AC 2007-1677: WELCOME TO THE "REAL-WORLD" - BALANCING PRACTICAL, LEGAL, AND EDUCATIONAL ISSUES IN IMPLEMENTING INDUSTRIAL SPONSORED STUDENT DESIGN EXPERIENCES

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Welcome to the "Real World" - Balancing Practical, Legal, and Educational Issues in Implementing Industrial Sponsored Student Design Experiences

Abstract

Engineering programs across the U.S. have long recognized the value of incorporating "real-world" active learning experiences into the curriculum. ABET's EC2000 Criterion 4 further solidified the approach of the many engineering programs that offer a "real-world" team-based senior capstone design experience with its mandate that students be provided a "culminating major design experience which incorporates appropriate engineering standards and multiple realistic constraints[1]". While these types of project experiences can be "created" within engineering departments, many programs have found that the most effective "real-world" experience comes from projects that are defined and sponsored by industry. Students participating in these projects have the opportunity for mentoring by industrial project managers and face an increased expectation of results and diligence similar to what they will encounter when they begin their professional careers. In addition to technical and project management experience, these students also gain valuable skills in such things as client development, structuring business relationships, and intellectual property management and rights distribution.

At Michigan Technological University, both the **Senior Design Program** and the more extensive **Enterprise Program** rely heavily on the supply of these "real-world" project experiences from industry. In this model, the industry sponsor typically provides financial and technical support and becomes a "client" of sorts to the student project team. The financial and technical involvement of external project sponsors introduces a number of related issues such as project deliverables, sponsorship costs, non-disclosure requirements, publication/presentation review, and intellectual property rights. While providing a more holistic experience, the handling of these issues often presents a further challenge of balancing the primary educational mission and scope of the projects against sponsor expectations for value from their investment of effort and financial resources. Furthermore, Michigan Tech views these project experiences to be a potential IP generator through student development of new products and technologies that could then ideally be commercialized through licensing or new business start-ups. How rights to this student generated IP are negotiated then becomes a key factor in allowing for this possibility.

For industrially sponsored projects, this results in an analysis, and often negotiation, of reasonable distributions of IP rights and sharing of proceeds from commercialization of that IP. This requires finding an optimum where not only the sponsor is comfortable with the investment of financial and intellectual resources but where the students also have some reasonable opportunity to benefit from the relative value that their independent creativity generates. Furthermore, as observing parties to the negotiation, students can be engaged in discussions with contract personnel on both sides about the relative value of their ideas versus the value of the experience and input that the sponsor is providing. This process can lead to a more sophisticated understanding of the relative value of ideas and the importance of commercial experience and execution than students would otherwise obtain strictly through classroom exercises.

This paper will discuss Michigan Tech's approach to searching out and securing these real-world industry-sponsored project opportunities, and considerations for addressing the associated legal, pedagogical, and practical issues and challenges. A comprehensive comparison of student/capstone design experiences across universities can be found within the 2005 National Survey of Engineering Capston Design Courses (Howe, Wilbarger)[2]. The goal of this paper is to focus in on the subset of student design programs that utilize externally sponsored projects and drive a contextual sharing of practices, perspectives, and experiences in this area among the increasing numbers of engineering colleges taking this and similar approaches to student design projects.

I. Background and Description of Capstone/Entrepreneurial Student Design Programs

The primary rationale for capstone project experiences is to meet ABET objectives by providing students the opportunity to *apply* engineering theory and principles, using a real problem with objectives and constraints. Secondarily, these projects have the potential to drive development of new technology and commercialization opportunities for students, universities, and project sponsors. Universities are increasingly turning to industry for the identification and sponsorship of these real-world experiences[2] as they typically identify a practical need and provide valuable technical and non-technical interaction between students and industry.

