Sources of Industrial Projects for DFMA Course

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Abstract

It has been our experience in both the Capstone Senior Design course and the Design for Manufacturing and Assembly (DFMA) course that students are far more interested in working on "real" projects. The problem is finding industrial support for about 100 projects per year. This paper will consider the various sources we have used. RIT works on the quarter system; DFMA is a four credit hour course; the project represents 25%-40% of the grade.

Background

The undergraduate DFMA course started as a required course 10 years ago. It was based on a very successful graduate course. The graduate course was an evening course with almost all students holding full-time engineering jobs [1]. Projects usually related to the students job or were obtained from a peer at work. The few full time students were allowed to use a commercial product they had at home or purchased at a local store.

RIT is a quarter based institution with a cooperative education program. For engineering students it is a five year program. As freshman and sophomores, they attend three consecutive quarters with the summer quarter as vacation. As third, fourth, and fifth year students they alternate academic quarters and work blocks. They must complete five co-op work blocks to graduate. The students are split into "A" and "B" blocks so the Institute holds classes all four quarters and about 50% of each class is on campus each quarter. Some co-op employers hire only for double blocks, wanting the student for six consecutive months.

DFMA is a required course for fourth year students. Prerequisites are Geometric Dimensioning and Tolerances and Manufacturing Processes. A normal track student will have completed two work blocks prior to taking this course. Due to a significant number of transfer students, and students who have experienced academic problems, the class usually has a few third year students, and several fifth year students.

The course covers two major areas: Design for Assembly (DFA) and Design for Manufacture (DFM). DFA covers two quantifiable measurements of assembleability; Boothroyd Dewhurst (BDI) manual and software techniques [2], and the SEER [3] Technology software technique. DFM covers: casting, molding, sheet metal, powder metal, extrusion, forging, and machining. The BDI DFM software [4] is used for the five processes that have been developed to date.

Homework consists of:

1. Reading from the text
2. Four papers
3. A DFA manual calculation
4. A "Tip-a-Can" design, and working prototype"'
5. A DFMA project; due in phases, to force timely work, and to make sure the grading workload is almost livable.

Projects

A project consists of a product or subassembly consisting of about 15 parts. Students are warned against choosing too large a project, and are allowed to reduce the scope of too large a project when they get into trouble. The student must provide a functional analysis of the assembly. Without this, an intelligent redesign is impossible. The functional analysis requires that they consider life, reliability, operating environment, etc. This requires sponsor support, either with an initial presentation, written specifications, and/or ongoing contact and support.

The project phases include:

1. Functional analysis
2. DFA analysis of initial design
3. DFM analysis of initial design
4. Redesign
5. DFA analysis of redesign
6. DFM analysis of redesign
7. Compare and contrast both the two designs and the evaluation techniques

Students are allowed to reanalyze and resubmit previously graded work within one week of original due date.

Project Sources

Coming up with 100 projects per year can quickly turn instructors gray. Seven main sources of projects have evolved over the past decade:

- Co-op Employer Sponsored-Students are encouraged to obtain a project from their co-op employer. Their project is a reward to the employer since they receive a significant piece of work at little or no cost. Since the students knows the appropriate company engineers, support is easily obtained on a timely basis. These projects often exceed the recommended 15 parts since the student has a vested interest in doing a good job so that he/she will be hired back for another block. An example is a roller assembly for a supplier to Xerox Corporation.
- Employer Sponsored-some undergraduate students work full time for two major Rochester employers that sponsor release time programs for employees seeking undergraduate degrees. These are essentially the same as the projects covered in the previous source. Examples are paper handling subassemblies for Xerox Corporation.
- Consulting Related-two of us that teach DFMA also consult and are always looking for projects. These can either be related to a consulting project or just come about due to contacts made while consulting. Potential consulting may never develop into a contract due to cost but instead becomes a student project. Not as good as having the professional consultant do the analysis; but a great low cost substitute. Since these are a substitute no example is supplied to save embarrassing any company.
- Conference Related-Conferences with predominate attendance by industry are a very fertile source of projects. By giving a talk or paper related to student work on DFMA a great deal of interest can be generated. For example, as a result of a presentation at the Annual International DFMA Conference sponsored by BDI, Ford Motor Company's Vincent P. Render "adopted' us. Over the past few years he has furnished a Taurus SHO, a Taurus Sedan, and an Explorer as well as four automotive doors. Ford sponsorship has gone well beyond projects and has included such things as BDI software, and BDI hardware keys, House of Quality software, internal Ford DFMA course attendance by RIT faculty, visits, and lectures. We have done hundreds of projects for Ford. Each of the vehicles has had many, many assemblies that students analyzed. Examples from this past quarter are the vehicles jack, the door handle assembly, the seat mounting assembly, and the turn signal.
- Industrial Workshop Contacts- As a BDI Workshop Leader, and as an instructor for RIT's Training Group I have made many contacts while giving workshops. It may be called begging, but I am not too proud to do it. It sells well as free consulting. Every student in a class is a potential gold mine of projects. The most fantastic contact was at II Case. They have furnished two skid steers, a cable plow, a Magnum Tractor and two tractor cabs, as well as various assemblies. They even encouraged their seat supplier to also support projects.

