DESIGN PROJECTS and INDUSTRY ENGAGEMENT in a MECHANICAL ENGINEERING TECHNOLOGY CURRICULUM

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Abstract

Design projects are encouraged and even required in most engineering technology programs. Design is and should be introduced at the earliest stages of the technology education; however, “real” design projects are rarely included in the student’s education. Instead, fictitious and “sanitized” projects that fit the level of understanding and education of the student are assigned. Many times these projects are selected and written to allow completion in one semester.

This paper will discuss design projects that undergraduate students have been involved in with industrial clients. The projects were “real world” because they were real problems that these clients had. They were not prior selected for the students and the project scope was not selected for completion in one semester. The paper discusses how these projects were obtained, the initiation of the projects, when the projects were begun and how they were conducted.

Intellectual property issues can be extremely sensitive. Guidelines are given for the initiation of and conduction of projects so that all parties are protected sufficiently. A practicing patent attorney discusses the necessary intellectual property considerations for the student, university, and the client and provides a checklist of issues that need to be addressed.

Background

Purdue University has one of the oldest and largest schools of technology, and one of the oldest departments in the school is Mechanical Engineering Technology. The MET curriculum is divided into what is known as a two plus two curriculum. During the first two years, the student takes the fundamental courses of math, science, and humanities. The technical courses that are required, are: engineering mechanics (statics, dynamics, and strength of materials), fluid power, heat power, and machine elements. After completing the Associate Degree, the student may choose to stop, or, continue two more years for a Bachelor of Science in Mechanical Technology.
Purdue University has a statewide network of technology programs at various locations around the state of Indiana. Some of these sites offer only an associate degree; while, others offer the complete bachelor degree curriculum. At the Muncie, Indiana site, on the campus of Ball State University, the associate degree curriculum is offered in mechanical engineering technology. Night classes are offered at the Muncie Site and as a result many of the students are non-traditional. For most non-traditional students, the associate degree is the terminal degree. The technical courses at Muncie are taught with that in mind. For example, MET 214 Machine Elements is taught more as a machine design course than just learning about the elements of a machine. The other courses are also taught with sufficient rigor.

Machine Elements

MET 214 Machine Elements is normally taught in the fourth semester of the curriculum. The prerequisites for this course are: the engineering mechanics sequence of statics, dynamics, and strength of materials. The prerequisites for these courses include algebra, trigonometry, and the first course in calculus. The subjects covered in the course are:

- Sizing of Shafting – for strength, deflection, and speed.
- Bearings – journal and anti-friction.
- Springs – compression, leaf and washers.
- Gears – Spur only.
- Brakes and clutches
- Bolted joints
- Welded joints
- Acme and ball screw systems
- Electric motors
- Hydraulic and pneumatic actuators
- Cams and followers

The syllabus is full with about one week allowed for each subject.

The Case for Industrial Projects

Almost everyone has something that they would like to see designed. “I wish there was a…” is something we have all said at one time or another. However, the idea here is to showcase our students and give them the opportunity to use their skills in the industrial environment, so we need to derive our projects from industry as much as possible. In addition, there are many things that can be taught in the industrial environment that cannot be taught in the classroom with made-up projects.

First, the definition of the project in the typical industrial environment is much less formal than the textbook problem definition. The definition will typically be verbal as opposed to written. It will be from the managers mind and he/she have been thinking about this for a while and they know how they would solve it if they had the time. Therefore, the problem definition will typically be “we need this device”, and they continue to describe their solution. Our students should learn to tactfully stop that kind of definition and ask what the problem is. Get a definition that is as general as possible. Ask, “what is the problem we are to solve”, not what is the solution, that you have in mind. Don’t become biased too soon.

Second, students need to become aware of the constraints that industrial projects have on them.
Money, for example, should be discussed in the first meeting. How much do you or would you have budgeted for this project. Students need to become aware of the financial constraints early on. Also, they need to learn to ask about the other constraints for their project, such as: utilities, people requirements, maintenance requirements, etc. These things can only be taught effectively with industrial projects.

Third, communications skills need to be taught in the industrial environment. How do I get information from a busy manager? How do I keep this person informed on the progress of the project? What communication is needed for the completion or termination of the project? These are all questions that can only be answered with industrial projects.