The traditional project experience is one that occurs during the senior year, and may be one or two semesters in length as required by the university, college, or department. Further, many of these programs (like Michigan Tech's) have evolved to encourage teams across the various engineering disciplines. Beyond these 'senior design' programs, many universities are also recognizing the value of taking the team concept beyond the engineering 'design-build-test' cycle, and have implemented broader 'interdisciplinary programs' – programs that promote entrepreneurship, innovation, and teamwork across the campus. Michigan Tech's Enterprise Program, the University of Florida's Center for Entrepreneurship and Innovation, Purdue University's EPICS Program, and the Illinois Institute of Technology's IPRO Program[3-5] represent some of the existing programs that fit this category. The following section describes some of the primary considerations for describing programs across universities:

Team size and composition - The experience of working in teams is perhaps the biggest source of learning on these projects, in many cases much more so than the technical aspects of a particular design problem. Furthermore, the composition of the team directly influences the approach to the problem, and therefore is critical to the overall quality of the experience. Most 'capstone' design programs involve a team of about 3-5 students[2], where most 'interdisciplinary' programs are likely to involve larger teams. Michigan Tech senior design teams consist of teams of approximately five students, and, while the program is administered at the department level within the College of Engineering, coordination across departments takes place to facilitate multi-discipline engineering teams. Michigan Tech's Enterprise program on the other hand is administered at a University level, and Enterprise teams are perhaps more accurately described as organizations or 'virtual companies' composed of various functional and technical teams. These organizations may consist of students from Arts & Sciences, Business, Engineering, Forestry, and Technology, and range in size from 10-80 students. In these Enterprises, a

leadership team (e.g. President and Vice President positions) and one or more project sub-teams (e.g. Project Manager and associated team member roles) is a typical organization structure.

Project duration - The size and scope of the project, and therefore the amount of experience gained by the student, are directly influenced by its duration. Most capstone design projects appear to span in duration from one quarter to one full academic year[2]. Michigan Tech senior design projects span one academic year (two semesters), which equates to roughly 1000 total student hours invested in a project. By contrast, projects within one of Michigan Tech's Enterprise teams can vary from one semester to multiple academic years; a student who joins the Enterprise Program in their sophomore year therefore has an opportunity to get six semesters or more of project and organizational experience. Students take responsibility for the Enterprise and seek to develop into a self sustaining entity by serving internal and external clients and securing resources for continuing projects. The size, multi-functionality, and duration of Enterprise teams allow, and indeed require them to function more like a business than like a discrete project team with a clearly defined endpoint and single set of technical objectives.

Sponsorship fee - Michigan Tech and many others have adopted the practice of a fixed sponsorship fee. Upon reviewing several program websites and conducting a brief survey, project fees ranging from $1,500 to $41,000 per project exist today. Also, this fee can vary by department within a university's College of Engineering. The funding is often described as a tax-deductible 'donation', 'gift', or 'educational grant' to the university. Typically, the student team receives a portion of this funding to use directly for project materials and travel. The remainder is allocated to supporting university / college infrastructure (such as software, hardware, professional staff, etc.). A review of available information from several university websites, along with the above-mentioned survey, finds that the team budget can range from 8-50% of the total. For reference, Michigan Tech's Senior Design Program requires a fixed fee of $15,000 for a two-semester project; of this, up to $4,000 is available directly to the team.[6-15] For Michigan Tech's Enterprise Program, the sponsorship fee is more flexible, due to the variation in team size and project duration, but ranges from $500 to $40,000. In the case of fixed-fee sponsorship, if the budget necessary for a given project is likely to exceed the team's allocation, universities like Michigan Tech request additional funding from the sponsor, or alternatively, request a change in scope consistent with the team's budget allocation. In short, while the concept of a project sponsorship fee is quite common, both the overall level of funding and the subsequent allocation to the project team vary significantly across universities.

Alternatively, some programs do not require a fixed sponsorship fee at all, but instead require that the sponsor directly cover all expenses during the course of the project. In this case, the sponsor typically provides an up-front estimate of project budget, and the team refines this during the planning and design phases in the form of a proposal submitted to the sponsor.

