ENHANCEMENT OF MECHANICAL ENGINEERING STUDENT MOTIVATION, LEARNING, AND LEADERSHIP THROUGH AUTO RACING INTERESTS INVOLVING MULTIPLE COURSES

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Abstract

Due to student interest in auto racing, projects with racing were incorporated into five mechanical engineering courses involving five faculty members, nine student projects and about twenty students. The racing projects provided outstanding student achievements along with having fun.

Introduction

While teaching a senior 58:055 Mechanical Systems Design class during fall 2002, the author became aware that a strong student involvement in auto racing existed with about 15% of the class. This involvement included two professional stock car race drivers plus crewmembers and several SAE Mini-Baja car team members. Interest in auto racing permeated throughout the class discussions providing significant engineering knowledge and student (and teacher) excitement. For example, a fatigue failure of a race car component was brought to class by one of the drivers and studied by the students while they were learning about fatigue design. Figure 1 shows a photo of five mechanical engineering students involved in professional dirt track auto racing. In the foreground to the right is senior Matt Furman, a professional NASCAR late model dirt track stock car driver with ten years racing experience and driver of the car shown. To the left foreground is Shaun Carr, a Mechanical engineering freshman and crewmember. In the background from left to right is senior TJ Johnson, a crew member and restorer of older muscle cars, senior James Arkema, a former professional hobby stock racecar driver who temporarily halted professional racing to devote full time to earning his BSME, and Nate Horn, BSME May, 2002 and currently an MS student in mechanical engineering and former crew chief and currently crew member of the Furman racing team. Furman's number 51 racecar on the track is

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shown in Figure 2. The Mini-Baja racing team is multidisciplinary within the College of Engineering, however, two seniors in this course, Matt Heistad and Curt Caldwell, were very active in designing and building the 2003 Mini-Baja race car. With the above background, the application of auto racing involving about twenty mechanical engineering students, five different courses, nine different projects, and five faculty members, during the 2002/2003 academic year, is brought out in this paper. The student motivation, learning, and leadership in these auto racing projects has been awesome to experience. The students' work/accomplishments enhanced the Furman racing team's ability to better understand adjustments to the car for better racing performance. The following indicate the nine different student racing projects involving five different senior or graduate mechanical engineering courses.

58:055 Mechanical Systems Design, fall 2002 (instructor: Stephens)

Students as a team of two devote 1-1/2 weeks to library research on a specific engineering standard of their choice, prepare a written report and make a ten minute oral presentation to the class. James Arkema and another student chose the topic of auto racing uniforms. This was the first project chosen involving auto racing. They emphasized the significant fireproof requirements of the racing suit in the standards.

Students as a team of four devote 1-1/2 weeks to creating and performing a data acquisition/durability experiment on a component of their choice. This requires the team to choose the component, install a strain gage in a critical region in the direction of the maximum principle normal strain, simulate a typical load spectrum, and use fatigue life prediction software to predict the fatigue life of their component. This software uses rainflow counting, linear damage accumulation and the local strain fatigue life model. Each student within a team writes her/his own report on the project, while using the same data. Matt Furman, Matt Heistad and two other students tested one of the Furman racecar wheel hubs. They applied variable amplitude lateral bending but could not produce the torque component. With this simulated bending, they found significant fatigue life existed with the wheel hub.

58:080 Experimental Engineering, fall, 2002 (instructor: Hardin)

As a part of the course, students as a team of four create and run their own experiment and prepare a written report. Matt Furman, Matt Heistad and two other students tested shock absorber seal drag on altered shock absorbers from Furman's racecar. These tests were

performed in the Fatigue and Fracture Mechanics laboratory as shown in Figure 3. Kyle Sigl, an M.E. graduate student, and Nate Horn provided the expertise to operate the servohydraulic test system. Using a triangular waveform and a one inch stroke, they found the alterations were not significant and that other shock absorbers would be purchased for the racecar.

58:152 Vehicle Dynamics and Simulation, spring, 2003 (instructor: Han and TA: Wang)

During registration for spring 2003, James Arkema raised a question of the Mechanical Engineering Program offering a course on racing vehicle dynamics since he had come across a book entitled “Race Car Vehicle Dynamics” by Milliken and Milliken. The program did not have a normal fit for this course, but Professor Han, when he realized how much student interest existed, agreed to organize the course with a TA as an extra teaching load similar to an individual investigation. Ten students took the course including Arkema, Furman, Heistad, and Horn. This wonderful result was motivated by student interests and properly accommodated by the Mechanical Engineering Program.

58:086 Mechanical Engineering Design Projects, spring, 2003 (instructor: Stephens)

This is the senior capstone design course where students as teams of three or four choose design projects from those offered by industry, faculty, or students themselves. Matt Furman, James Arkema and two other students chose to design a mechanical tire testing system for use by the Furman racing team. Their end product was to be the actual workable product along with testing of several race tires. The goal was to be able to measure both normal and lateral racing tire stiffness. Values of stiffness will aid the Furman racing team since these values are normally company or team confidential. The project involved significant brainstorming, since this equipment is already available on the market, but at a tremendous expense. The test system had to use some parts already available by the Furman racing team with a low additional cost. The ProE drawing of the test system is shown in Figure 4 and the actual photograph of the test system in use is shown in Figure 5. Test data were obtained for several tires and air pressures. The system has proven to be functional and will contribute to future Furman racing team tire decisions.

