

**TECHNIQUES FOR THE IMPLEMENTATION AND  
ADMINISTRATION OF INDUSTRIAL PROJECTS FOR  
ENGINEERING DESIGN COURSES**

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Abstract

The benefits of company sponsored student design projects, both to academia and to industry, have been well established recently in symposia and in publications. In spite of these known benefits many institutions have been slow to implement student projects with industry. Much of this reluctance has been due to the perceived difficulties of the administrative tasks necessary for arranging and planning these matches between student teams and company projects. Admittedly, in preparing project activities, there are numerous administrative tasks that transcend normal teaching responsibilities but if these tasks can be clearly outlined in advance then they can be made manageable and can lead to effective design education experiences.

It is the purpose of this paper to identify the necessary steps for soliciting, screening, and selecting the types of company projects that will enhance educational objectives and further industrial partnerships.

Introduction

Industrial/Academic partnerships are essential for technological development, regardless of the discipline. The purpose of this paper is to show how student design projects furnished by industry cultivate this partnership and benefit both groups. A further purpose is to present specific steps for arranging these industrial projects. The basic concept is to use actual "real world" problems suggested by companies for student team design projects which are a required component of senior mechanical engineering design courses. The successful experiences of the mechanical engineering department at Rose-Hulman Institute of Technology will be used as a model to describe how such programs can be implemented. It is hoped that the procedures described here will assist other institutions in realizing the same benefits.

The two most important aspects of a senior design course are to learn the methodology of design and to gain design experience. The methodology can be learned in the classroom but the experience is best gained by completing actual projects, preferably as a member of a design team.

These projects can be chosen by the students (something they're interested in), or they can be created by the instructor. But, there is a better way.

At any given time all companies with an engineering staff are faced with design problems of various degrees of difficulty and with a large range of priorities. Many of these problems, which the engineering departments fully intend to address eventually but may not have the highest priority, are excellent design projects for student teams. It is just a matter of making the industrial contact and then matching their problems with student projects. This process can be logically broken down into the categories of solicitation, screening, and final selection. Suggested components for each of these categories follow.

### Solicitation

The first step in arranging industrial/student projects is to make the appropriate contacts with companies. These contacts/solicitations can take many forms and the instructor/administrator should take advantage of every opportunity to inform industrial friends of the possible opportunities to work with student design teams on relevant problems.

\* Letters of invitation to participate are very effective in informing large numbers of companies of the opportunities for participation. Names and affiliations can be obtained from chambers of commerce, alumni offices, business directories, personal contacts, etc.

\* Alumni newsletters are another effective strategy in initiating industrial contacts to inform company officers of on-going educational programs with industry. These articles should, of course, include benefits to the companies, educational objectives, and also names of appropriate faculty contacts.

\* Phone calls to individual alumni in industry, especially ex-students are time consuming, but are particularly effective. Again, these contacts should review the potential benefits to both parties.

\* Plant visitations by any faculty or administrator should be used as opportunities to leave business cards and to suggest the benefits to the company of taking advantage of the opportunities to work with teams of bright young minds on projects of their choosing.

### Screening

As a result of solicitation techniques such as those above and others, there will be inevitable responses from industry in the form of many suggested problems/projects for student teams. Not all industrial problems, however, are appropriate for student team design projects, and it is here that the instructors must screen the proposed projects very carefully. The following questions need to be asked and discussed with the industrial contact. (See Gibson [1].)

\* Is the scope of the project of appropriate length? The time required for the estimated completion of the project should match as nearly as possible the length of the quarter or semester. Projects that are structured to run for longer than one quarter or semester can have advantages if they are carefully conceived. However, not all projects will run smoothly and maintain student interest and

therefore it is usually of greater educational benefit to have two shorter projects rather than one longer one. It is frustrating for all concerned to commit to a long term project (2 or more quarters) and then determine that, for no one's particular fault, the project "dead ended" prematurely or became undesirably redirected. It must be kept in mind that the overall objective is to maximize student design experience. That is usually accomplished by the completion of more, rather than fewer, projects.

\* Is the proposed project really a **design** project? Perhaps the company is just looking for some specific **analysis**? It is tempting for a company to suggest a design project when, in fact, what they want are specific answers to some analysis problem. In these cases the students just do what they're told and do not benefit from experiencing the design process.

\* Is there opportunity for student management of the project? The student teams must be allowed to manage themselves and thus maintain "project ownership". The industrial contact and the instructor must restrain themselves from dictating the project direction even when they feel that would be more efficient. The instructor must be available for advice, counseling, and expertise, but must not direct the project. The degree of guidance requires considerable judgement on the part of the instructor but in order for the students to gain this valuable design management experience they need to be allowed to develop their own design decisions. It should be obvious that this strategy is only possible when projects are on a "no-fee" basis. Company reimbursement for student travel to plant facilities is, of course, expected.

\* Does the project have the potential for benefiting the company? Usually a company is looking for some fresh ideas or new approaches to their design problem. Not all student projects will result in design breakthroughs but each one should present some new ideas in a rational, well-thought-out format that will be of some benefit.

## Final Selection

After all of the projects suggested by companies have been narrowed down using the screening process above, a final selection can be made using the following criteria.

