ROLE OF INDUSTRY SPONSORED PROJECTS IN ENGINEERING EDUCATION

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Abstract

The experience gathered with industry-provided projects for senior design courses for mechanical engineering majors at Minnesota State University, Mankato, in recent years has been discussed. The author acted as the faculty adviser to three student design teams which addressed three such project topics. The projects are briefly described. These company-sponsored senior design projects are considered an important link between the engineering coursework and real life engineering tasks. The relationship between these projects and the remainder of the curriculum has been discussed and the advantages of this approach to teaching senior design have been pointed out.

Gaining Design Experience through Industry Sponsored Projects

The present ABET accreditation criteria for mechanical and other similar engineering programs, the EC 2000 require students to be exposed to a considerable amount of design content throughout various engineering courses. One significant source of design experience for the students has been in the form of senior design courses. Most engineering curricula include a sequence comprising two courses in the senior year. This is how these required courses are incorporated into the mechanical engineering program at Minnesota State University, Mankato. The mechanical engineering department at Mankato is a relatively small department with a distinct emphasis on preparing its graduates to act efficiently as practicing engineers as soon as they join the workforce. Based on the various forms of feedback, notably that provided by its alumni and Industrial Advisory Board members, the department has been quite successful in attaining this goal.

For some time now the department has had a sequence of two courses for this objective. They are ME 428 and 438, Senior Design I and II, respectively. The students take them in the fall and spring semester, respectively, of their senior year. By that time the students have completed the required course in design of machine elements and are taking concurrently a course in computer aided engineering, encompassing both design and analysis parts. The problems tackled in ME 428 & 438 have been provided by about half a dozen engineering companies from the area. These are typical real world engineering problems for which the companies do not have the resources to address yet they would benefit from having them addressed. The available projects are presented to

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the students by the companies early in the fall semester. The student teams, consisting of four to five students each, evaluate and rank the projects according to their interests and future career plans. Typically, there have been enough of these projects (the companies often present several projects each) so that all major areas of mechanical engineering are covered. The faculty member coordinating the course in consultation with other mechanical engineering faculty members who will serve as faculty advisers to the teams make final decisions on assigning specific projects. Every effort is made to best pair the teams and the projects, and typically every team gets their first or second choice.

Once assigned a specific problem, a student design team develops the strategy for addressing it in the most efficient way. They work closely with the faculty adviser. The emphasis is placed on producing a workable solution within the time available while meeting other constrains, the budget, for example. In the fall the teams are expected to develop and brainstorm several alternative solutions leading to the alternative of choice which best meets all the design criteria. During the spring semester this concept is developed in detail. The necessary analysis is conducted and the proposed solution is continuously optimized. Considerations such as cost to build and operate, serviceability, and potential for upgrade are also included when the best form for the function is selected.

This is a valuable experience in working as a group that is expected to solve a real engineering problem. The characteristics of group dynamics are constantly present. The differences in individual approaches, which are necessarily present, must be reconciled and the project moves toward its completion. The teams meet at least once a week and the decisions on the next phase are made. Regular weekly meetings are held with the adviser as well as with the company at least once a month. Two major presentations are made by each team, one in the fall at which time the student teams outline the planned approach to solving the problem, and the second at the end of the spring semester by which time in most cases a working prototype has been developed and tested. These final presentations are regularly attended by all mechanical engineering faculty, company and the American Society of Mechanical Engineers (ASME) regional representatives.

Examples of Industry Provided Student Projects

In recent years five to six projects have been addressed each year depending on the number of mechanical engineering seniors. Three such projects are outlined next.

Curved Windshield Wiper Design

The goal of this project was to design, build and test a wiper mechanism for the curved windshield of a new tree feller/buncher tractor cab developed by Blount Inc. from Owatonna, MN. A major design constraint was that the wiper had to have fairly low profile relative to the cab to avoid damage to the wiper in operation. One of the goals was also to use as many commercially available components as possible. The team selected two concepts for further evaluation, a vertical track and a dual pivot system. After careful consideration of the pros and cons of each concept, the pivot-based design was selected as the alternative of choice. The sponsoring company endorsed this design and agreed to build a prototype. To facilitate effective testing the company delivered a full scale mockup of the cab. A number of configurations were built and tested. The final result of this work was a dual wiper system with a pivot in the top center and top corner of the windshield, see Figure 1.

Maintenance Free Solder Plating Jig

This project was sponsored by Thin Film Technology of North Mankato, MN. The company manufactures passive thin film components serving the telecommunication, computer, test equipment and automotive markets. Most of their products use substrates – ceramic plates going through a series of processes which are finally separated into individual pieces and laminated together to produce the final product. A process known as electroplating, which incorporates an acidic bath, is used to plate substrates with solder. In order for the solder to plate the substrate, an electric current must flow though the substrate which, in turn requires that copper be sputtered on the sides of the substrate. The exposed electrical contacts of the moving jig which is used to hold the substrates in the acidic bath themselves plate with solder with time. This buildup of solder reduces the electrical contacts between the jig and the substrate. To remove the solder accumulation from the jig a process of reverse plating is conducted. During this process, the jig is placed in the acidic bath without the substrate and the electrical current is reversed. This process takes significant time. Therefore the objective of the project was to develop a jig which would not plate in the process and thus it would be 'maintenance free.' The newly developed jig had to maintain the overall dimensions of the existing jig. It also had to be able to accommodate future modifications to the substrates. Five original concepts were considered. The chosen solution involved an H-member holding the four contacts, which are covered individually by rubber boots, see Figure 2.