Protecting sponsor-supplied confidential information - Because these are student projects, many universities caution, and in some cases discourage, projects that include confidential information. Most programs like Michigan Tech's offer provisions for the sponsor to enter into a non-disclosure agreement with the students; this is either an agreement between the sponsor and students (not the University) or between the University and the sponsor with some additional mechanism in place to bind the students to the University similar to an employment agreement.

Such non-disclosure agreements are intended to protect sponsor input to the team's efforts. The resulting output of the team is NOT part of this agreement, as the students must present their findings and demonstrate that they have fulfilled ABET program requirements.

Ownership rights of intellectual property (i.e. patents and copyrights) - The desire to take on practical and significant industry projects, while encouraging student innovation and entrepreneurship, raises questions regarding intellectual property. Universities vary in their approach to IP resulting from student projects. Some stay out of the matter altogether and leave it up to the individuals (sponsors and students) to pursue on their own. Others require students to assign IP rights to the sponsor up-front. Yet others maintain a position that the university will own any resulting IP and therefore have sole discretion whether to retain or transfer ownership. The final option is a collaborative or joint agreement, where each party contributes and may possess rights. Michigan Tech's experience has been that undergraduate student design projects historically have not been a significant source of patents; nonetheless, processes are in place to reasonably balance sponsor, student, and University interests and are discussed further in Sections III, IV, and V.

II. Securing Industry Sponsorships

Michigan Tech employs two full time industry project coordinator staff positions who are responsible for developing industry sponsorships and projects. These staff bring significant industry experience to the positions and are soft-funded through the sponsorship fees generated. In surveying capstone program contacts from other universities and reviewing available website information, the full time staff coordinator position appears to be unique to Michigan Tech's approach. Key responsibilities of these positions include: identification of projects of appropriate scope, cost and duration, management of sponsor expectations related to project outcomes and deliverables, and overall management of sponsor relationships. Furthermore, these positions are organizationally housed within academic unit(s), as opposed to reporting directly through the University's development or corporate relations offices. This structure maintains the emphasis on Senior Design and Enterprise as educational programs, and allows the staff to objectively address the needs and interests of the University, the students, and the project sponsor. Moreover, Michigan Tech faculty can focus their efforts on the activities by which they are more directly evaluated - instruction and research.

When searching for potential project sponsors, companies that recruit at the University and/or alumni tend to provide the best inroad to a company's decision makers. Coordinators make initial contact through the recruiters and alumni to gauge the level of interest in sponsoring undergraduate projects. In the process, coordinators also leverage their industry networks and experience, which can serve to increase the quality of interactions with industry as well as expand Michigan Tech's presence with additional companies. An onsite visit to present the opportunities and potential benefits then follows. Here, the program objectives, costs, and sponsor responsibilities are outlined. The key benefits of interest to most sponsors are the intangible ones (e.g. access to students and visibility for the company on campus), although the value of project results and sensitivity to commercial issues (e.g. IP ownership, confidentiality, and restrictions on publication) are also identified, prioritized, and ultimately balanced. Having full time coordinator positions allows Michigan Tech to work individually with each sponsor to

better manage the expectations, which can and do vary significantly amongst project sponsors. Since the project work is done by undergraduate students and therefore results can not be guaranteed, the potential benefit for successful delivery of a solution is offered only as a secondary benefit. Once the company decides to move forward with a sponsorship, the project coordinators then move on to the project definition and contract negotiation stage.

III. Overview of Contractual Issues

Sponsored project teams produce relationships of one form or another between the sponsoring entity (typically a company), the University, and the individual members of the student team. These relationships may or may not involve formal written agreements but regardless, they generate implicit or explicit obligations for the students. At a minimum, the teams are obliged to use the sponsorship funds consistent with the intent with which they were provided and to follow the reasonable direction of the sponsor. Teams may also be obliged to assign their rights to any intellectual property developed with sponsor funding.