Source and Scope of Projects

There probably isn’t a manager alive that doesn’t have some problem they would like to have solved. The best source of projects is with the Industrial Advisory Committee. First, they serve on that committee because they are interested in the success of the school. They care about students as well as their own companies or they wouldn’t be there. Ask them if they have any projects that you could assign to your students.

If you do not have an industrial advisory committee, contact some of the local industry and ask for a project.

Obviously, some projects are beyond students with only two years of technology education. However, don’t look for projects that are too limited or are too remedial. A good project is one that is a little beyond what the student knows. It should be a challenge and require some research to complete.

Assign the project in the first two or three weeks of the semester. The students will be gaining knowledge as they work on the project and will learn to use the elements of a machine in a real project. You will see them thinking about the project in the framework of the last element they have learned about. They will be asking, “how can I use this”?

Real projects are sometimes not completed by the person or team that started the project. For that reason, students need to learn how to prepare a project to be past on to the next person or team.

Reporting

There are two types of reports that are necessary for these kinds of projects: the progress report and the final report. If the progress reports are detailed and kept up to date, the final report is easier to prepare. Also, the progress report tends to keep the students on track and on schedule.

The first progress report is made up of the definition of the problem they are solving, the specifications for the design, and a schedule for completion. After that, the progress reports are to answer four questions: what did I/we accomplish this week, what are the goals for next week, are we on schedule and why or why not, and what questions do we have or problems that we need help with. The last one of these questions needs a little further explanation. This is there for the students that need help with getting information from someone or something that is out of their control. For example, students on one of the last projects were having trouble getting promised information from the industry manager. He had been in the hospital and was not, or could not
fulfill his obligation. The students noted that in their progress reports. This prompted me to step in and help.

Progress reports are sent to the industry sponsor by email with a copy to me. I am the one grading this project, so I am kept up to date; however, the industry sponsor needs to know what is happening as well.

The final report is both written and oral. The students prepare a team report on the project. In addition, they present this report to the industry sponsor and give an oral presentation of their design. This is done in an industrial setting, like a conference room at the company. This is totally up to the industry sponsor. The report is due the week of finals and the presentation is help at the same time.

Legal Roadblocks

You may not expect your students to produce a design that needs protected. However, any design should be treated as if it can be patented. Students need to learn the procedure for protection of ideas. They should be required to buy a laboratory notebook and required to make notes in the notebook, sketches of ideas, and shown how to protect those ideas. These are habits that can be instilled during projects of this type.

There are some possible legal roadblocks that need to be considered before the project gets underway. First, who owns the intellectual property if some ideas come out of the project that are worth patenting or copyrighting? Second, who is responsible for protecting these ideas. Third, is a confidentiality agreement in order to protect the industry sponsor?

Another thing that needs to be considered is the liability for physical injury. Do the students need to have insurance before they go onto the industry property, and in particular before they go into the industrial area?

The legal department of your university, or your faculty handbook are possible sources for answers to the above questions. You will probably find out that the university says it owns all intellectual property, no matter who comes up with it, or what prompted the discovery. If this is the case, the industry needs to know this ahead of time.

Intellectual Property Overview

In the present technology-driven economy, intellectual property (IP) has become increasingly important to both industry and academic institutions. Industry is now often unwilling to invest in bringing a product to market unless some form of exclusivity such as a patent or trade secret is available. To deliver technological contributions to society in a tangible way and to provide an important additional source of revenue to support research efforts, academic institutions now regularly obtain patents for the inventions of faculty and staff and actively pursue licensing agreements with industry. Pursuit of exclusivity sometimes delays academic publication of important discoveries, but in general, once a patent application covering the discovery is filed with the U.S. Patent and Trademark Office (USPTO), faculty should be free to publish their findings.
ownership of resulting technology and the security of pre-existing technology. Thus, it is necessary for technology and engineering students to have a general understanding of IP, practical knowledge of how to protect IP benefits, and an understanding of how to avoid infringement of patents and disclosure of confidential information. Educating students in this regard will not only help protect industry and university interests during a joint project, but also prepare students to protect IP benefits in their future employment.

Intellectual property is traditionally divided into four conceptual areas and bodies of law: trade secret, patent, copyright, and trademark. Trade secret law gives the right to exclude the unauthorized use of a trade secret by someone: (1) in a special relationship to the owner, e.g., an employee, and (2) who unfairly obtained the information. The subject matter of a trade secret must be protected by an appropriate level of security, not generally known, and provide a competitive advantage. Examples of appropriate subject matter include manufacturing processes, product design information, product formulas, engineering research and development results, customer lists, customer pricing, and business methods.

