

Graduate Student Industrial Experience Program

Daniel P. Hess
University of South Florida

Abstract

This paper describes a pilot program for graduate students that integrates interaction with industry with thesis research. Since 1996, five graduate students have participated in this program through projects with Breed Technologies, Loctite Corporation, Johnson Gage Company, and Tampa Electric Company. Since the level of interaction of each student with industry varies, each case is presented and discussed separately. An assessment of the program, which identifies positive aspects as well as potential problems, is also included.

Introduction

The United States has seen a shift in attitude in research over the past few years. There now exist many incentives for cooperative research activity between academia and industry that give our industry a global competitive edge [1]. Yet few if any engineering programs exist, that mandate an industrial connection or interaction as part of a graduate program. Such a program would force cooperative research activity between industry and universities, enrich the graduate student experience and better prepare them for employment opportunities, and ultimately improve our industrial competitive edge.

In 1994, the author developed a plan to implement such a program within Mechanical Engineering at the University of South Florida. Initially, this plan was part of a National Science Foundation Career Proposal which was funded in the Summer of 1995. The goal was to establish a pilot industrial experience program with a few master level students under the author's direction. The focus of this pilot program was to define and perform applied research activity with industry on topics involving dynamics of machinery. An important element of the program was that the students would obtain guidance from both an engineering university professor and engineers from industry.

To date, five graduate students have participated in this industrial experience program. Two of these students started in the Spring of 1996 through a project with Breed Technologies. One student started in the Fall of 1996 through a project with Loctite Corporation. A fourth

student started in the Spring of 1997 through a project with Johnson Gage Company. The most recent student, started during the Summer of 1997 through a project with Tampa Electric Company. The projects with Breed and Loctite were cost shared by the National Science Foundation, however, the other two projects were funded completely by industry.

This paper reports on the success of this pilot graduate student industrial experience program based on experiences with the first five participating students. The interaction of the students with industry varied with each of the four projects. A brief description of each project is given, and more importantly, the interactions of the students with industry are presented and discussed.

Assessments of the program based on industry, student, and the author's evaluations are included and discussed. This information identifies not only the positive aspects of such a program, but also some potential problems. It is expected to be of use to others interested in developing a similar program within their own discipline.

Pilot Programs

To date, the author has managed to establish five thesis projects for graduate students that involve direct support and interaction with industry. In what follows, these projects and examples of student interaction are described. In each case, the level of student interaction with industry varies from modest to extensive. However, in each case, the student is found to benefit from the interaction, even when the interaction is modest.

Breed Technologies

In the Spring of 1996, a project with Breed Technologies of Lakeland, Florida was established. The goal of this project was to model and analyze the dynamic behavior of mechanical sensors used in airbag systems, and to determine sensor design modifications for improved performance. This project initiated the planned graduate student industrial experience program for two graduate students pursuing Masters degrees. One student focused on the dynamic modeling and simulation aspect of the project, and the other student focused on developing a test apparatus

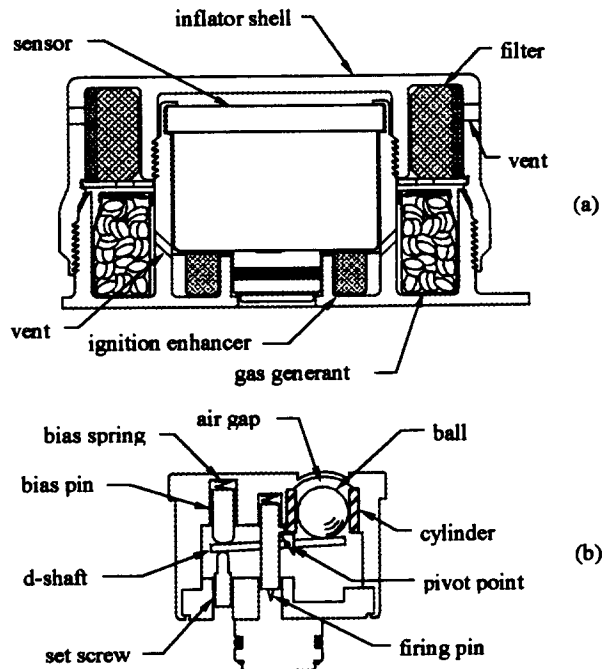


Figure 1 (a) All-mechanical sensor in inflator shell for automotive air bag system, and (b) details of sensor.