Whether they are contractual or not, relationships between industry sponsors and student teams can enhance the educational experience of participating students by adding a level of expectation in performance and mentoring and by allowing students to participate in structuring business relationships and evaluating considerations important to constructively building and maintaining those relationships. That is, students in Michigan Tech's Enterprise Program often participate directly in structuring and managing relationships in order to maintain sponsor good-will. University personnel lead this activity however to ensure that this is done in a way that will not compromise the primary educational mission of the program. This often requires a balancing of sponsor expectations for return on investment, the students' enthusiasm for 'real world' experiences, and reasonable expectations of student effort, performance, and relative commitment. In addition to project funding, sponsors often contribute personnel effort in mentoring that further enhances the educational experience for the participating students but can also introduce proprietary issues resulting from information transferred by sponsors to students.

Flexible sponsorship arrangements, diligent consideration for the primary goals of the program, and a mindfulness of the experience level of the students involved are required on both the sponsor's and the university's side of the table to structure projects and agreements that maximize mutual benefit, provide opportunities for student entrepreneurship, and allow the program to achieve its educational goals. While a detailed analysis of the legal and practical issues surrounding structuring sponsorship arrangements is beyond the scope of this paper this section describes Michigan Tech's approach to handling sponsor relationships as a means to support and encourage further discussion around the relevant issues.

IV. Sponsorship Mechanisms at Michigan Tech

Michigan Tech has two primary mechanisms for providing sponsored funding to student design projects and programs; restricted and unrestricted sponsorship. Restricted projects involve a formal contract including a clear articulation of such things as the disposition of project-generated intellectual property and publication of project results. Sponsors of restricted projects enter into formal contracts with the University. The terms of these contracts are subsequently

extended to the participating students through documents similar to employment agreements in private industry.

Projects without written contracts between the University and the sponsor are referred to as unrestricted projects, but at the teams' discretion, or otherwise as necessary, these projects may also involve agreements between individual team members or between the team members and the University related to such things as the handling of proprietary information or distribution of rights to patentable innovations. In both restricted and unrestricted projects, students are often exposed to and confronted with "real world" issues including confidentiality, intellectual property rights, and expectations of performance. This exposure expands the scope of issues that the students gain experience with well beyond specific technical and project management matters typical to capstone programs.

Characteristics of Restricted and Unrestricted Sponsored Projects - The primary distinction between unrestricted and restricted sponsored projects is in the formal disposition of rights to intellectual property resulting from the project and the ability of the sponsor to specifically define project tasks and required outcomes or deliverables. While the label 'unrestricted' may suggest that sponsors are not involved in selecting or managing projects, sponsor involvement is expected and encouraged on these projects as with all sponsored projects. Expected outcomes are articulated by the sponsor and the students are managed by the faculty advisor and by participating sponsor personnel on both restricted and unrestricted projects toward achievement of these outcomes.

If the sponsor is exceptionally prescriptive in identification of both the problem and the preferred solution leaving little room for team or advisor discretion, then the project is sponsored as a restricted project. Consistent with the academic nature of the programs, neither restricted nor unrestricted sponsored teams incur formally enforceable obligations to perform beyond the reflection of their performance on their academic record. While restricted projects include a more detailed and administrative process for evaluating and ensuring performance, terms on restricted projects do not provide for recourse by the sponsor in the case of lack of performance beyond a bad grade for the credits taken on the project. Additionally, while sponsor input in grading is taken into consideration, grades are established by the project advisor and not directly by the project sponsors on both restricted and unrestricted projects.