TJ Johnson and three other students chose to design a brake system adapter to replace drum brakes with disc brakes on a 1967 Chevrolet Chevelle (a muscle car). They also felt this product could be marketed, but products liability insurance concern has postponed this goal. A finite element model of the final brake adapter is shown in Figure 6. To better clarify the durability of the adapter, the team mounted strain gages in critical locations and performed real on-car fatigue testing based on SAE brake testing standards. Using procedures learned in Mechanical Systems Design, fatigue life calculations based on the acquired strain-time data indicated the bracket was satisfactory. The bracket will be used to install disc brakes on the Johnson car.

58:198 and 58:098 Independent Investigation, summer and fall 2003, (instructor: Chen)

The University of Iowa is home to the National Advanced Driving Simulator, NADS, along with the Center for Computer Aided Design. These two centers have the most advanced state of the art simulation and computational abilities. Nate Horn and TJ Johnson will be involved with using these facilities by modeling and simulating the dynamic response of the Furman racecar. Nate Horn will start summer 2003 by determining pertinent component properties and using a multibody dynamics program to computationally determine the race car response to parametric alterations of the racecar. A modeled dirt track racecourse will be used in the computations. Additional work during fall 2003 by TJ Johnson involving the driving simulator will be used to compare the modeling and simulation response. Thus both auto racing aspects and computational/simulation capabilities of NADS will be obtained.

Mini-Baja Race Car

The Min-Baja racecar has been an important SAE project at The University of Iowa for many years. Hundreds of engineering students have worked on this program. Although the Mini-Baja project does not involve course credit, it still is another racing project. This year the students started from scratch and built and raced in the Midwest competition. This involved the two seniors mentioned previously along with other engineering students.

ABET

ABET has entered this racing experience in an unusual manner. Since ABET wants external judges for the capstone design evaluation, the author sought highly qualified engineers to be judges. (The author has always opposed the use of additional judges to evaluate student work

and grading, and without the ABET request he would not use other judges). One judge, a former Vice President of Engineering for a large company had recently retired. When asked why he retired early, he said so he could devote more time to sports car racing. This was the straw that broke the camels back and the author joined the Sports Car Club of America, SCCA, went to racing school, and took up amateur Autocross Solo II sports car racing (a dream since high school) with his Audi TT sports car. Thus, two semesters of student influence and excitement with auto racing and ABET's request for judges, of which one turned out to be an amateur race car driver, motivated the author (teacher) to join in the fun of auto racing. A wonderful synergistic student/faculty involvement. The author and his wife have since become sponsors of the Furman racecar with a specific decal emphasizing "U of Iowa Engineering."

Future Projects

Nate Horn and Matt Furman are in the process of designing a shock absorber dynamometer to be used for custom valving the low speed response characteristics of the team's shock absorbers. When asked what courses or student experiences will best aid them in this project they started naming certain courses. Then the comment of "hey, the whole engineering education experience at The University of Iowa is involved." What a wonderful response!

Conclusions

The auto racing subject that was important to students significantly enhanced their motivation, learning and leadership. Their excitement rubbed off on the author and provides an example of where both student and teacher motivation/excitement can have significant influence on each other. This brings out the importance of having student projects that provide academic achievements along with some fun.

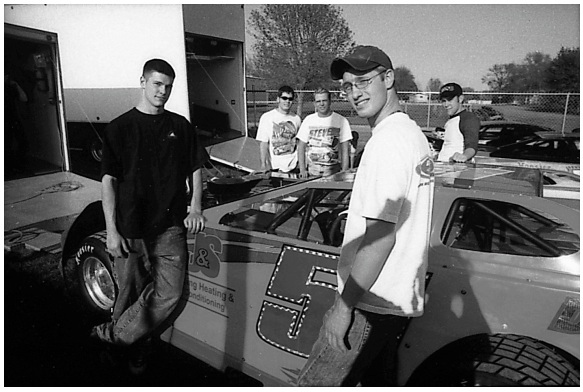

Figure 1 Mechanical engineering students involved in professional dirt track auto racing. (Photo by Miranda Meyers)

Figure 2 Matt Furman's number 51 NASCAR late model racecar on the track.

Figure 3 Shock absorber test setup.

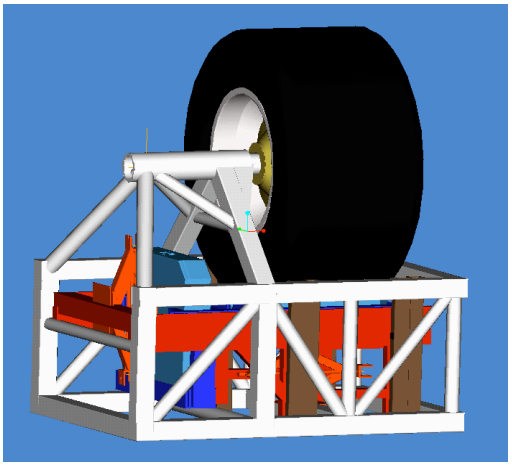

Figure 4 ProE model of tire test system.

Figure 5 Tire test set up.

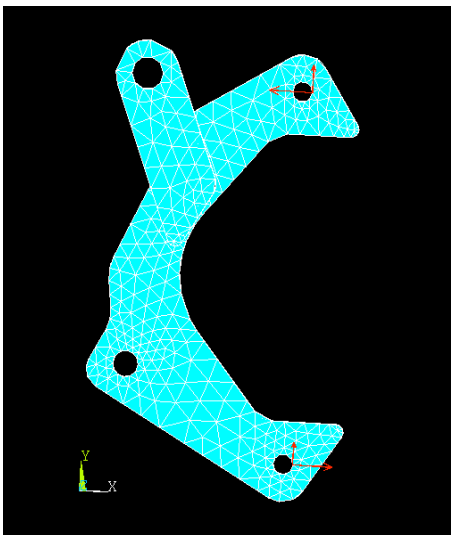

Figure 6 Brake adapter FEM model.