Implementation of an Industrial-Based Case Study as the Basis for a Design Project in an Introduction to Mechanical Design Course

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Introduction and Study Context

This article discusses the evaluation of student learning in the Spring 2009 ME 324 Introduction to Mechanical Design course at the University of Mississippi. This is the first mechanical engineering design course in the Mechanical Engineering curriculum at the University of Mississippi. As such, this course is designed to introduce students to the field of mechanical engineering design and familiarize students with techniques and processes they will encounter in their careers as engineers. Learning activities used to accomplish this include lectures, demonstrations, design projects, case studies, and assignments. Students gain experience working on design teams and apply written and oral communication skills through the preparation of reports and presentations. In addition to lectures and problems solving activities related to machine design, two major design projects are components of this class.

While the class content has been slightly modified over the last few years to incorporate improvements identified through student surveys and instructor observations, the general topics of the design projects have not been varied for the last 5 years. The first design project topic is a "Rube Goldberg" type project; this project is primarily intended to allow students to practice and develop professional skills including teamwork skills, communication, project management, and problem solving in the context of a design project with a physical deliverable. In most cases, this is the first time these students have been responsible for creating a physical deliverable while being required to maintain a project schedule, submit progress reports, and provide oral and written reports. In the past few years, the topic of the second design project has been the development of a conceptual design of a product that would enable a physically challenged person to participate in a new leisure activity.

Although students in semesters prior to Spring 2009 were assigned the second course design project to develop products for physically challenged customers in the context as their work assignment for a hypothetical company, students had limited exposure to industrial design projects in this course. To improve the exposure of students to industrial projects, a course modification was implemented for the Spring 2009 ME 324 Introduction to Mechanical Design course at the University of Mississippi. This course modification involved the use of an industrial case study as the basis of the second design project. The "Lorn Manufacturing Case Study" developed by P.K. Raju and Chetan S. Sankar with the Laboratory for Innovative Technology and Engineering Education (LITEE) was implemented as part of the Spring 2009 ME 324 Introduction to Design [1].

Methodology and Procedures

ME 324 Introduction to Mechanical Design is a required class for junior mechanical engineering majors at the University of Mississippi. This class is taught during the spring semester. During the Spring 2009 semester, when the "Lorn Manufacturing Case Study" was utilized, there were twenty-two students in this class. Demographics of the Spring 2009 ME 324 class included twenty Caucasian males, one Caucasian female, and one male of African descent. Of these twenty-two students, twelve students indicated on surveys administered at the beginning of the semester that they had at least one year of work experience. However, only six students indicated that they had any engineering-related work experience. Of these six students, five students had held an engineering internship for one summer and one student had worked at an engineering firm for more than ten years but was not an engineer or designer. The remaining sixteen students indicated no engineering related work experience. Though surveys to determine engineering related job experience had not been administered in previous semesters, the instructor's interaction with students in previous years indicated that this was a typical representation of engineering related experi-

Abstract

The purpose of this paper is to discuss the implementation of an industrial-based case study as the basis for a design project for the Spring 2009 Introduction to Mechanical Design Course at the University of Mississippi. Course surveys documented the lack of student exposure in classes to the types of projects typically experienced by engineers in an industrial setting, and one goal of this course modification was to improve the exposure of students to industrial projects. Results from the pre-course and post-course survey demonstrate that students had a positive perception of the influences of the learning activities employed in the ME 324 course. Also, the open-ended post-project self-evaluation questions indicated that the incorporation of this industrial-based case study project was especially significant for students in this curriculum due to the lack of exposure of most of the students to the types of projects addressed by engineers in industry.

Keywords: Industrial-based Case Study, Learning Activities

ence for students in this course through the last ten years.

The lack of engineering experience for most students entering the ME 324 course had been identified as an area of need by the instructor, and various tools have been used to improve the students' exposure to and understanding of the engineering profession. Prior to the Spring 2009 ME 324 course, tools used to introduce the students to aspects of the engineering profession have included panel discussions by practicing engineers, reading assignments addressing the engineering design process in an industrial setting, utilization of the "Professional Practice Curriculum" modules available from ASME, and presentation of example reports for industrial projects by the instructor. For the Spring 2009 ME 324 course, the utilization of the "Lorn Manufacturing Case Study" as the basis for the second course design project was implemented. This case study was selected to enhance the students' exposure to real-world design projects in an industrial setting.

