Curriculum Integration of Some Engineering Technology Courses With Sunrayce 95

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Abstract

The US Department of Energy (DOE) organizes a solar car race called Sunrayce, once in every two years. This race is open for all colleges and universities in the North American continent. As faculty advisor for the undergraduate team here at Middle Tennessee State University (MTSU), I submitted a proposal in Spring, 1994 and we were selected as one of the 65 teams to compete in Sunrayce 95. The biggest challenge of this project was that the students had to design, fabricate and test the solar car raising money and materials mainly from outside sources. We received support from MTSU and the area industry, and built the solar car, the SOLARAIDER. Curriculum integration was one of the requirements of Sunrayce 95. I identified several problems from the SOLARAIDER project with our Basic, Intermediate and Advanced CADD (Computer-Aided Design/Drafting), Senior Project and Shop Problems courses. The solar car project gave our students a unique opportunity to apply their theoretical knowledge to practical situations, gain hands-on experience, and at the same time, get credit for their work. I also worked with the Journalism Department at MTSU, and Motlow State College in Tullahoma, Tennessee, and identified some aspects of the solar car project with their curriculum. The project was a great success and we are looking forward to doing more curriculum integration for Sunrayce 97.

About MTSU

Middle Tennessee State University is located in Murfreesboro, about 30 miles to the south of Nashville. MTSU, which was founded in 1911, is the fastest growing university in the state of Tennessee. Currently, our university has an enrollment of approximately 18,000 students and 700 full-time faculty members. The university has five colleges; Basic and Applied Sciences, Business, Education, Liberal Arts and Mass Communication. Industrial Studies is one of the 10 Departments under the college of Basic and Applied Sciences.

The Industrial Studies Department has Engineering Technology, Industrial Technology and pre-engineering programs. There are about 600 undergraduate students in the Department, and approximately 200 of these students major in Computer, Design, Electro-Mechanical and Manufacturing Engineering Technology areas.

Sunrayce - The Solar Car Race

The objectives of the Sunrayce are to stimulate interest in technical education and careers among students, and promote energy efficiency and the use of renewable sources of energy. The race is nationally sponsored by major corporations such as GM, HUGHS, DELPHI AUTOMOTIVE SYSTEMS, MRI, CHEVROLET and EDS. In January of 1995, we received a Request for Proposal (RFP)[1] to compete in Sunrayce 95, which is the third in the series.

I submitted a proposal on behalf of MTSU in February of 1994.2 In the proposal, I discussed, in accordance with the guidelines of the RFP, different aspects of the project including Design and Engineering (driver safety, design and analysis, and material selection), Organization and Project Planning, Curriculum Integration, Fund Raising and Team Support, Vehicle Testing and Driver Training, and Logistics. I explained how we were going to meet all of the specifications listed in the Sunrayce 95 Regulations.[3] The proposals submitted by different universities were evaluated and scored by sponsors and other experts at the National Renewable Energy Laboratory (NREL, a unit of DOE). We were selected as one of the of 65 teams to compete in Sunrayce 95. The list included MIT, Yale, Texas A&M, Stanford, University of Michigan, and Auburn, and universities from Canada, Mexico and Puerto Rico.

Many undergraduate students, the Industrial Studies Department Chair, the Dean of the College of Basic and Applied Sciences, the Public Relations, the Development and the Foundation, at MTSU were involved in the project in different capacities. We designed and built a solar car, the SOLARAIDER (FIG. 1). The project was a great success and put MTSU on the national scene. The specifications of our solar car are given below.

Weight: 500 kg (1 100 lb)
Dimensions: Length: 6m (19.7 ft), Width: 2m (6.6 ft), Height: 1.2m (3.9 ft)
Motor: 6 kW (8 hp); brushless permanent Magnet; 11.8 kg (26 lb), Manf: Solectria
Solar Array: 120 W Manf: ASE Americas
Batteries: 133 kg (293 lb), Manf Delphi Automotive Systems
Chassis: Made of foam-carbon fiber-fiber glass composite with aluminum and steel suspension units, has 3 wheels, two in the front and one in the rear
Brakes: Disk, caliper, hydraulic (dual systems)
Wheels: 3, aluminum alloy; 66 cm (26 in), slick, Murray-Ohio

MTSU'S solar car team comprised of fifteen active undergraduate students. The team was divided into subgroups to work in different areas of the project such as fund-raising, publicity, design, fabrication, and electricity and electronics. As faculty advisor, I helped the team members at every stage of the project. We met once or twice in a week and discussed all relevant aspects, and each member reported their progress to the team. The following are the highlights of our solar car project.