Intellectual property disposition is therefore often left as the key distinguishing characteristic between restricted and unrestricted projects. Specifically, sponsors of unrestricted projects do not have any formal exclusive rights to intellectual property developed by the students under the project. The University may objectively determine that providing a portion or all of its commercial rights to the sponsor is in the greatest interest of the public and it therefore may provide those rights outside of the sponsoring arrangement. These rights would be provided under a separate license agreement to the sponsor, or under any agreement or arrangement that is acceptable to the sponsor and the University and is in the best interest of commercializing the intellectual property. The licensing decision in this instance would be made independent of the sponsorship issue and based on the sponsor's ability to bring the technology to the market. Given the primary educational mission of projects, this structure is often appropriate and does not unreasonably inhibit the sponsor from generating and articulating business value and

therefore justifying their investments. In fact, since 2000 more than 80% of Enterprise and more than 70% of all student design projects at Michigan Tech have been sponsored in an unrestricted manner.

Sponsors that either intend for student teams to develop intellectual property or are uncomfortable without formal rights to project developed intellectual property typically prefer an agreement negotiated with the University. As the students participating in the sponsored teams are not employees or formal representatives of the University, each team member on a restricted project is also bound to the terms of these sponsorship agreements through a separate agreement not unlike an employment agreement commonly used in private industry. This is often the first experience students have with such agreements which will be commonplace throughout their professional careers. The characteristic terms of sponsored project agreements are discussed below.

V. Issues and Considerations

Regardless of whether projects are handled as restricted or unrestricted, issues to be addressed when structuring sponsor relationships and articulating mutual obligations and expectations include such things as; publication rights, treatment of confidential information, disposition of intellectual property rights and ownership, guarantee of deliverables, and expectations of team performance. The following sections include a discussion of the elements and examples of how Michigan Tech approaches these considerations.

Outcome Expectations/Deliverables - Sponsors contribute financial resources in the form of direct project sponsorship and in-kind resources in the form of project identification, project management, and team mentoring. To justify these investments, sponsors often seek some form of stated deliverable and expect a certain level of team performance or milestone based payment schedules. Sponsors are certainly justified in seeking return on their significant investment. In addition, the need to satisfy the team's client is one of the important educational experiences of industry sponsored student projects, keeping in mind the need for reasonable expectations for outcomes given the experience level of the team and the relative amount of time they are able to commit to the project. While these students are being challenged in a real world setting, they often do not have significant experience in project management and are working on the project only as part of a full course load. As a result neither restricted nor unrestricted projects contain an explicit guarantee of results. Additionally, while milestone based payment schedules are common in private industry and even in University contract research, outcome based milestone payment schedules would obligate students at an unreasonable level and are generally not accepted.

Contractual guarantees of performance are generally not granted but sponsor personnel are expected to manage projects for results. That is, implicit obligations to perform are often appropriate, but explicit obligations to perform and legal or financial consequences of lack of performance are rarely considered. The team advisor, the University, and the team members do have a vested interest in performance and in maintaining sponsor good-will. The benefit of exceptional performance is a continuing relationship with the sponsor as a prospective employer of the student team members and as prospective supporter of other University programs and

student projects. This situation is sufficient to provide for adequate performance guarantees for most sponsors and is in keeping with the primary educational mission of the program. Likewise, project sponsors have a vested interest in maintaining university good-will. The obvious benefit of a positive corporate image on campus is maintaining a pipeline of interested future employees; however, additional benefits can be realized, such as: access to additional research and partnership opportunities beyond sponsored student projects; additional company exposure through university events which showcase sponsored student project work; and more broadly, adding Michigan Tech faculty, staff, and students to their network, which can prove beneficial in both the near and long-term.