As seen in Table 1, the design project based on this case study served as a learning activity that addressed all of the learning objectives of the ME 324 course. This case study is an analysis of an actual accident in which a man lost three fingers during a routine maintenance procedure on a lap winder. The man sued for negligence in the design and manufacture of the lap winder. An industrial case study was included because the discussion of case studies has been shown to be an effective educational tool that helps motivate students and expose them to real-world problems that they will encounter in industry [2 - 4]. This particular case study was selected because it specifically addressed the topics of safety, ethics, professional and legal responsibility of engineers, codes and standards, communication skills, and design procedures which directly corresponded to learning objectives of ME 324.

The "Lorn Manufacturing Case Study" was introduced and discussed over a number of ME 324 class periods in place of the lectures traditionally delivered to introduce the topics of safety, ethics, professional and legal responsibility of engineers, and codes and standards. Outside readings and resource investigation assignments designed to supplement the case study topics were also incorporated into the project assignment. The case study included a design project: redesign the lap winder machines to have appropriate safety equipment for maintenance workers, and this project was used as the second design project assigned in the Spring 2009 ME 324 class. Approximately 3 class periods and two class assignments were devoted to the background information related to the case study before the students were expected to develop design solutions of redesigning the lap winder safety equipment. Also, additional background resources for the project were provided to the students via the class Blackboard site.

The first design project (Rube Goldberg project) had already introduced concepts of the stages of the design, team building, communication, and project management. The Lorn Manufacturing project, as the second design project, was used to reinforce these concepts. The steps of the formal engineering design process that are normally taught in ME 324 were addressed by the students in the case study project of redesigning the safety equipment of the lap winder machines. As discussed in the case study project assignment, the problem definition, concept formulation, concept evaluation, concept selection, detailed design, prototyping/testing, production, and presentation stages of a design process were practiced during this real-world problem design project. Students worked in design teams to develop at least two unique solutions to this design problem. As part of this design project, students were required to research and apply applicable safety standards. Students were also required to utilize procedures including failure mode and effect analysis (FMEA) in the evaluation of their potential design solutions. After evaluating their design solutions based on safety, economics, ergonomics, etc, each design team, consisting of 5 to 6 students, submitted a final written design report and made a final presentation intended to convince management to select their preferred design solution. Therefore, utilization of this case study was used to facilitate the students' progression from knowledge through synthesis and evaluation. Following completion of the project, each student also completed a post-project evaluation to self-assess the project and identify lessons learned.

A variety of tools were used to evaluate the effectiveness of this industrial case study for the Spring 2009 ME 324 course. During the initial week of the Spring 2009 ME 324 class, an initial survey was administered to the students. This initial pre-course survey was intended to identify the students' expectations for the course. Following the completion of the Lorn Manufacturing Lap Winder redesign project, a post-course survey was administered. The survey tools utilized were adapted from the

Learning Objective	Learning Activities	Assessment Tools
Students will practice and apply steps of the design process taking factors such as aesthetics, safety, economics, and social impact into account. The successful completion of the design projects will require the application of mathematics, science, and engineering and the utilization of creative thinking to create and evaluate a design to meet requirements.	• Design projects • Design assignments	• Final reports • Progress memos • Final presentations • Project notebooks
Students will recognize, be able to discuss, and apply characteristics associated with engineering professionalism. Specific areas to be addressed include ethical and legal responsibilities; the need to engage in life-long learning to remain knowledgeable concerning contemporary issues; and the broad, social impact of engineering solutions.	• Design projects • Design assignments • Web-based study module • In-class discussion	• Final reports • Progress memos • Final presentations • Quizzes/exams
Students will examine, recognize, and practice the application of the design process in an industrial setting.	• Design projects • Reading assignments	• Final reports • Progress memos • Final presentations
Students will identify, formulate, and solve engineering problems. Contemporary analytical practices will be employed.	• Design projects • Lectures • Homework assignments	• Final reports • Final presentations • Quizzes/exams • Homework
Students will recognize and apply good engineering practices including the use of free-body diagrams to solve engineering problems and the use of correct engineering units during the solution of problems.	• Lectures • Homework assignments • Design projects	• Quizzes/exams • Homework • Final reports • Final presentations
Students will develop and practice professional skills including teamwork, project management, and communication skills.	• Design projects • Design assignments • In-class discussion	• Final reports • Final presentations • Design assignments • Post-project self evaluation
Students will develop and practice effective written and oral communication. Both formal and informal communication skills will be addressed.	• Design projects • Design assignments • Web-based study module • In-class discussion	• Final reports • Progress memos • Final presentations • Design assignments • Post-projects self evaluation

