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Advanced Engineering Lab

Ware Lab Team Innovations and Career Opportunities

Autonomous Systems: *Sailboat/Astrobotics/HEVT* - these teams are addressing hardware/software problems encountered in mechanical systems that have partial or full autonomy. Challenges include robust design, safe operations, and cost reduction. It is a challenging task to take a system that is manually controlled and provide it with the proper level of programming so it can handle a multitude of inputs (think wind, water current, hull geometry for SailBOT - terrain, environment: Mars dust storms, lack of oxygen, low sunlight, for Astrobotics - road and weather conditions for HEVT). Addressing multiple inputs is known as *robust design.* How do we create robots that interact with humans that are safe while being cost effective to build and operate?

Carbon Fiber Materials: *Formula SAE/Human Powered Sub/SailBOT*. Carbon fiber is a very strong, lightweight material, but it is expensive. Formula SAE is on the forefront of using carbon fiber for a full vehicle chassis which involves handling (cutting, placing, and curing), and temperature and pressure control during curing (autoclaving). Strength (compliance) testing is critical in the use of carbon fiber material since there are no published properties, like steel, aluminum, and titanium. Issues with bonding carbon fiber with aluminum must also be addressed. Aircraft and space industries are tackling these issues since they need stronger and lighter materials in the construction of air/space craft.

EV Power Train: *HEVT, Formula SAE-EV, BOLT Electric Motorcycle.* These teams are spearheading the application of effective total electric EV powertrain systems. Battery energy density, charge time, depletion time, battery longevity and disposal are all pressing issues addressed by these programs. How should batteries be stored and handled during vehicle construction? What safety certification is necessary when working with high voltage (>100V DC) systems. How do you address issues with high end torque versus endurance during long completion events? The growth of EV industries is huge considering the advanced in the last 10 years in the reduction of battery weight vs. performance and longevity. Think Tesla, think iPhones!

Optimized Structures and Materials: *Steel Bridge Team, Concrete Canoe.* Our civil programs include a bridge group that uses truss and frame designs to construct structures having optimal weight, deflection, and strength characteristics. SBT's bridge can carry up to 2500 lbs. (2.5 kips) and only weighs 200 lbs. resulting in a structural efficiency of 12.5:1! Centerline deflections typically are less than an inch over a free span of 20 feet (< L/240 deflection limit that is typical in building roof construction). Concrete Canoe uses a mix consisting of cement, water, air, and high strength sheets of plastic tensile reinforcement to allow the canoe to carry up to four adults during competition. The resulting concrete mix has a unit weight slightly less than water, so it floats like ice!

Career Opportunities: *GM, FORD, SpaceX, Nucor, Lockheed Martin, Boeing*, and *Leidos* are just some of the companies that support Ware Lab teams in the form of money, in-kind contributions and in hiring students after graduation. Ware Lab students go into entry level design positions, providing organizations engineering services from the day they start work. Many new hires, not having *the Ware Lab experience*, require time to get up to speed as engineers. Our graduates "hit the ground running". Other students continue onto graduate schools at world class universities and are well prepared to do research, having been immersed in the engineering design-build process.

For more information on Ware Lab email Dewey Spangler (Ware Lab manager) at spangler@vt.edu.