

RIDING WITH THE SUN: MTSU'S EXPERIENCE IN SOLAR CAR DESIGN AND THE IMPACT ON COMMUNITY

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ABSTRACT

This paper describes Middle Tennessee State University (MTSU) efforts in:

- promoting its Basic and Applied Sciences programs in general and the Engineering Technology program in particular,
- demonstrating the impact of engineering physics and technology on the community, and
- boosting environmental awareness in the Middle Tennessee area.

The Department of Engineering Technology and Industrial Studies at MTSU has participated for the first time in Sunrayce 95 through its entry SOLARAIDER III. The biennial solar car race is designed to promote the use of renewable energy sources, the efficient use of energy, and innovation in engineering and technical education. The author has served as a faculty advisor to the undergraduate student team overlooking the design, construction, and testing of the solar car. Benefits of this project to MTSU students, the younger generation in particular, and the public in general are described below.

INTRODUCTION

Sunrayce is a biennial solar car race sponsored and organized by General Motors (GM), Electronic Data Systems (EDS) and the U.S. Department of Energy (DOE). The race is designed to promote the use of renewable energy sources, the efficient use of energy, and innovation in engineering and technical education¹. The 1,250-mile race starts in Indianapolis, Indiana and finishes nine days later in Colorado. The competition is held in June and is open to all colleges, universities, trade schools, and other post-secondary educational institutions in North America. However, for safety purposes, only 40 solar cars are allowed to participate in the actual race. These 40 entries are selected upon successfully passing the Scrutineering (compliance with regulations) and the Qualifier^{2,3} (a 50-mile pre-race road test).

In response to the Request for Proposal from Sunrayce Headquarters, MTSU submitted a proposal in February 1994 to participate in the Sunrayce 95 competition. The proposal discussed design specifications, project planning, fund raising, construction techniques, and testing. After reviewing all proposals at the National Renewable Energy Laboratory (Golden, Colorado), MTSU was selected to be among 65 participants eligible to compete in the race.

MTSU'S SOLAR CAR TEAM

MTSU is located in the city of Murfreesboro, 30 miles south of Nashville in the state of Tennessee. With current enrollment of approximately 18,000 students, it is the largest and fastest growing in the Middle Tennessee area. The Department of Engineering Technology and

Industrial Studies (ET&IS), one of the 10 departments in the College of Basic and Applied Sciences, currently enrolls about 600 undergraduate and 50 graduate students. There are four Engineering Technology programs in the department, they are: Computer, Electro-Mechanical, Design, and Manufacturing Engineering Technology.

With the announcement of the project, many students from the department expressed their interests to participate in the project. Over fifteen Engineering Technology students were actively involved in the actual fund raising, design, construction, and testing of the solar car. The author was one of two faculties from the Department of Engineering Technology and Industrial Studies who advised the all undergraduate student team. The team members had varied technical and logistics experiences and came from all of the four ET programs.

PROJECT SOLAR CAR

Since this project was one of the biggest, and first in its kind, undertaken by the Department of ET&IS, outside funding sources were needed. Fund raising efforts by team members started immediately after the launching of the project. Companies in the Middle Tennessee area were contacted and the aspects of the project were presented. As prospective employers to our Engineering Technology graduates, they have realized the benefits of such an endeavor that provides the student with conceptual design skills and techniques, hands-on experience, and the capacity to function in a team-based environment. In many cases, local companies were visited by the team members where they discussed the project with plant engineers and technicians, learned from their experiences, and observed product development and production techniques. An additional benefit to participating companies was the free publicity as their names were mentioned in the news and their logos were placed on the solar car. Several local and national companies, organizations, and individuals have contributed about \$40,000 in cash and in materials to the venture. While the whole project cost about \$60,000, including travel cost, the remaining balance was provided by the Dean of Basic and Applied Sciences.

SOLARAIDER III

The solar car was designed, constructed, and tested by the team members at MTSU facilities. The one-seater three-wheel car had approximately 500 kg (1100 lb.) in total weight, 6 m (19.7 ft) in length, 2 m (6.6 ft) in width, and 1.2 m (3.9 ft) in height. The frame was made of aluminum and steel while the chassis and the body were made of carbon-fiber- and glass-fiber-foam composites. The solar array was composed of 840 photovoltaic cells (10X10 cm. each) arranged in four groups pattern, each yielding a maximum voltage of 100.8 V and a maximum current of 2.9 A. The four groups were connected in parallel to yield a maximum current of 11.6 A and a maximum power of 1170 W (1.6 hp). Excess solar-generated electrical energy were stored in a seven-module battery system with a total weight of 133 kg (293 lb.). A 6 kW (8 hp) brushless permanent magnet DC motor was used to propel the car. The wheels were 66 cm (26 inches) bicycle wheels, two in the front for steering and one in the back for propelling (Fig. 1).



Figure 1. MTSU SOLARAIDER III and the Team Members

THE PUBLIC PERCEPTION

While the car was under construction, several news organizations have contacted MTSU in order to promote the project to the community and to boost environmental awareness in the Middle Tennessee area. Team members were interviewed by TV reporters, radio talk hosts, and news columnists. During interviews, the team members explained to the audience, in simple terms, the technical aspects of the solar car and the basic principles behind converting solar energy into mechanical energy. The advantages of using composites to reduce weight while providing the required strength, the use of Earth friendly recyclable materials, the importance of aerodynamic design to reduce drag, and best of all the use of a clean and readily available energy source were among the many topics discussed in these interviews.