Patent Fundamentals

Patents issued by the USPTO give the right to exclude others from making, using, offering for sale, or selling the invention in the U.S. The patent owner’s limited monopoly generally extends for 20 years from the filing date of the utility patent application. Applications have historically been held in secret until the patent issues, but now applications are published and available to the public 18 months after the filing date unless the inventor requests nonpublication and does not file a foreign patent application. Applications include claims that are similar to a surveyor’s legal description of land used for a real estate transaction or a deed. The claims define the subject matter for which the patent grants protection to the inventor. After the application is filed the examiner will review the application to ensure that it complies with disclosure requirements and that the invention is acceptable subject matter, is novel, has utility, and is not obvious.

Patentable subject matter includes any new and useful process, machine, article of manufacture, or composition of matter, or any new and useful improvement to patentable subject matter. Products of nature are not patentable. A product of nature is merely discovered in its natural state rather than invented by man.

An invention may be barred from receiving a patent if there is a delay of more than one year in filing a U.S. application after public disclosure, public use, sale, foreign patenting, or abandonment. Specifically, an application must be filed within one year after the invention is patented or described in a publication anywhere in the world. An application must also be filed within one year after public use or offer for sale in the United States. As long as the use is public, the use still falls within the one-year bar even if the actual invention itself is hidden from public view. Any offer to sell an embodiment of the invention can lead to the on-sale bar; however, sale or licensing of the patent rights does not invoke the on-sale bar. Finally, a U.S. application must be filed within one year after filing any foreign patent application or inventor certificate.
Invention Notebooks

The process of protecting patent rights and procuring a patent begins when the process of inventing begins. Inventors should keep a bound notebook recording the work of each research project that could lead to a patentable invention. Notebooks should be legibly written with each page sequentially numbered, signed and dated by the inventor, and signed and dated by a witness who has read and understands the notes. Both broad concepts and detailed accounting of and work relating to these concepts should be carefully recorded.

In addition to the notebook, inventors should retain written records that document certain benchmark dates. These dates include conception, reduction to practice, first public use, first publishing or other public disclosure, first offer for sale, and first sale. When the invention conception is documented, it should include both sketches and written descriptions that are signed and dated by all inventors and by at least two witnesses who are not the inventors and have read and understand the invention. In order to document diligence from conception to the date of reduction to practice, work performed and results should be recorded in the invention notebook at least once per month, and signed and dated by all inventors and witnesses. Actual reduction to practice should also be recorded in the notebook and documented by any other associated records.

Invention Disclosure

Inventors should disclose any inventions to their patent counsel or intellectual property manager at both conception and reduction to practice. Generally, industry and universities use a standard invention disclosure form. The disclosure may contain, for example, the following information:

- Names and departments of inventor(s)
- Invention description and drawings
- Related prior publications or embodiments
- List of benchmark invention dates (as listed above)
- Description of the problem invention seeks to overcome
- Advantages of invention over prior art
- Novel features of invention

Inventorship And Ownership

Inventorship and ownership are separate concepts. Patent applications must be filed in the name of the inventor. The inventor is the initial owner of a patent application or issued patent unless it is assigned to another individual or entity by a written document such as an employment agreement. The inventor is the person who conceived the invention according to the claims of the patent. Persons who helped to reduce the invention to practice under the direction of the inventor are not entitled to inventorship status.

Though ownership of patent rights originates with the inventor, in the employment context employees are sometimes obligated to assign their rights to their employer. While an express employment contract may specify an employee’s obligation to transfer rights, an employee may also be obligated by the employer’s publishing the requirement in an employee policy manual, by hiring the employee to use his inventive skills, or by what is common and accepted practice in
the workplace. University and industry policies are often far reaching and may require assignment of rights even if the invention was conceived without the use of the employer’s facilities or resources, as long as the invention is related to the subject area of the individual’s employment. Though patent law is exclusively federal, the issue of whether a faculty member or employee must assign his rights in an invention to his employer is an issue of state employment contract law. When a faculty member is hired, they most likely signed an employment contract or received an appointment letter which included a provision referring to university policies, one of which may specify an obligation to transfer certain intellectual property rights to the university.