One additional issue, related to but separate from, expectation of outcomes is indemnity with respect to the sponsor's use of any project outcomes. As sponsors often expect to use project and program results in their business, they sometimes request that the University accept legal responsibility for events occurring as a result of the company's use of those results. As the student teams rarely have the time to fully evaluate the ultimate feasibility of their innovations and substantial product development effort is often required to commercialize most project or program outcomes, Michigan Tech's standard position on any project and for any set of project terms is that the sponsor is responsible for its use of information provided by the student teams. This stance has resulted in Michigan Tech declining to enter into two projects since 2000; to put this into perspective, Michigan Tech's Senior Design and Enterprise programs together involve around 75 sponsored projects annually. While it is unfortunate to lose any opportunities for students to work on applied problems, the risk incurred by the students and by the University in accepting legal responsibility for the sponsor's ultimate use of team developed information is too substantial to allow for any flexibility on this issue.

Confidentiality of sponsor provided information - In order for sponsor personnel to actively engage in the project, they often need to transfer company proprietary information to the student team. Reasonable confidentiality agreements can be entered into either between the students as individuals and the sponsor, or the University and the sponsor. These agreements should only restrict company proprietary information, not the results of the students' work. In accepting confidentiality agreement terms and in handling sponsor confidential information all parties should be mindful of where the project participants are in their career planning and professional development. In particular, while students are generally overly cautious, some may not fully appreciate the significance of proprietary concerns and may inadvertently disclose sensitive information. In addition, under most circumstances, team members will be in the middle of, or about to initiate a job search. It is possible, if not likely, that any given team member could soon be working for a sponsor's competitor or at least another company in a related field. While taking on the responsibility of handling sensitive information is part of the important educational experience offered by the program, sponsors and team advisors should carefully consider the realistic consequences of leaks of sensitive information and the limited experience level of the team before disclosing such information. Team advisors should also consider this when considering receiving sponsor confidential information.

Publication/Presentation of Team Developed Information - On restricted projects, sponsors may desire to manage public dissemination of information developed by their sponsored teams. This may be out of a concern for protecting patentability of team developed inventions or other

proprietary concerns related to commercial application of project outcomes. Reasonable accommodations can be made for sponsor review and for filing of patent documents prior to public disclosure of patentable subject matter, but it is very important to not unreasonably inhibit the students' ability to disclose and discuss their work. At a minimum, the work must be reasonably described to peers and to faculty in order for the team to be graded. In addition, since project results are representative of the student's collective educational experience, they should have the ability to use the results of their projects to promote themselves to prospective future employers.

Michigan Tech will accept limited delays in public dissemination of information but will not accept any terms that allow a sponsor ultimate control of all publication decisions. That is, sponsors may be given time for review and comment, and for patent filing, but ultimately the work must be publicly disclosed in one form or another. When considering delays in publication for sponsor review and or patent filings, the time scale of the academic semester should be considered. Within a 14 week academic semester, significant developments occur on a weekly basis therefore sponsor review cycles must be in days or weeks and not months. While this does not allow as thorough a review by the sponsor as likely desirable, sponsor personnel should be advised to be watchful of this issue during their project management efforts to begin considerations for patentability or other public disclosure issues as soon as it seems prudent rather than waiting for a draft report or presentation that may formally come to them only a short period of time before a planned public disclosure event.

Some sponsors express an interest in having a mechanism for holding student developments as trade secrets. This expectation by sponsors should be avoided entirely for many of the same reasons presented in this section and the section on confidentiality agreements. Trade secret work is simply inappropriate for a student based educational program.

Intellectual Property - Sponsors of unrestricted projects do not require explicit access to project intellectual property for one reason or another. Often, the sponsor may simply not expect or intend for the project to generate tangible intellectual property or may have a sufficiently strong background position to protect it in the field that it is asking the student team to explore. Regardless of the rationale, many projects are conducted successfully in an unrestricted manner. There remain sponsors, however, that consider the generation of tangible intellectual property to be possible or intended and therefore want to ensure commercial access to that intellectual property in one form or another. In these circumstances, the project sponsorship agreements clearly define the handling of intellectual property resulting from the project and the disposition of commercial and research rights to that property. Rights or ownership to project intellectual property are specifically provided through licensing or assignment provisions in the sponsorship agreement.