With all the attention the project has begotten, it was decided that the solar car project be used as a vehicle to reach the public at all levels. Some of the objectives of this campaign were: promoting MTSU and its Engineering Technology program, boosting public environmental

awareness, and increasing public interests in engineering, physics, and mathematics especially among the younger generations. Examples of such activities are given below.

- The author have used the solar car, since its conception, as an example in his lectures especially in the Basic Electricity and Electronics, Analog, and Digital Electronics courses. He showed how basic physical principles that the student learned in classroom can be applied to real-life situations. He also stressed the importance of using the solar energy, using energy efficiently, and keeping our environment clean. The students showed their interests and enthusiasms, asked technical and logistical questions, and shared their own experiences and fascinations with others in the classroom.
- The project was also presented to groups of Boy's Scouts as they participated in the Merit Badge University (MBU) program at MTSU. This is an annual one-day event where young scouts participate in hands-on experiments and demonstrations and are introduced to the topics of their own interests (the author is responsible for the Electricity and Electronics division of the MBU program at MTSU). The scouts were intrigued and very excited and they expressed their interests in furthering their education in a related field.
- Students from different high schools were also exposed to the project during several occasions. The author displayed the solar car, while being constructed, to minority students who participated in the Inroads Pre-College Summer Training Program at MTSU. The students were also introduced to the different stages of design and construction of such a car and they were briefed about different engineering fields and professions. Additionally, SOLARAIDER III was displayed at Riverdale High School during Earth Day along with the hydrogen car that was designed and developed in the Department of Agribusiness and Agriscience at MTSU.
- The solar car was also displayed to the public during various events such as the Technology Show at the Stones River Mall and during the Murfreesboro Street Fair.

The car drew much of public and, in particular, youth attention during these events. In every occasion, the team members answered questions from the enthusiastic crowd. Typical questions were centered about Sunrayce, the possibility of utilizing solar energy as an alternative source of energy, the importance of using composites and good aerodynamic design to achieve highest efficiency, technical and design questions, and whether MTSU is going to participate in future races. Moreover, several school teachers have expressed their interests in hosting the team and the car at their schools.

During the above mentioned activities, the audience has witnessed first hand how physics, engineering, and mathematics can play a major roll in advancing our civilization in ways that are Earth friendly. Additionally, the public was reminded with the importance of conserving energy in order to save our planet for generations to come.

THE DEPARTMENT AND ITS STUDENTS ALSO BENIFIT

A study done by the Department of ET&IS has revealed that the majority of our students transfer from other universities and community colleges in the region. The above project along with other on going efforts are intended to attract high school students and interested persons from the local workforce to our programs. Furthermore, it is hoped that this endeavor will

increase the public interest in our ET program in particular and in the Basic and Applied Sciences in general.

The benefits to our students were also great. The student gained a better understanding of the basic physics and engineering concepts that she/he learned in the classroom, acquire hands-on experience, and worked in a team environment. In addition, the student was involved in the different design stages of such a large project which well prepares her/him to meet today's industrial challenges.

FUTURE RACES

Because of the positive results of this project, the Department of ET&IS at MTSU is going to participate in the Sunrayce 97. The author, along with a colleague from the ET&IS Department, have submitted a proposal to Sunrayce Headquarters in January 1996. The proposal was selected for a \$2,000 award and the new solar car SolaRaider V is being designed and constructed and will be ready for the June 97 race.

CONCLUSIONS

With the declining interests in mathematics, physics, and engineering among the younger generations, a bridge is needed to link the gap between higher education institutions and K-12 students. A project like the solar car stimulates the creative thinking in our youth and brings to their attention the importance of committing themselves to excel in the science courses. More college Freshmen are surprised, nowadays, to find that they have to be enrolled in remedial courses in order to pursue their majors. These courses do not normally count toward the student's degree and that prolongs her/his stay in college and increases costs. The author found, from his experience in advising Pre-Engineering and Engineering Technology students at MTSU, that these additional courses may cause the student, in some cases, to lose interests in pursuing an engineering degree. It is therefore recommended that high school students be well prepared in math and sciences before starting their higher education. It is hoped that the SOLARAIDER project can serves as a stimulant and a reminder to our youth.

Many students at MTSU have realized the benefits of being involved in a hands-on team-oriented project like this. Currently, there are more students in the SolaRaider V team including several from other departments. These students are learning from the experience of their predecessors and improving the design and reliability of the new car while reducing weight and drag.

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BIOGRAPHY

DR. SALEH M. SBENATY is currently an Asst. Prof. in the Department of ET&IS at MTSU. He received the B.S. degree in EE from Damascus University and the M.S. and Ph.D. degrees from Tennessee Tech. University. He is actively engaged in research in the area of mass spectrometry, power electronics, instrumentation, and lasers. He is a member of ASEE, IEEE, SME, and the honorary societies of Phi Kappa Phi, Eta Kappa Nu, and Tau Beta Pi.