Fund raising

The SOLARAIDER cost approximately $60,000. I contacted several companies and organizations directly and several others through the Development office, Department Chair, College Dean and the Alumni Association. We raised nearly $20,000 in cash, and $20,000 in material such as fiber glass, carbon fiber, foam, epoxy, wood, steel, aluminum, hardware items, and computer software. The balance $20,000 was given to the project by the College Dean. Our list of donors included several individuals and small businesses in the Middle Tennessee area, Industrial Studies Alumni, and corporations such as ASTRO/PROCRAFT, CALSONIC, NISSAN, SATURN, SAMSONITE, SQUARE-D, SOUTHEASTERN TECHNOLOGY and TEXTRON AEROSTRUCTURES, and software companies such as Knowledge Revolution and UTS.

Design and analysis

The structural report on the solar car was due on January 31, 1995. As none of our team members had taken any of the required courses such as Statics, Strength of Materials and Dynamics, I performed a

structural analysis for the car using the energy method and submitted the report to NREL.[4] I briefed the team members about the technique, and different criteria used in the analysis. The report was reviewed for NREL by Dr. Thomas Service, an independent consultant. As per Dr. Service's suggestions, I revised the structural report and included additional analysis.[5] A test main frame, with a driver roll cage, was built at SAMSONITE by two of our team members. The frame was tested for side and rollover impacts using a 6-ton fork lift. These test results were also included in the revised report.

Fabrication

Most of the fabrication of the SOLARAIDER was done by the student team members in our Department's wood shop. We received help and advise from some instructors and students at MTSU'S Aerospace Department regarding fiber glass/carbon fiber/foam composite fabrication. The driver roll cage and the fabric seat were made at SAMSONITE. One of our team members, who worked there was mainly responsible for these two items. We received help and advise from ASTRO/PROCRAFT in composite fabrication. The team members got an opportunity to paint the car body at their plant using modem facilities. Most of the machining was done in the Department's machine shop. Some precision machining was done at Hyder Mold, a tool shop run by one of our team members father. Aluminum and steel welding was done at SAMSONITE and Hyder Mold. One of our team members designed wheel and axle hubs of the SOLARAIDER. The hubs were precision machined on a CNC lathe at SOUTHEASTERN TECHNOLOGY, where this student worked. Thus our students got several unique opportunities to work with the local industry and gain knowledge and experience. Two team members and another Industrial Studies faculty member worked on the solar panel wiring, batteries, the D. C. motor and controller unit, and the instrumentation of the solar car. During the week ends and nights, I and other two team members fabricated ribs, panels and bulkheads for the solar car using carbon fiber, fiber glass, foam and epoxy. All of us learned a lot in the process.

Publicity

This project generated a lot of publicity for the Department, College and University. The student team members got several opportunities to speak to reporters from the area newspapers such as The Tennessean, The Banner, The Daily New Journal, and the MTSU newspapers, The Sidelines and The MTSU Record, about the SOLARAIDER, energy, environment and education. They spoke to local television reporters from Channel 4 (live) and Channel 2, and participated in a local radio talk show, and discussed our solar car project. Some our team members were invited on campus to the Journalism Department to talk to a group of their students about the SOLARAIDER. During the phone-a-then fund-raising, some team members got an opportunity to talk to several Industrial Studies alumni about the Department and the solar car proj ect.

Curriculum integration

I teach three Computer-Aided Design/Drafting (CADD) courses, besides Statics and Dynamics, at MTSU. I am advisor for the Design Engineering Technology majors in the Department. Out of our three CADD courses, CADD I deals with the two-dimensional concepts, CADD II emphasizes on the application of solid modeling techniques to design/drafting, and Advanced CAD deals with topics such as customizing menus and AutoLisp. Curriculum integration was one of the requirements of Sunrayce 95. As faculty advisor for the MTSU'S team, I identified several problems related to the solar car with our courses, CADD I (ISET 231), CADD II (ISET 336), Advanced CAD (ISET 433), Senior Project (ISET 480D for Design majors and, ISET 480E for Electro-Mechanical majors) and Shop Problems. (IS 479). This helped several students,

members of the solar car team and others, get credit for their design of the SOLARAIDER. They got several opportunities to test the design and make necessary changes. The team members gained good hands-on experience in fabricating the components they designed. In both CADD II and Advanced CAD, students received credit for the final project which contributed 25% and 50'% towards the final grade. In CADD I, they received extra credit for their work on the solar car. The Senior Project requires that the students complete all freshman, sophomore and junior level courses in all disciplines before they register for this course. Two solar car team members received credit for their Senior Project which involved design and fabrication of some major components for the SOLARAIDER.

