Four new courses (Automatic Test Equipment; ATLAS Programming Language; Test Engineering I; and Test Engineering II) were proposed. Test Engineering I concentrates on analog and digital electronics, while Test Engineering II concentrates on RF engineering.

To ensure that the option was viable, Lockheed Martin donated 8 SUN workstations. Later these machines were upgraded to new models of SUN systems. This equipment allowed the Department to introduce the "UNIX like" environment to the students and provide the platform for the ATLAS programming language.

Senior Projects

To gain further support from industry, companies were allowed to suggest senior projects for students. Projects in the areas of optical filtering in real time, conversion of standard television to high definition television, dc to dc conversion for the space station, and design of the tilt micro-mirror capacitance measurement system proved too much for a fledging department. While a department can find many organizations to propose projects, very few will provide the supporting material and nurturing to make sure that undergraduate students are successful. After several attempts to acquire technical support from companies, the faculty decided to only approve projects in areas that the faculty has expertise.

Special Program Support

One of the justifications for initiating a new program in electrical engineering was to support microelectronics in the Northern Alabama area. Therefore, an option in VLSI engineering was incorporated into the program. Currently, there are six undergraduate courses in this option. Since the program is new, there are no facilities to support this option. To provide laboratory support, a collaboration was established with the University of Massachusetts, Lowell. Every summer, students in this option take a special hands-on six-week course in Massachusetts. Funds to support this activities have come from the National Science Foundation and the Army's Aviation and Missile Command in Huntsville.

Collaborative Activities in the Department of Mechanical Engineering

THE BOEING COMPANY

During the final stages of curricular development for the Mechanical Engineering Program, Boeing personnel from the Seattle-Everett Area assisted the department in reviewing the manufacturing option in particular courses related to quality and reliability assurance and operations planning and scheduling.

For the development of the Mechanical Engineering Department Industry and Government Advisory Board, Boeing-Huntsville provided leadership and support for the establishment of this Advisory Board.

For preparation for the ABET AC2K accreditation visit, Boeing-Huntsville provided a Boeing Executive to assist, review and verify adequacy/compliance of the accreditation criteria for the civil, electrical and mechanical engineering program.

For laboratory development, Boeing Corporate Foundation assisted the ME program with support for the acquisition of a supersonic wind tunnel.

For additional infrastructure development, Boeing-Huntsville is assisting the School of Engineering and Technology with construction planning and supervising for the new Engineering Building.

Boeing-Saint Luis is providing additional assistance and support for contract opportunities and for master's level course development.

U.S. ARMY AVIATION AND MISSILE COMMAND (AMCOM)

AMCOM has provided support for contractual research in advancing rapid prototyping of printing wiring boards. This has help student involvement in research and the acquisition of instrumentation for testing of prototypes. This assistance is helping the manufacturing option of the ME program.

AMCOM is supporting the ME industry and government advisory board with high management personnel to review and advance the development of the ME program.

AMCOM has contributed for the development of laboratory infrastructure by donating a utility helicopter in support of the propulsion option in the ME program.

DEFENSE INGELLIGENCY AGENCY - MISSILE AND SPACE INTELLIGENCE CENTER

DIA-MSIC has provided support for contractual research on propulsion technology abroad. This has help student involvement in rocket fuels and oxidizers research.

OAK RIDGE NATIONAL LABORATORIES (ORNL)

ORNL has provided support for contractual research on energy conservation studies for residential hot water systems. This has helped students to develop projects and hand-on instrumentation and testing of hot water systems. This has also helped the department to build its laboratory instrumentation capabilities for data acquisition and data processing.

DEPARTMENT OF ENERGY (DOE)

DOE has provided support for contractual research on High Performance Computing. This has supported the research efforts for CFD simulation and master level courses in grid generation.

ALABAMA INDUSTRIAL AND DEVELOPMENT TRAINING CENTER (AIDT)

AIDT is supporting the manufacturing option in mechanical engineering by donating a flexible manufacturing cell.

TRW

TRW has provided support for contractual research on pintle-type injectors. This is helping to develop the propulsion option in the ME program.

National Aeronautics and Space Administration (NASA)

NASA has provided support with senior personnel to work with the departmental industry advisory board, providing topics for student senior design projects and providing a NASA Administrator's Fellowship Engineer to work with the ME faculty in expanding the capabilities of the High Performance Computing Laboratory to include parallel processing.
Lockheed-Martin

Lockheed Martin has provided support in reviewing proposals for research in micro propulsion systems and participated actively in the leadership of the industry advisory board.

Northrop Grumman

Northrop Grumman has provided support with program review and program preparation for accreditation through its participation in the industry advisory board. Also they have made available tours through their manufacturing facility.

Thiokol

Thiokol has provided support to the program via the industry advisory board, and they have provided assistance while touring their manufacturing facility.

U. S. Navy

The U.S. Navy has provided support to the program by commissioning an officer to an adjoint position to assist students and faculty in student projects. They contribute with experts to present topics of relevance in engineering to students and faculty in the program.

VIII. CONCLUSIONS

The authors provide an insight for the need of corporate culture and academia culture to mutually adapt and resolve differences in procedures and work to address issues of mutual interest. The authors highlight some of the benefits derived from industry and academia collaboration. Expanding the collaboration among industry and academia will provide new incentives to sustain long term industry involvement with the advancement of academic programs.

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