- Prior Students-Students are encouraged when they take the course to remember us once graduated and employed. Contact with alumni includes a request for projects. Prior students who call with technical questions are asked for projects. Last year we struck gold on this type of contact with an alum working for US Surgical. He brought his supervisor to campus, they made an excellent presentation, furnished many assemblies of a surgical stitching device and even interviewed and hired a co-op! By having a sponsor who had "sat in their chair", just four years prior, the students were "turned on". This alum, Scot Martinella, returned 20 Feb. 97 to again interview for a co-op and to furnish two more surgical devices. These are again extremely interesting designs and we expect a very high level of student interest. The work will take place in the time span between writing this paper and presenting it in June.
- Chance DFMA Contacts-a casual call for some DFMA information from a major manufacturer resulted in some great DFMA design examples and three excellent projects: a castle, a kitchen set, and a playhouse. They gave excellent lectures and showed a superb manufacturing video. This sponsor is nearby, major manufacturer of children's toys. The customer requirement, are very detailed and severe. The safety of the children requires robust design that will not injure the user even if they abuse the toys. The customer requirements are very detailed and severe. The safety of the children requires robot design that will not that will not injure the user even if they abuse the toys. These are summarized in Table 1.

Table 1
Summary of Project Sources

Sponsor Source	Examples
Co-op Employer	Xerox Roller Assembly
Employer	Xerox Paper Handling Assembly
Consulting Jobs	N/A
Conferences	Ford Explorer Jack Ford Explorer Seat Mount
Workshops	JI Case Cable Plow Instrument Panel JI Case Cable Plow Muffler Assembly
Prior Students	US Surgical Blood Vessel Clamp US Surgical Stitching Device
Chance Contacts	Fisher Price Castle

Every business trip, every social affair, every organizational meeting is a potential source of projects. Keep going after you ask the other person what they do for a living. You need to be "on duty" at all times. On one plane flight back from a workshop in Hungary I sat next to the owner of a company making the best slot car wheels. On the bus from my son's college town to the airport I sat next to the inventor who had real, and interesting needs. Be certain you always have your business cards in your wallet.

Turnover!

Only Ford has survived year after year. Jobs and funding change. Sometimes the companies are overwhelmed by a carton of reports and need time to digest them. Today's engineers are often very overworked and they are drained by supporting student questions and then receiving a number of reports. If inadequate functional information is given to the students the reports recommendations may not be useful. The company has to be in an active DFMA mode both to support and to then use the results of the projects. This runs hot and cold at many companies.

Only a few companies such as Ford have fully embraced the DFMA concept and then stuck with it on a long term basis.

Techniques to Encourage High Quality Reports

Two incentives have been developed over the years to encourage high quality reports. Since the reports are furnished to the sponsoring company the students are strongly encouraged to prepare reports that are a credit to both themselves and the Institute.

The first incentive is to opt out of the final exam. To do this the student must have an A (.90) or B (.80) average in the course and an A (.90) grade on the report. With a final the grade is determined by: homework (25%), quizzes (25%), project (25%) and the final (25%). Without a final the grade is determined by: homework (30%) quiz grades (30%) and the project (40%).

The second incentive is the opportunity to upgrade previously graded work. I started this 10 years ago based on a talk given by one of the Eisenhart Award winners. The Eisenhart Awards are RIT's excellence in teaching awards. The ground rule is that regarded work must be submitted within one week of the original due date. The two grades are averaged. For example, a "C" regarded to "A" becomes a "B" in the book. The original work must be attached. I was really impressed by the award winners presentation and the answers to the inevitable questions asked and concerns expressed. The winner answered a statement that everyone would abuse it by assuring us that most students lack the ambition to resubmit work. I have found this to be true. The most amazing thing is that those with the least to gain use the option the most! Usually, it is "A" level students who resubmit! For example a resubmitted "B" that is regraded to an "A" becomes a "B+" with only a half grade increase. Grades of "D" or "C" can increase by at least a full letter grade, yet they are seldom upgraded.

If a report clearly does not meet required standards, which has happened a few times I do not furnish it to the sponsoring company.

Conclusion:

Industry sponsored DFMA projects are a very effective educational tool for a DFMA course. It requires extra effort on the part of the instructor and on the part of the sponsor. Since the instructors, the departments, and the institution's reputation are at stake, it is essential that high quality reports are prepared. Bottom line, our experience, supported by student and sponsor feedback, is that the use of these projects is worth the gray hair they cause.

References:

(1) Freckleton, "Graduate Level Training in DFM for' the Practicing Engineer". Second International Conference on DFM/DFA, Newport RI, 1987

(2) Boothroyd G., Dewhurst P., Knight W., "Product Design for Manufacture and Assembly," Dekker, 1994

(3) Boothroyd Dewhurst Inc, Wakefield RI, G. Boothroyd recently retired for URI P. Dewhurst is at URI, Recommended PC have minimum of : 486,16mb RAM, 12 Mb available Hard Disk Space, and Windows 3.11 or 95.

(4) SEER DFM Software, G.A. SEER Technologies, Division of Galorath Assoc, Los Angeles, Web Site :http://www.gaseer.com

(5) Freckleton, "The Tip-A-Can Project" ASEE Annual Conference, 1993.

Biographical Information

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