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Solar BikeRayce Competition Caps Success in Technology Student Team Project

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Abstract

After a solar bike workshop was held at Middle Tennessee State University, the “we can do this” syndrome hit some of the students and faculty on campus. A group of engineering technology and industrial studies students felt they could design, engineer, manufacture limited parts, construct, and compete in a vehicle of their own creation. The ongoing demands of the solar bike project provided impetus for creative design, student involvement, opportunities for displaying the bike, recruitment of team members, and a continued level of student interest.

Introduction

The idea of building a solar vehicle first caught the interest of some Engineering Technology and Industrial Studies (ETIS) faculty during a solar vehicles workshop conducted at Middle Tennessee State University (MTSU) in the Fall of 1998. Intrigued by two motorized bikes on display and available for test rides, discussion turned from "we could do this" to "we can do this" and a new student project for the department was sparked. Believing not only engineering technology students, but also those in environmental science and technology and other areas might be interested, the idea spread and slowly gained support. A solar bike project was initiated by ETIS faculty, however, the criteria for the project to be successful had to be established to gain the support of the ETIS department and to attract students. The project had to be educational, offer hands-on experience, encourage active-mind involvement, and provide an opportunity to apply classroom knowledge. That the project would touch upon an environmentally friendly area such as solar technology was an added benefit, as was an established competition to verify project results, the Solar BikeRayce '99 event in Topeka, Kansas scheduled for the following May.

Why solar?

Solar energy is a free resource offering a healthy, efficient, and environmentally friendly fuel alternative. It is a mainstream resource and important to the future of our environment. The environmental gain is reduced pollution and increased awareness of environmental stewardship. The educational gain is the development of a project making use of available technologies from start to finish and a hands-on opportunity for students. Practical experience gained using solar technologies stimulates student's interest and the Rayce provides a competitive forum for solar vehicle design. Another plus was that the Solar BikeRayce event, to test the performance of the vehicle, was in place and offered an incentive to complete the project. Forming a team to support the idea of entering a national solar vehicle race was the next step to actually committing to the project. Having a sanctioned event to shoot for added impetus to the project as well as a deadline that once committed to, had to be met by the "we can do this" team.

Project planning

While attending another workshop, the faculty advisor and the student project leader were even more convinced that the more technical S-Class was the better choice to suit the interests and capabilities of an MTSU team. Researching the Rayce in order to develop the student project objectives, the four classes of vehicles allowed in the Rayce were compared, and it was determined the S-Class vehicle with larger batteries sans pedals would be more challenging for students at the university level than a solar/electric motor assisted bicycle. Time and effort would be devoted to designing and constructing a competitive vehicle, including custom designed parts and features. Members of the team felt a three-wheel vehicle with two wheels in front, for steering and braking, driven by a single wheel at the rear could be competitive. Developing a design was foremost in the process. Ideas for a custom designed solar vehicle that would be competitive in its class were easy to come by. Coming up with the best of these became the challenge. The necessity to fabricate certain integral parts provided the team the opportunity to progress from classroom theory to real-life application. Rayce regulations and specifications contributed to all design decisions relating to overall vehicle configuration. After initial design decisions were made, the parts to be fabricated in the ETIS labs were determined and the next phase, construction, began. The ongoing demands of the project provided the impetus for more creative design work, additional student involvement, and a continued level of interest to keep the project active.

A quick weight and balance CAD drawing based on estimated weights for all the vehicle components, including a hypothetical 120-pound driver, was used to determine wheel loading and basic component layout. It was concluded that small diameter wheels with narrow hard tread tires would improve aerodynamics, lower rolling resistance and rotating inertia, and still provide sufficient traction for cornering and braking. The small wheel/tire assembly would also simplify the drivetrain by allowing a single speed reduction from motor to driven wheel, eliminating the need for a more complex and expensive jackshaft assembly. A potential Rayce driver provided the physical measurements necessary to design a snug fitting chassis and aerodynamic body.

The chassis constructed was of a space frame design consisting of small diameter steel tubing with braze welded joints. The most energetic in-house fabrications were the three eight-inch wheels with turned aluminum hubs, spun aluminum disks, and cast polyurethane tires. The small diameter tires/wheels were designed for low aerodynamic drag, low rolling inertia, and low rolling resistance provided by the hardness of the solid tires. These technology related choices offered the students many decision-making opportunities regarding design, fabrication, and testing of the vehicle.

Most all the electrics were agreed on early in the design process. The battery groups were specified in the BikeRayce Regulations along with solar panel physical size limits. An energy needs assessment was performed prior to selection of the solar panels, motor, motor controls, and wiring. The addition of an e-meter (an electronic fuel gauge) allowed for data acquisition necessary for forming Rayce strategy. The electric motor, motor controller, circuit breaker, and main fuse selections were race proven and readily available.

Decisions regarding the hydraulic brakes, battery group, drive train, and body shell were also made by team members. Overall, the technical elements involved in the design and construction processes stimulated student's interest and provided an avenue for physical and mental involvement throughout project development and implementation. Project structure, project management, electrical and mechanical engineering principles, teamwork, communication, and budget contributed to the complete project package.

Putting it together

The team and the project were coming together. Student majors from industrial management to engineering technology to environmental science and technology, and aerospace approached the project from different perspectives. The mutual attraction for the project was designing and building a solar S-Class bike. Team development considerations included understanding project goals, defining objectives, creating a plan, assessing the plan, implementing the plan, and choosing team leaders. The competition was the ultimate goal. As the Rayce neared, enthusiasm for the project grew.

The Rayce

The intercollegiate competition in Kansas provided an opportunity for the team to observe the race-worthiness of the vehicle and to evaluate their design and fabrication efforts. Three major challenges met the team in Kansas. First, the vehicle had to pass technical regulations check known as scrutineering where physical dimensions, batteries, solar arrays, and vehicle performance, including handling and braking, were inspected and tested. Also, the electricals and safety features were reviewed. Rayce-Array passed with flying colors. Passing this stage, the bike was entered in The Sprint, the second challenge, an acceleration and top speed test to determine pole position, and, third, The Rayce, an endurance test of the vehicle and driver. This was the competition the team anxiously anticipated.

In the Sprint, the bike performed very well, placing sixth overall, assuring a sixth place out of sixteen on the starting grid for the Rayce. Elated with the performance to this point, the team was stunned to discover a shredded tire and damaged wheel following the Sprint. Unfortunately, as a result of the very limited budget, no spare tires or wheels had been constructed, so entry into the Rayce competition ended. However disappointed the team felt, they were not discouraged since the Rayce-Array had performed so well up to that point. The project was deemed a success by all involved.

Conclusion

The project provided an avenue for departmental and other interested MTSU students, to participate in a technology oriented extracurricular activity that allowed them to demonstrate, and put to the test, skills and knowledge gained in the classroom and through participation on this project. The design, construction, and testing/development comprised the avenue for demonstration. Vehicle and team performance in a nationally sanctioned competitive event, Solar BikeRayce ’99, provided the ultimate test. The project has resulted in national recognition for the team’s efforts in competition with their peers. An additional benefit for MTSU and the Engineering Technology and Industrial Studies Department that supports Rayce-Array is the vehicles use as a recruiting mechanism. An area high school has already committed to designing and constructing an S-Class vehicle and competing in the Solar BikeRayce 2000 as a result of a recent workshop held on campus that targeted local schools. Encourage by the MTSU team, whose members have themselves committed to the next Rayce, this school and possibly others in the area, benefit from that same "we can do this" attitude.

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