\* Is there a reasonable expectation of the project's successful completion? Clearly some design projects will require a degree of expertise that is beyond that of the typical engineering senior. It is the responsibility of the instructors to select only topics that are matched to the students' professional level.

\* Will the students' design education be enhanced by their interaction with a company's engineering staff? There is significant educational benefit from having a student team sit down with practicing engineers and discuss real problems faced by the company. This is an environment different from what the students are used to but it is an excellent preview of their future activities.

\* Is a visit by the student design team to the company facility reasonably convenient? A tour of the company's manufacturing (or research or test) facility is an added educational benefit. A four hour maximum drive is a usual requirement. Again, the company should agree in advance to reimburse the students for nominal travel expenses.

\* Will there be a company contact person that can be reasonably relied upon to furnish needed data/information to the student team in a timely fashion? The students need to realize that their company contact has many other important responsibilities but the contact also needs to keep in mind that the students are under an inflexible deadline. The actual faculty time expended during the solicitation screening, and final selection processes are, of course, quite difficult to assess, but the authors estimate the about 3-5 hours per selected project for these activities are required before the quarter or semester begins.

### Project Administration

At Rose-Hulman, two design courses that use exclusively company suggested projects are MACHINE DESIGN and SYSTEMS DESIGN, both senior mechanical engineering courses and both four quarter hours of credit. These design projects represents 50% of the course grade in both courses. The enrollment in each course is approximately 110. The students are normally expected to spend approximately 10 hours per week on their projects.

In the MD course the student design teams usually have three members and in the SD course, where the projects are somewhat broader in scope, the teams usually have five members. The composition of the teams usually is made by the instructor and this has been found to be the most effective procedure. The students are reminded that in industry engineers are assigned to groups and are assigned projects, and that an essential skill that they must learn is teamwork on projects, and with other members, not necessarily of their choosing.

In both courses, each project team in the course (typically 35-40 teams in MD and 20-25 teams in SD) meets with the instructor once a week at a pre-arranged time and submits a written status report. The company contact may also request weekly status reports. In both courses formalized design methodologies are required. (See for example Paul and Beitz [2] or Dekker and Gibson [3].)

Basically this process is: 1) Problem Definition in its broadest form, 2) Conceptual Design or identifying alternatives, 3) Embodiment Design or configuring the most likely candidate, and 4) Detail Design or completing the recommendation.

Oral presentations and final written reports are required of each design team in each course. Additionally, many of the companies invite the teams to their facility for an in-house oral briefing.

### Educational Benefits

In addition to experience in project definition, development, and management, there are other important benefits to the student in completing industrially sponsored projects.

\* “People skills” is an attribute that companies increasingly value in hiring entry-level engineers. These types of projects are excellent in providing opportunities for students to build these skills. In addition to working under pressure with classmates toward a common goal, the students must also interact with their industrial contacts.

\* An exposure to “real world problems” is provided by these types of projects. After the initial

plant visitation and the discussions with company engineering staff, students invariably return to campus feeling that they have an opportunity to contribute to an actual problem. From experience it can safely be stated that their motivation is higher than it would be on project topics they have chosen and definitely higher than it would be on topics created by the instructor.

\* The development of new job opportunities is made possible by student/company contacts. It is not unusual for a graduate to obtain employment as a result of his or her experience with a company-sponsored project.

\* Faculty have the opportunity to learn more about contemporary industrial problems. Educators need to take advantage of every opportunity to stay in touch with the types of design problems faced by industry.

### Industrial Benefits

In addition to the many implicit benefits that industry realizes in working with academia on student projects, there are also some very direct payoffs.

\* Many of the student design project recommendations receive quick implementation. The projects suggested were actual problems faced by the company that needed solutions. They actually “contracted” out a task and received a deliverable in the form of a written report even though there was no fee involved. Student recommendations that are not immediately implemented are usually still beneficial for their fresh and unbiased response from “outsiders” to an internal problem.

\* Companies have an opportunity to work with young and energetic engineers, to develop long term contacts, and even to take advantage of the hiring possibilities of these entry level engineers after seeing their performance.

\* Relationships that these project activities foster allow industry to have an impact on curricula. As practicing engineers learn more about recent educational trends and requirements, they can suggest and influence activities in the undergraduate programs.

### Conclusions

Industrial/academic partnerships are essential in our growing technological society. In this paper the authors have described how this partnership has been enhanced at Rose-Hulman Institute of Technology through required student design projects which are furnished by specific companies. The benefits, both to Rose-Hulman and to the individual companies, are well-established and have been discussed here. In the two required senior mechanical engineering design courses mentioned, all of the team projects now come from industry. Although the advance planning and organizational efforts are substantial, they are considered to be justified. It is hoped that the positive experiences with student projects and the specific guidelines for implementation described here can be effectively implemented at other institutions.

### References

- [1] Gibson, J.D., "The Use of Industrial Design Projects as a Means for Integrating Senior Engineering Design and Engineering Economics", Proceedings of the ASEE Annual Conference, Seattle, 1998.
- [2] Paul, G. And Beitz, W., Engineering Design: A Systematic Approach, Edited by Ken Wallace, Springer-Verlag, The Design Council, 1988.
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