It is less likely that a university student is legally required to transfer to the university or the industry entity IP rights relating to a university project. Because a student is not an employee, an express agreement to assign rights would likely be necessary to transfer ownership of a student's invention to the institution or joint project partner. However, the context of a research assistant may be more akin to an employer/employee relationship than is the context of a typical undergraduate student.

Royalties for an exclusive patent license typically range between 1 to 10%. Universities generally share between 20 to 50% of net royalty income with the faculty inventors. For example, it is one university’s policy to share 50% of the first $200,000 of net royalty income and 25% of income after that with the faculty inventor.

Joint University and Industry Development Projects

A working relationship between multiple entities can easily give rise to a myriad of legal issues and concerns. In the IP context, however, a minimal amount of careful forethought and agreed-upon conditions can avoid most pitfalls. Three general types of agreements should be considered for joint research or design projects: a specific project agreement, an information exchange and material transfer agreement, and a nondisclosure agreement, though other types of agreements or contracts such as a license agreement may need to be considered in certain circumstances.

A specific project agreement will specify who the parties to the agreement are, the purpose and subject matter of the project, the project term, duties and responsibilities of each party, payment or other forms of sponsorship, ownership or transfer of the rights in patents and other IP, royalty or other licensing benefits, nondisclosure and publication, and other terms that are typical of business contracts. The ownership and assignment of IP rights could vary between the university retaining all rights, some rights, or no rights to the IP developed as a result of the joint project.

Depending on the various interests of the university and the industrial partner, faculty and students may be bound by the terms of a general agreement to not disclose any information obtained in the course of a joint project, or may have full rights under a broad agreement to present and publish the details of the project. While such an agreement may bind the two entities to nondisclosure and transfer of rights, it may be necessary that the university further have project participants each sign a nondisclosure and transfer of rights agreement that is in accordance with the terms of the project specific agreement. Nondisclosure agreements generally identify the parties and subject matter of the agreement, the extent and limitations of the confidants’ obligations, and acceptable remedies for breach of the agreement.
When sensitive information is involved in a potential project, a nondisclosure agreement or an information exchange and material transfer agreement may be used in the preliminary stages of investigating and negotiating the joint project. Such agreements will be directed to limiting the uses of information and material that are exchanged between the university and industry and will also serve to limit liability of the transferring party. While an extensive joint development project will involve detailed agreements specifically tailored for the circumstances of the project, a project of smaller scope or involving less sensitive subject matter may be adequately handled by a single, less comprehensive agreement. However, project directors should always consult legal counsel in designing an agreement appropriate for the circumstances.

It is sometimes surprising how small an improvement over the existing art is either patentable or is better protected as a valuable trade secret. It is most prudent to protect the interests of all parties before engaging a joint project.

Intellectual Property Summary

A general understanding of IP law in the university setting can assist faculty in advancing the sometimes conflicting interests of industry and universities involved in a joint research or design project, and in instructing students to protect and procure IP benefits. While industry will certainly be sensitive to protecting their IP interests in joint projects with academia, universities can help to overcome such concerns by offering well-drafted agreements that adequately protect the interests of all involved. Inventors and others who work with IP are well advised to seek competent legal counsel to maximize the benefits of IP and minimize the risks involved. If you need to locate a patent attorney, one way is through Lex Mundi, the world's leading association of independent law firms (http://www.lexmundi.org). Two helpful on-line sources of IP information and university information are: http://www.bakerdaniels.com/newsstand/issues_all.cfm?pubID=13 and http://www.autm.net.

Conclusion

Industry sponsored design projects are one way of providing students with real-world problems. They teach skills that cannot be taught from a textbook and provide interest that fictitious problems can’t. They do come with some overhead, however, and require some extra work on the part of the professor. The extra work is well worth it for the students and will produce a student product that is unattainable any other way.

The importance of intellectual property and the necessary procedures for protection of this property can be presented best in design projects that are industry based. Students can get real life experience in the art of protecting their ideas and those of others.

Please recognize that the contents of this article are not specifically directed to your circumstances and jurisdiction, and that the contents do not constitute legal advice that you should rely on for a specific problem. Rather, the contents are educational in nature to help you recognize matters that you and an attorney should address within the scope of an attorney-client relationship.

References

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