Table 1. Learning Objective Course Map for ME 324

"Pre-survey for Senior and Graduate Students" and the "Post-survey for Senior and Graduate Students" provided on the Laboratory for Innovative Technology and Engineering Education (LITEE) web site [5 - 6]. While the pre-course and post-course surveys addressed all class learning activities, the post-project self-evaluation administered as part of the second design project addressed only the second design project based on the Lorn Manufacturing case study. In addition to the surveys in which the students were asked to indicate their level of agreement with statements, open-ended questions were also posed as part of both the pre-course and post-course surveys. Open-ended questions were also posed as part of the post-project self-evaluation that was completed as part of the second design project. For the survey questions using "strongly agree", "agree", "neutral", "disagree", or "strongly disagree', an

"agreement score" was determined to demonstrate the overall balance of agreement with each criterion among respondents using a technique employed by Penny [7]. To calculate the "agreement score", each "strongly agree" scored +2, "agree" scored +1, "neutral" scored 0, "disagree" scored -1, and "strongly disagree" scored -2. The scores for each statement were then summed and expressed as a percentage of the maximum possible score if all respondents had strongly agreed with each statement. Thus, the maximum possible "agreement score" for each statement would be 100.

Results and Discussion

Pre-Course and Post-Course Survey Responses: Table 2 provides results of the post-project survey assessing consensus agreement with criteria related to the statements shown. Table 3 provides a comparison between the initial pre-course survey results and the post-course survey results. The construct addressed by each statement is provided in parentheses following the statement. For the "pre-course" survey, each statement was phrased to assess the student's expectation of the achieving agreement with the statement. For example, in the pre-project survey, the statement assessed was, "I expect that using the instructional materials will help me improve my team-building and interpersonal skills." In the post-course survey, the corresponding statement was, "The design projects helped me improve my team-building and interpersonal skills." The pre-course survey was administered during the first week of class, and the post-course survey was administered following completion of all class learning activities on the last day of class. It should be noted that the pre and post survey questions were phrased to evaluate the overall class activities including both design projects; therefore, the survey evaluation did not reflect the impact of only the Lorn Manufacturing design project.

As seen in Table 2, the students believed that the class learning activities were very successful in addressing higher order cognitive learning skills, with an average of 83% of the students agreeing (indicating agree or strongly agree as their response) with the statements

	SD	D	N	A	SA	Agreement Score	% agree
I get frustrated going over engineering tests/problems in class. (Ease of learning subject-matter)	4	10	2	3	3	-20	27
I am under stress during engineering classes. (Ease of learning subject-matter)	0	4	5	9	4	30	59
Learning engineering requires a great deal of discipline. (Ease of learning subject-matter)	0	0	2	6	14	77	91
Through completion of the design projects, I learned how to identify engineering tools and procedures that will assist me in decision-making. (Higher-order cognitive learning)	1	1	0	17	3	45	91
I learned how to inter-relate important topics and ideas through completion of the design projects. (Higher-order cognitive learning)	1	0	3	16	2	41	82
I learned how to identify various alternatives/solutions to a problem through completion of the design projects. (Higher-order cognitive learning)	0	0	2	17	3	52	91
I improved my problem solving skills through completion of the design projects and assignments. (Higher-order cognitive learning)	1	0	5	15	1	34	73
I improved my decision making skills through completion of the design projects and assignments. (Higher-order cognitive learning)	1	0	3	15	2	40	81
I learned how to sort relevant from irrelevant facts through completion of the design projects and assignments. (Higher-order cognitive learning)	1	1	4	15	1	32	73
My confidence in applying engineering concepts to real situations improved as a result of this engineering course. (Self-Efficacy)	0	0	5	15	2	43	77
My understanding of the importance of safety and the use of relevant contemporary safety standards improved through the completion of the design projects. (Relevance of subject matter to society)	1	0	0	17	4	52	95
The design projects, class activities, and assignments were integrated in a way that made my learning easier.	3	3	8	6	2	2	36
I believe that an interdisciplinary focus is important in engineering. (Subject matter understanding)	0	0	3	16	3	50	86
The design projects emotionally engaged me in learning the course topics. (Self-Efficacy)	1	4	10	5	2	7	32
The completion of the design projects increased my self-confidence. (Self-Efficacy)	2	1	8	10	1	16	50

