Apr 16th, 11:00 AM - 2:00 PM

The Scholarly Role of Faculty Advisors in Student Engineering Competition Projects

Gerald M. Brown
Cedarville University

Timothy B. Dewhurst
Cedarville University

5th Annual Research + Scholarship SYMPOSIUM
Cedarville University: Inspiring Greatness

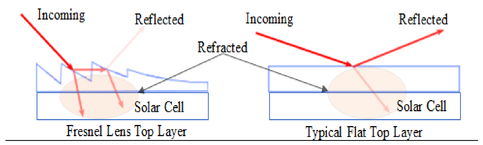
The Scholarly Role of Faculty Advisors in Student Engineering Competition Projects

Dr. Gerald Brown – Dr. Tim Dewhurst

The Elmer W. Engstrom Department of ENGINEERING AND COMPUTER SCIENCE
CEDARVILLE UNIVERSITY

Increasing Solar Power Available by Developing A New Surface for Solar Panels

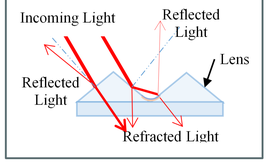
Joel Dewhurst

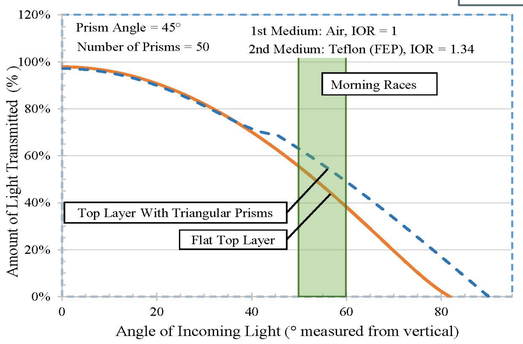


Consider: A Fresnel Lens top layer on the solar panels could capture more low-angle incident light than a standard flat top surface.

Scholarship Model: *Joel conducted the optics study on his own and occasionally consulted with faculty for input. This Faculty/Student relationship is like a Manager/Engineer. To master the manufacturing steps, however, a transition to a Master/Apprentice role may be necessary because numerous unknown manufacturing difficulties have yet to be overcome.*

Innovation: A top surface of prisms can capture even more low-angle incident light.

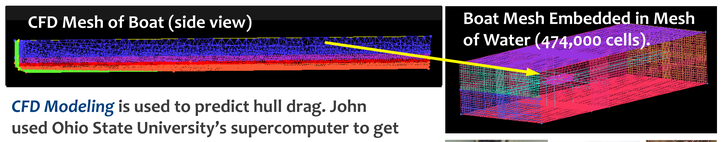




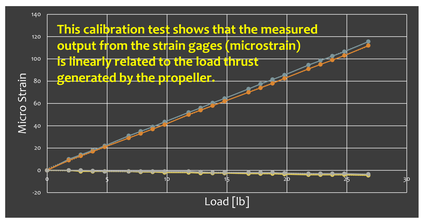
Analysis: The amount of low-angle incident light captured by the solar panels during morning races will be increased using prisms on the top surface but not reduce the amount of light coming in at higher angles later in the day.

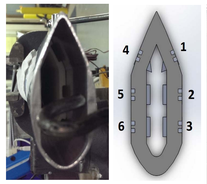
Improved Prediction of Hull Drag using Computational Fluid Dynamics (CFD)

John Howland



CFD Modeling is used to predict hull drag. John used Ohio State University's supercomputer to get realistic results using an extremely large mesh.





Looking inside the downleg where six strain gage have been mounted

Side view of downleg with wires exiting from the top

CFD modelling requires massive amounts of computing power but requires field measurements to validate the results. John mounted strain gages *inside* the downleg to measure thrust and torque produced by the propeller. At constant speed hull drag and thrust are equal, so John can verify the accuracy of his simulation. He has documented his work for future teams.

Scholarship Model: John received close oversight by a faculty member with good CFD experience, but also did much work beyond the faculty's expertise. This is a case of both Manager/ Engineer and Master/Apprentice relationships.

Abstract

ENGINEERING FACULTY ADVISORS at Cedarville University work closely with senior engineering students on the Solar Boat team to improve the boat's performance each year and continue the team's legacy of 7 wins in the last 10 years at the Solar Splash Competition. *The faculty-student relationship* is, at times, similar to that of a *mentor and apprentice* and at other times similar to that of an *engineering manager and an engineer*. These relationships allow us to maintain *technical continuity* from year to year between student teams, develop and maintain an *increasingly sophisticated team knowledge base*, coach the students through *design issues beyond the scope of their in-class instruction*, and *model the diligence, effort, and attention to detail* that are essential to be *successful at the international level* in student engineering competitions.