and performing experiments. Figure 1 shows a typical all-mechanical sensor used with airbag systems. Since Breed Technologies is within a half-hour drive from USF, student interaction with their engineers has been convenient. Activities of interaction have included general project discussion meetings, regular progress review meetings, telephone discussions, faxes, and collaborative testing. Although the students have performed about ninety percent of their work at USF, the interaction with Breed, as described above, has been extremely beneficial to the students professional development.

Part the plan of the program was to have the students carry a significant portion of the responsibility of the project. For example, the students prepared and presented almost all of the progress summaries at the project meetings. The concept of a potential career opportunity with the company after completion of the project has helped the students become more self-motivated and responsible, than students working on projects without the industrial connection.

Loctite Corporation

In the Fall of 1996, another graduate student was brought into the program through a project with Loctite Corporation of Rocky Hill, Connecticut. This contract supports research on assessing and quantifying the useful life of thread locking adhesives under dynamic loading environments. The goals are to develop an apparatus and test procedure for

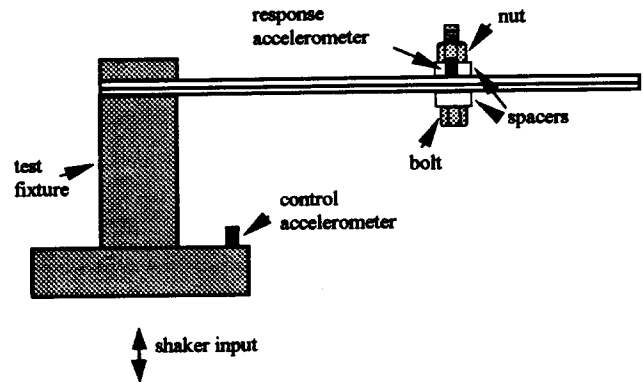


Figure 2 Test apparatus for thread-locker life tests and threaded fastener dimensional conformance tests.

an accelerated vibration life test for threadlocking adhesives, and to use this life test to evaluate and compare various thread adhesives. The apparatus used in this work is shown in Fig. 2.

Because of the physical distance between Loctite and USF, the interaction between the student and engineers at Loctite was more limited compared to the Breed project. In this case, essentially all of the apparatus development and testing was performed at USF. However, interaction with Loctite engineers was facilitated through weekly email, mail and fax correspondences as well as telephone discussions. This project actually had only one progress meeting at Loctite facilities. As with the Breed project, the student prepared and delivered the progress summary.

Even though the interaction between student and industry in this case was not as strong as with the other project, the idea of working on a problem that solves a current problem for industry was very appealing to the student. The student felt that his employment opportunities would be better as a result of this type of project compared to a purely academic thesis project.

Johnson Gage Company

In the Spring of 1997, a fourth graduate student was brought into the program through a project with Johnson Gage Company of Bloomfield, Connecticut. This contract supports a series of tests which examine the effect of dimensional size conformance of bolts and nuts on vibration-induced loosening. The test specimens consist of master bolts and nuts with precisely controlled nuts and bolt pitch diameter, minor diameter, major diameter, lead, thread angle, helical deviation, front and back taper, and out of roundness. The apparatus used in these tests, is similar to the one used in the Loctite tests (see Fig. 2).