Table 2. Post-Project Survey Results

I achieved a sense of accomplishment in learning through completion of the design projects. (Self-Efficacy)	1	0	6	14	1	32	68
The completion of the design projects helped me learn to assume a greater responsibility for my personal learning. (Self-Efficacy)	0	1	7	12	1	31	62
The design projects helped me improve my team-building and interpersonal skills. (Teamwork)	1	0	7	10	4	36	64
The design projects helped me and my classmates listen carefully to each other's statements and ideas. (Teamwork)	0	0	7	12	3	41	68
The design projects helped me and my classmates arrive at decisions based on consensus building. (Teamwork)	0	0	5	13	4	48	77
The design projects helped me and my classmates share ideas with each other. (Teamwork, communication)	0	0	2	18	2	50	91
The design projects enhanced my interactions with my classmates. (Teamwork, communication)	1	1	3	11	6	45	77
My understanding of the importance of communication skills improved as a result of this engineering course. (Communication)	1	1	5	11	4	36	68
My understanding of the importance of project management and systems engineering skills improved as a result of this engineering course.	1	0	6	13	2	34	68
My writing skills improved as a result of this engineering course. (Communication)	2	1	10	8	1	11	41
My formal presentation skills improved as a result of this engineering course. (Communication)	1	1	5	11	4	36	68
My informal communication skills improved as a result of this engineering course. (Communication)	1	1	6	10	4	34	64

Table 2. Post-Project Survey Results (continued)

that addressed higher order cognitive learning. The survey statements associated with the general attitude toward subject matter indicated that students do not view engineering as an easy subject to master. This is reflected in the 91% of the students who agreed that "learning engineering requires a great deal of discipline." This statement had an agreement score of 77, the highest agreement score associated with any of the survey statements. As seen in Table 2, the majority of students were in agreement with most items associated with all constructs other than those for self-efficacy. All statements associated with self-efficacy had an average of 53% of the students that agreed with them. Only 36% of the students agreed that the design projects emotionally engaged them in learning the course topics, with an agreement score of only 2. The Lorn Manufacturing case study involved the serious injury of a worker due to the lack of safety equipment, so it was thought that this aspect of the case study might prompt an emotional engagement to the topic. Although one of the goals of using the industrial case study as the basis for the second design project was to increase the interest of the students by having them work with real-life problems, this survey response indicates that the students did not feel an emotional connection to the problem that enhance their learning. This lack of emotional engagement with the topic is also reflected in the responses to the open-ended questions on the post–project self-evaluations discussed below.

However, the high level of agreement indicating that students agreed that the class learning activities were very successful in addressing higher order cognitive learning skills, outweighs the low agreement with emotional engagement. If the design projects successfully exercised the students' higher order cognitive skills, they were successful learning activities even if the students were not emotionally engaged in the design projects. Agreement with the statements associated with communication also indicated success in addressing this area, with an average of 68% of the students agreeing with this group of statements. It should be noted that the group of statements associated with communication had the largest increase in agreement from the pre-course to the post-course survey. As seen in Table 3, an average of only 52% of the students indicated agreement with the group of statements associated with communication in the pre-course survey. However, 68% of the students indicated agreement with the same statements in the post-course survey. Student/teacher interaction during the course also indicated that students gained an appreciation and understanding of the importance of communication in engineering, just as the surveys reflect. The response of one student to the open ended question of "Did any of your perceptions of engineering and the engineering profession change as a result of this course? If so, please describe," reflects this. In answer to

	Pre-Project Data		Post-Project Data	
	Agreement Score	% agree	Agreement Score	% agree
I get frustrated going over engineering tests/problems in class. (Ease of learning subject-matter)	-14	27	-20	27
I am under stress during engineering classes. (Ease of learning subject-matter)	27	59	30	59
Learning engineering requires a great deal of discipline. (Ease of learning subject-matter)	61	86	77	91
Through completion of the design projects, I learned how to identify engineering tools and procedures that will assist me in decision-making. (Higher-order cognitive learning)	59	91	45	91
I learned how to inter-relate important topics and ideas through completion of the design projects. (Higher-order cognitive learning)	52	82	41	82
I learned how to identify various alternatives/solutions to a problem through completion of the design projects. (Higher-order cognitive learning)	59	87	52	91
I improved my problem solving skills through completion of the design projects and assignments. (Higher-order cognitive learning)	59	91	34	73
I improved my decision making skills through completion of the design projects and assignments. (Higher-order cognitive learning)	N/A	N/A	40	81
I learned how to sort relevant from irrelevant facts through completion of the design projects and assignments. (Higher-order cognitive learning)	59	91	32	73
My confidence in applying engineering concepts to real situations improved as a result of this engineering course. (Self-Efficacy)	75	91	43	77
My understanding of the importance of safety and the use of relevant contemporary safety standards improved through the completion of the design projects. (Relevance of subject matter to society)	N/A	N/A	52	95
The design projects, class activities, and assignments were integrated in a way that made my learning easier.	66	86	2	36
I believe that an interdisciplinary focus is important in engineering. (Subject matter understanding)	41	64	50	86