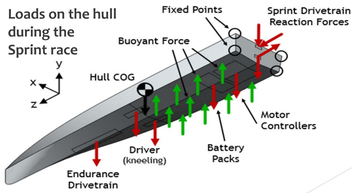
EACH YEAR the team seeks to improve several aspects of the boat's performance. They follow a *Design Process* that has a large emphasis upon the manufacturing and testing of their designs. Throughout the project phases the role between the faculty and student can change.

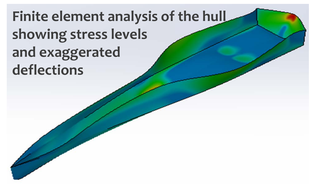
- ***THE DESIGN PROCESS – A MEANS TO AN END***
  - Background research – building upon prior years' knowledge and experience
  - Proposal development – the new team's contribution
  - The Power Budget – an analysis method that defines the capability of the system and sets individual system specifications for the boat to perform as needed
  - Design and model components and circuits – beyond the classroom to details that stretch and develop engineering skills
  - Manufacture components – a well equipped shop, skilled guidance, hands-on work
  - Component and system testing – a key to reliability in the field
  - Iterate the design – it's not done until each component meets the performance specifications
- ***THE MANUFACTURING PROCESS – BUILDING IS LEARNING***
  - The unique nature of the project leads to design solutions that are not generally available for purchase off-the-shelf. This includes most major components such as the solar panels, electronics, motors, propellers and hull.
  - The team builds as much as possible in-house to give students experience in manufacturing – many things are learned best by doing.
  - Some components require facilities or technology which we do not have – we coach the students in working with vendors to develop custom solutions.
- ***THE FACULTY / STUDENT RELATIONSHIP – SCHOLARSHIP IN A NEW CONTEXT***
  - As faculty advisors we demand close adherence to the Power Budget because it ties together the individual performance specifications and work of each student.
  - ***Scholarship through Oversight:*** In the design, manufacturing, and testing phases, we encourage students to develop their own solutions and have frequent faculty/student meetings where the advisor's role is similar to an engineering manager, and the student's role is much like an engineer (Manager/Engineer Model).
  - ***Scholarship through Example:*** When the complexity of the project goes beyond the capability of the student, the advisor works side-by-side with the student, sometimes for hours-on-end, demonstrating the technical knowledge, problem solving capability, diligence, and attention to detail necessary to master the problem and bring the project to a successful completion. In these times the faculty/student relationship is more like that of a Master and Apprentice (Master/Apprentice Model).
  - ***Scholarship that Bears Fruit:*** Students often develop expertise beyond that of their advisor and contribute greatly to the team's knowledge base, doing great scholarship in the context of an engineering competition project.

Reducing Power Requirements by Manufacturing a New, Light-Weight Hull Using Advanced Materials and Practices

Joel Ingram

The Solar Splash Hull During a Sprint Race





The hull being manufactured using a vacuum infusion process to draw resin through the Kevlar fibers

Sample piece of new hull undergoing testing

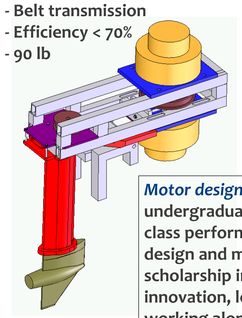
To improve performance, Joel must reduce weight but keep the hull sufficiently stiff and strong. The goal is to reduce the weight 50% to only 50 lb, thereby reducing drag by 20 lb and leading to a 20% increase in speed, in line with the overall Power Budget.

Scholarship Model: The student already has significant manufacturing experience in this field, so the Faculty/ Student relationship is primarily Manager/Engineer.

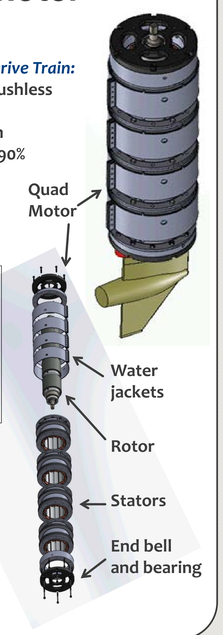
Doubling the Thrust by Developing a More Efficient Sprint Motor

Trevor Leeds

The Classic Sprint Drive Train:
- Twin motor, bushed DC
- Belt transmission
- Efficiency < 70%
- 90 lb



The New Sprint Drive Train:
- Quad motor, brushless
- Common shaft
- No transmission
- Efficiency near 90%
- Approx. 70 lb



Motor design is far beyond the scope of an undergraduate ME program. But world class performance requires state-of-the-art design and manufacturing. Faculty scholarship in this context involves innovation, leadership, coaching and working alongside students.

Scholarship Model: Trevor has outstanding 3-D modelling experience and worked extensively to manufacture the motor led by the ME advisor in a Manager/Engineer role. However, his work with the EE advisor and an out-of-house motor designer on magnetics, assembly and electronic control issues fits the Master/Apprentice model.