As with the Loctite project, interaction is somewhat limited because of physical distance. The types of interaction between the student and Johnson Gage engineers

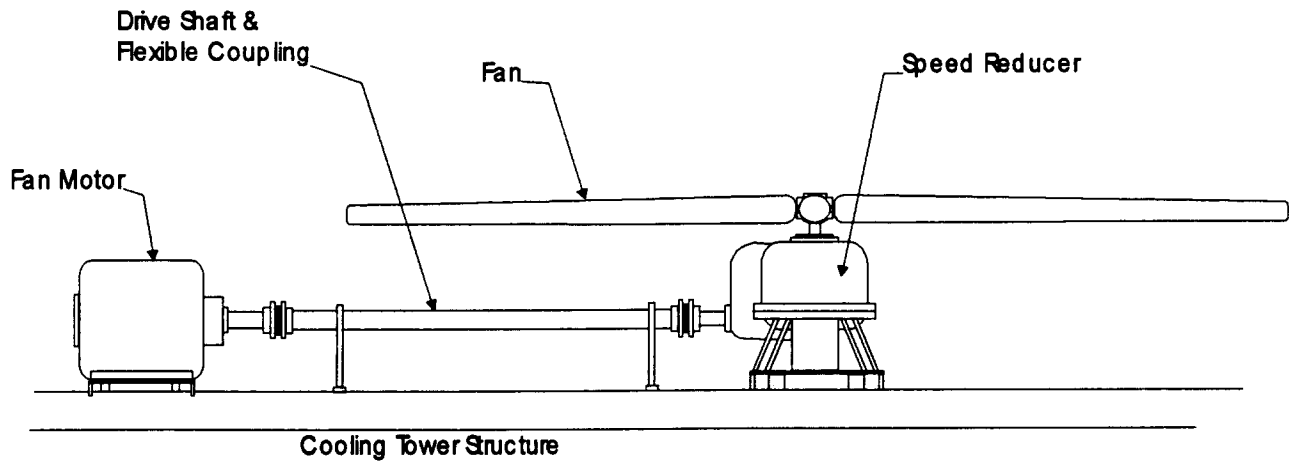


Figure 3 Water cooling tower fan system.

is similar to the interaction described for the Loctite project, except that a Johnson Gage engineer did travel to USF several times to help facilitate the actual testing. This person's expertise in gaging coupled with the author's expertise in dynamic testing, provided the student with excellent exposure and training. In addition, an early visit of the student and author to the Johnson Gage Company facility provided hands-on training of threaded component gaging systems and concepts.

Tampa Electric Company

During the Summer of 1997, a project with Tampa Electric Company was started. The focus of this project is to solve a dynamics problem associated with a water cooling tower fan system which manifests itself through excessive vibration. The ultimate goals of the project are 1) to reduce the frequency of repairs of the water cooling tower fan systems while keeping the time of repair short, and 2) to improve the reliability of the fan drive systems. The specific tasks to be performed include: 1) a thorough inspection of the fan drive system, 2) a dynamic analysis of the fan system, 3) a dynamic analysis of the support structure, 4) dynamic modeling of the system, and 5) implementation of system modifications. The fan system is driven by a two speed (850 and 1700 rpm) motor through a 5 foot drive shaft, couplings, and a six to one reduction gear box as shown in Fig. 3.

This project was set up such that the graduate student worked directly for the Tampa Electric Company as a graduate co-op student, and other project expenses were covered in a separate contract with the author. In this project, the student has performed most of the work, on site, at a Tampa Electric Company power facility. The student interacts with managers, engineers, and technicians together with the author to solve this machine dynamics

problem. As with the other projects, the student also will be responsible for writing and presenting project summaries.

Tampa Electric Company currently has a number of machine dynamics problems, and is interested in developing a long term relationship with USF that would support this program. Since machinery diagnostics has become a profitable business over the last decade, this is an excellent opportunity for graduate students interested in this area.