Table 3. Comparison of Pre-Project Survey Data and Post-Project Survey Data

this question, one student responded, "yes, the amount of communication involved."

Response to Open-Ended Questions:

While the pre-course and post-course surveys provided valuable information concerning the impact of the course learning activities, the surveys did not differentiate between the influence of each of the course design assignments. One open-ended question, "Please comment on your perceptions of this project (design project 2 – based on the Lorn case study) related to it introducing you to the type of projects you will experience in industry" was included on the post-project self-evaluation for design project 2 to evaluate the impact of using an industrial case study as the basis of the second design project. A companion question "Have you worked on any other projects from an industrial situation in or out of school? Please briefly describe the project if you have" also accompanied this question to evaluate the level of exposure that the junior-level students in the ME 324 class had to industrial-based projects. Of the twenty-two students who completed the post-project evaluation, nineteen students indicated a positive perception of the success of this project in introducing them to the types of projects that they would experience in industry. Only six of the twenty-two students indicated that they had worked on any other projects from an industrial situation; based on the responses to the open-ended questions, these six students were the same six students who had engineering-related work experience. Of the twenty-two students, only one student indicated that they had worked on an industrial-related project for another class project.

The lack of student exposure in classes to the types of projects typically experienced by engineers in an industrial setting is reflected in the responses to these questions, and this is seen to be a deficiency in our current curriculum experienced by freshmen through junior mechanical engineering majors. Although the senior capstone design project in our curriculum is an industrial-based project with an industry sponsor or "client" for each design group, this lack of inclusion of industrial-based projects

	Pre-Project Data		Post-Project Data	
	Agreement Score	% agree	Agreement Score	% agree
The design projects emotionally engaged me in learning the course topics. (Self-Efficacy)	27	50	7	32
The completion of the design projects increased my self-confidence. (Self-Efficacy)	32	59	16	50
I achieved a sense of accomplishment in learning through completion of the design projects. (Self-Efficacy)	43	73	32	68
The completion of the design projects helped me learn to assume a greater responsibility for my personal learning. (Self-Efficacy)	45	73	31	62
The design projects helped me improve my team-building and interpersonal skills. (Teamwork)	43	73	36	64
The design projects helped me and my classmates listen carefully to each other's statements and ideas. (Teamwork)	27	64	41	68
The design projects helped me and my classmates arrive at decisions based on consensus building. (Teamwork)	48	73	48	77
The design projects helped me and my classmates share ideas with each other. (Teamwork, communication)	41	73	50	91
The design projects enhanced my interactions with my classmates. (Teamwork, communication)	36	71	45	77
My understanding of the importance of communication skills improved as a result of this engineering course. (Communication)	N/A	N/A	36	68
My understanding of the importance of project management and systems engineering skills improved as a result of this engineering course.	N/A	N/A	34	68
My writing skills improved as a result of this engineering course. (Communication)	2	32	11	41
My formal presentation skills improved as a result of this engineering course. (Communication)	11	45	36	68
My informal communication skills improved as a result of this engineering course. (Communication)	7	41	34	64

Table 3. Comparison of Pre-Project Survey Data and Post-Project Survey Data (continued)

in other classes before the last semester of a student's senior year makes the use of a case study, such as the Lorn Manufacturing case study used as the basis for the second design project for the Spring 2009 ME 324 course, even more significant. As seen from the responses to these questions, at this juncture in our curriculum only students who had taken the initiative to obtain engineering internships had experience with industrial projects, and this represented only 23% of the students (5 of 22 students) in the Spring 2009 ME 324 class. Since not all students have the opportunity to obtain experience through internships, it is important for our curriculum to expose students to industrial-based projects prior to their capstone project in the final semester of the senior year. The use of a case study as the basis for one of the ME 324 design projects helps accomplish this.