Surgeless Trailer Brake Control System

The objective of this project was to design a brake control system that would replace the existing surge brakes. It is intended for use on heavy-duty trailers having a maximum weight of 80,000lb. The expected deceleration rate is 0.3g. The project was proposed and sponsored by MICO Incorporated of North Mankato, MN. First the team studied possibilities of using load pins to measure the trailer force applied to the towing vehicle while braking. Various load pins were researched so that the overall system limitations could be determined. Once the right load pin was selected a new hitch into which the pin could be incorporated had to be designed. The signal provided by the pin is fed into a DVC 10 logic controller which based on that information as well as on the instantaneous vehicle/trailer kinematic parameters determines the right level of braking pressure generated by a hydraulic pump. The controller needed to be able to determine when the towing vehicle's brakes are being applied and whether it is traveling forward or in reverse. Next several concepts for controller function were generated. A schematic drawing of the project is shown in Figure 3. Because of the unexpected delay in the acquisition of the final load pin selection the design could not be tested.

Conclusions

It is believed that a significant amount of hands-on experience is acquired by the participating students when they are presented with opportunities to work on industry requested and sponsored projects. Benefits to the students are many: exposure to real world engineering, advancement of their expertise in various areas of engineering, familiarization with the production programs of participating companies, development of first professional contacts, and enhanced problem solving, team working and communication skills.

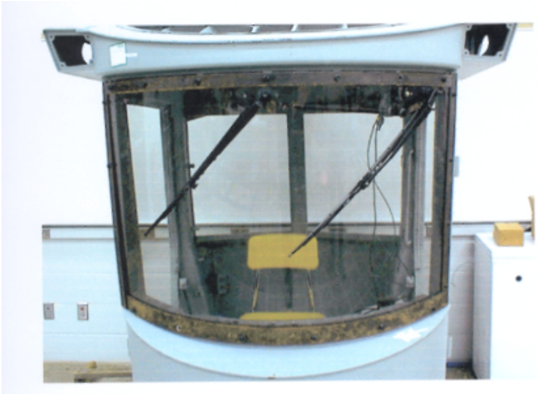

Figure 1 Curved Windshield Wiper System

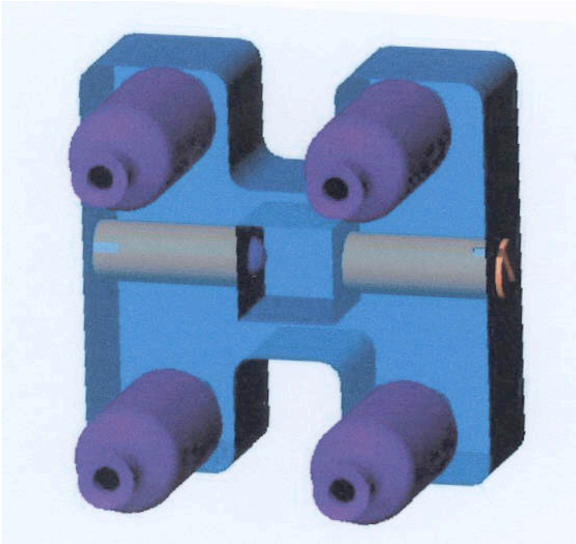

Figure 2 Maintenance Free Plating Jig

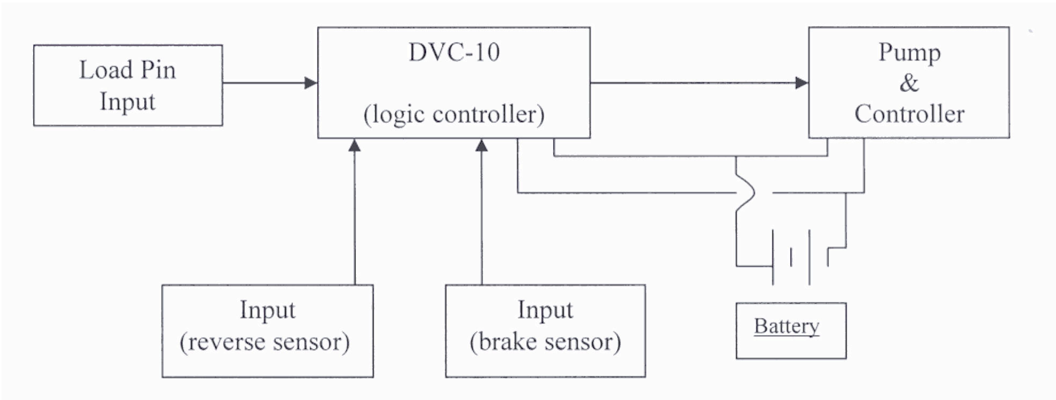

Figure 3 Schematic of Surgeless Braking System