Assessment

From the author's perspective, this graduate student industrial experience program has been a positive experience. The process of guiding a student's research is shared, to some extent, with managers and engineers in industry. The student is supported to work on a problem in industry, but at least a portion of the project funding gets funneled through the university which benefits the university and the principal investigator. In addition, aspects of such projects spill over into the classroom to make lectures and classroom projects more interesting.

With such projects, it is essential to select students who will be self-motivated and responsible. Otherwise, the entire load and responsibility of the project will rest on the faculty member. The probability of this problem can be reduced if students understand that their performance, as perceived by the supporting industry, on a project will determine their future employment opportunities. In addition, the students should understand that, to a large extent, the success or failure of the projects is determined by them. For the pilot projects described in this paper, the author has been fortunate to work with intelligent, self-motivated, and responsible students.

The response from students involved in the pilot projects to their experiences has been, in general, positive. Typical student comments include:

1. The project dealt with a practical problem in industry, instead of a purely academic one.
2. Interaction with practicing engineers and managers provided valuable insight on how industry operates.
3. Such a project improved communication skills including verbal communication, note taking, report writing, and presentation skills.
4. Developing and trying to adhere to a project timeline was a new and useful experience.
5. The fixed duration of the project helped in a timely completion of a thesis.

Personnel from industry have generally been pleased with the outcomes of the projects associated with this program. In most cases, the projects are an inexpensive approach to solving a problem. Also, such projects give personnel from industry a chance to assess a person for future employment without a significant commitment. Finally, the author has found that most industry is very interested in establishing cooperative relationships with universities, especially if the students are the main beneficiaries of such relationships. For the most part, the identification of a match for a project topic has been the most difficult task.

The author plans to continue this industrial experience program, and to promote such programs to other university faculty. In fact, the interactions with industry that have resulted from this program have initiated a number of other projects, outside of the author's expertise, for other faculty at USF. In addition, research projects which utilize undergraduate students have been shown to be fruitful [2]. As a result, the development of cooperative university-industry research projects which utilize undergraduate

students will be pursued to complement the current program.

Summary

A graduate student industrial experience program has been developed. A description of the projects and interaction of five students has been described, and a general assessment of the program has been provided. It is found that the program provides a win-win situation in that students enrich their education experience and are better prepared for employment, industry can get problems solved inexpensively and also screen future potential employees, universities establish ties with industry for research funding and student employment, faculty complement their research program with applied problems, and our industry ultimately improves its global competitive edge.

Acknowledgment

The author gratefully acknowledges the support of the National Science Foundation under Grant Nos. CMS-9501824 and CMS-9629217, as well as the support from Breed Technologies, Loctite Corporation, Johnson Gage Company, and Tampa Electric Company.

References

1. *Industry/University Cooperative Research Centers: Model Partnerships*, National Science Foundation Publication Number 93-97, 1997.
2. Mohsen, J. P. and C. Hoskins, "Undergraduate Research: A Useful and Growing Trend," *Proceedings of the 1996 ASEE Southeastern Section Meeting*, Gatlinburg, Tennessee, 1996, pp. 123-125.

DANIEL P. HESS

Dr. Hess is an Associate Professor of Mechanical Engineering and Director of the Dynamic Systems Laboratory at the University of South Florida in Tampa. He received his M.S. and Ph.D. in Mechanical Engineering in 1988 and 1991 from the State University of New York at Buffalo. In December 1996, Dr. Hess was honored at the White House with the National Science Foundation Presidential PECASE Award and designation of Presidential Faculty Fellow in recognition of major contributions to fundamental research addressing pervasive issues in the dynamics of mechanical and structural systems with friction. He has also received several education awards including the 1996 SAE Ralph R. Teetor Educational Award, the 1996 ASEE Southeastern Section Outstanding Teaching Award, the 1995 State of Florida TIP Award, and the 1995 USF Outstanding Undergraduate Teaching Award. He has an active research program in the areas of dynamics and tribology with significant funding from both government and industry.