Three students indicated a negative response related to their perceptions of the success of this project in introducing them to the types of projects that they would experience in industry. None of the students who held this negative perception had work experience as an engineering intern, and their discussion of their perceptions of the project reflected their lack of understanding of the responsibilities of engineers in industry. For example, one of the responses stated, "No, I think that it [the project topic] was a little too farfetched. Many of these problems have been solved…." Another negative response stated, "If the machine was about an object or process that we understood in greater detail it would be much better, easier, and engaging." The third negative response was from a student who had worked at an engineering firm but not in a position with engineering responsibilities; this student's response was, "It was frustrating to me because you were dealing with so many unknowns. Limited time made a real solution unrealistic." Although the specifics of this student's job responsibilities at the engineering firm are not known, this response would indicate that this student was likely not exposed to the types of projects and deadlines typically experienced by engineers in industry.

In contrast, the response from one of the students who had held an internship was, "Yes, I worked in a paper mill on a guard design to

prevent workers from slipping into the pulper pit. We needed to create this guard so we could meet OSHA safety standards. I thought this project served well in depicting types of projects we will see in industry. We had to define a problem with a current design and formulate solutions in order to solve that problem, taking into consideration standards, ethics, and basic engineering practices." Many of the students who had not held engineering internship positions also recognized the relevance of the project. One example of this type of response was, "I have not personally worked on any other projects from an industrial situation like we did during project #2 but I do feel as though it gave me an idea of what a future real life project could be like. I now know the correct questions to ask all parties involved… I know what details to look for and what codes to consult." While one student recognized the relevance of the project, this student's response reflected many students' expectations to only work on "glamorous" projects after graduation. "I think that it is a relevant project for an industry related engineering job because it realizes necessary situations and ideas, but it wasn't very interesting. I don't believe many engineering students plan on doing this kind of work (whether they do or not). Although this project can relate to basically any engineering situation, many students were discouraged over the topic in concern." This lack of interest in the particular topic of the case study was reflected in the responses of four students. While the topic of redesign of safety equipment for industrial machinery is a very relevant topic for a case study, the perceptions of these students will be taken into consideration as case study topics are selected for classes in the future. Since one of the goals of using case studies is to engage students and interest them in a project topic, the selection of a variety of case study topics for future classes will help to engage and interest a wider variety of students.

Answers from the students indicate that for the vast majority of the students the case study did accomplish the goal of introducing students to numerous design aspects that would be encountered in real-world design projects in an industrial setting. Even students who indicated that they were not specifically interested in the topic had responses that indicated that they learned about numerous design issues. For example, one student responded, "The case study provided a little bit of information regarding the design of safety features, but it was mostly legal." This response shows that the students experienced working with a design issue incorporating legal considerations; without the use of a case study as the basis of a design project, it is difficult to incorporate aspects such as legal concerns in an academic design project. However, this response implies that the student did not recognize the significance of legal issues in engineering design. While the legal implications of engineering decisions were discussed in class, this response indicates that it is necessary to spend more time explaining the importance of this aspect of the design process to students in the future.

Summary

The "Lorn Manufacturing Case Study" was successfully used as the basis for a design project in the Spring 2009 ME 324 Introduction to Mechanical Design course at the University of Mississippi. The project based on this case study served as a learning activity that addressed all of the learning objectives of the ME 324 course. Results from the pre-course and post-course survey demonstrate that students had a positive perception of the influences of the learning activities employed in the ME 324 course. Also, the open-ended post-project self-evaluation questions posed to the students following the completion of the second design project indicated that the incorporation of this industrial-based case study project was especially significant for students in this curriculum due to the lack of exposure of most of the students to the types of projects addressed by engineers in industry. Although the survey responses indicated that students benefitted from the use of this case study, some students indicated a lack of interest in the topic of this particular case study. The course evaluations have demonstrated that the use of a case study had a positive impact on this class; however, the perceptions of the students related to their interest in the topic of the case study will be taken into consideration as case study topics are selected for classes in the future. Data and lessons learned from this initial implementation of an industrial-based cased study that was used as the basis of the second design project in the ME 324 course will be utilized in the design of upcoming semesters of this course. A significant point brought to light by the analysis of these course surveys is the lack of exposure of our students to industrial-based problems and projects. This is a significant lesson learned from this work, and this finding will be considered in the ongoing development process

of this and other courses in this curriculum. This finding will also be shared with other faculty members in this curriculum. Future course evaluation follow-up surveys will be refined to investigate more details concerning students' perceptions of the relevance and value of the industrial-based case study projects.

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