I worked with the Journalism Department at MTSU and Motlow State College, which is located 50 miles to the south of Murfreesboro, and identified some aspects of the solar car project with their curriculum. A few of our solar car team members visited the Journalism Department and gave a talk about the SOLARAIDER and Sunrayce 95 so that their students may write feature articles for credit. Motlow State is a two-year college where students receive an Associates degree and may transfer to a four-year university to receive their Bachelors degree. Motlow state has a good CADD program. Some of their seniors visited our solar car fabrication facility, obtained the necessary information in order to generate various computer models for the SOLARAIDER shell. These students received credit for their work. Our plan was to write these designs in the IGES format and mail them to EDS in Detroit for aerodynamic analysis. We could not carry out this task last year due to the time limitation.

Visit to local industry

I took the solar car team members and other interested Industrial Studies students to several local industry to discuss with the engineers and managers the SOLARAIDER project, and explore possibilities of donation of money, material and technical services, and availability of their facilities for the project. In this connection, industry such as ASTRO/PROCRAFT, CALSONIC, GABRIEL RIDE CONTROL, NISSAN, SATURN, SAMSONITE, SQUARE-D, SOUTHEASTERN TECHNOLOGY and TEXTRON AEROSTRUCTURES were visited. During each visit, not only the students got an opportunity to observe and learn about new methods in production, planning and manufacturing, but also they discussed with the engineers, managers and technicians specific aspects of the solar car project. Later on, some of the team members worked in collaboration with these people in the industry. Our solar car team members also had an opportunity to attend the Sunrayce 95 workshop in Indianapolis and learn more about the solar car project from those teams which had competed successfully in the previous two races.

Sunrayce 95 competition

We built the SOLARAIDER on time and invited the sponsors and all others who contributed to the project, for the unveiling of the car. On that day, June 5, 1995, all of us met with the sponsors and thanked them for their support. The following week, I and the undergraduate team members took the solar car to Indianapolis to compete in the race.

Conclusions

The SOLARAIDER project and curriculum integration of some our engineering technology courses with Sunrayce 95 have been very successful. Our students had a lot of fun in designing, fabricating and testing of the solar car. At the same time, they received credit for their work in the appropriate courses. The solar car project served as a bridge between theory and practice in engineering education here at Middle

Tennessee State University. All of us learned a lot from the SOLARAIDER project and Sunrayce 95. We are excited about competing in Sunrayce 97. Currently, we have approximately 10 team members and are working on the preliminary design of MTSU's second solar car.

Acknowledgment

I would like to thank each and every one responsible for the success of MTSU'S solar car project.

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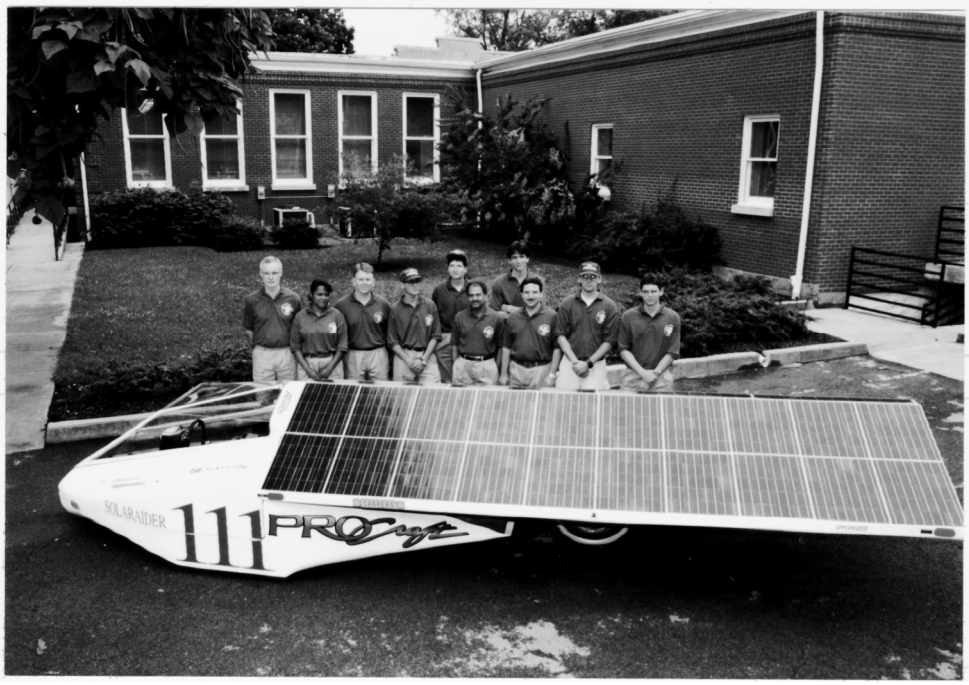

FIG. 1 a. The SOLARAIDER, MTSU's Solar Car and the Team.

FIG. 1 b. The Front Side of the SOLARAIDER.