Contract terms are often individually negotiated to provide for the best fit between the sponsors expectations and requirements, the proprietary interests and concerns of the team advisor and team members, and the educational nature of the program. As a starting point for discussions, Michigan Tech has developed two standard term sets specifically for student design activities that differ only in how they treat intellectual property developed under the project. One set of terms provides for a sponsor license to project intellectual property and is used in circumstances

where sponsors are agreeable to providing some financial incentive to team members for commercially viable innovations. The other standard set of terms provides for sponsor ownership of project intellectual property and is used in circumstances where the sponsor's proprietary concerns dictate their funding decision. That is, these terms are used for projects that would not be sponsored unless the University and the students are willing to relinquish any right to resulting intellectual property.

As a general principle, terms are negotiated to preserve as many rights for the students and for the University without holding up projects due to intellectual property rights. An effort is made to reasonably provide opportunities for students to personally benefit from their creativity and innovation but intellectual property is never held by the University as a deal breaking term unless the team advisor or participating students are unwilling to relinquish rights to their intellectual property in return for an opportunity to participate in the project. While some students and advisors have declined to participate in projects requiring sponsor ownership of developed intellectual property, the ability of the University to assign intellectual property to sponsors has insured that this has never been a significant barrier to project sponsorship. Perhaps surprisingly, some entrepreneurially minded sponsors have even suggested that providing an opportunity for student benefit from intellectual property in the form of a reasonable royalty on the outcomes of both restricted and unrestricted projects is a desirable incentive for team performance.

Academic Progress - As these projects are built around an academic semester and students must receive a grade at the end of the semester, all contracts are structured so as not to allow project conditions to inhibit academic progress. Therefore, projects can be conducted as educational experiences first and as contract obligations to the participating students and the University second. To-date, the teams have an excellent track record of balancing academic progress with satisfying the specific requests of the sponsors as evidenced by the number of return sponsors and the lack of significant disputes over contract performance.

Entrepreneurial Training and Opportunity **-** Beyond the important experiences of the team in conducting the projects themselves, the participation of students in sponsored projects presents opportunities for training in other topics important to aspiring entrepreneurs related to relationship management and contractual obligations. While appropriately structured projects may allow for direct entrepreneurial outputs in the form of spin-off or start-up business opportunities by team participants, all teams will gain experience participating in such things as project sponsorship and confidentiality agreements. This allows team members to become familiar with contract terms and analyzing tradeoffs in obtaining funding for pursuing their own innovations or for supporting the pursuit of others' innovations.

VI. Summary and Conclusions

In conclusion, the benefits of incorporating "real-world" industry sponsored active learning experiences into the curriculum must be balanced with industry's expectations regarding project cost, and outcomes, as well as contractual considerations such as publication rights, intellectual property, and confidentiality. By having a structured process for handling these concerns, students can benefit by learning first hand about confidentiality, the impact of public disclosure on patentability, how to work with clients to satisfy reasonable requests and respectfully dispute

unreasonable ones, and the importance of diligent project management to achieve complex goals in limited time periods. Whether they have the opportunity to pursue entrepreneurial opportunities directly from the project or not, the practical lessons learned will put the participants in a better position to work through these issues later in their careers and allow them to more effectively pursue entrepreneurial endeavors. That is, even if students emerge from these programs without a startup business, as is most often the case, they will have faced issues related to important aspects of entrepreneurship such as business contracting, intellectual property ownership and rights distribution, confidentiality, and client expectations management. Having faced and considered these issues in a relatively 'low-stakes' academic setting, they will be better prepared to address the issues and seek appropriate counsel as necessary when they face them in their professional careers.

Michigan Tech has presented here its views and processes for addressing these issues and hopes to generate further sharing of best practices as well as considerations and context for establishing such practices among the increasing numbers of engineering colleges taking this approach to student design and entrepreneurial education.

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