Cyberphysical system project to be undertaken through an undergraduate course with the ambitious time limit to be completed in a single term

The challenge built up the understanding and usage of good modeling is complex and difficult, but notably successful. All learned to verify/validate your model with experiments. Items became more complex when one bounded into the minute details of fabrication and assembly. REDESIGN is a needed part of the design cycle.

Three universities participated in the challenge-Vanderbilt, MIT and California-Berkley. All the universities included an introduction to Cyberphysical modeling as part of the challenge.

Ten Vanderbilt undergraduate students formed a Multidisciplinary team from:
- Mechanical Engineering
- Electrical Engineering
- Computer Science

These were very strong students, but had limited previous experience with:
- Software Modeling
- Machining/fabrication
- Composites
- Motor and Powertrain Elements

The Vanderbilt MBARC team

Objective
Cyberphysical system project to be undertaken through an undergraduate course with the ambitious time limit to be completed in a single term.

Project focused on the design, development, fabrication and validation of a 1:5th scale amphibious vehicle to meet a set of realistic design requirements. (<20kg, 2MJ of Energy on board, <1m length, carry 20kg, etc…)

- Built a series of comprehensive software models to create an amphibious vehicle with modern design tools.
- Complete the complementary hardware and control software development and design (and re-design) in one term.
- The culmination of the design competition matched the vehicle’s performance with the simulation and dynamics models of the vehicles.

Each term of the undergraduate course with the ambitious time limit.

Final vehicle Design specifications:
- Chassis - modular extruded aluminum for strength and flexibility (similar to 80/20)
- Land/Water powertrain - dual 4.7HP BLDC motors – from Leopard motors
  - Land power train is RWD through an Integy Differential
  - Water power train is belt driven water jet
- Hull - Hand fabricated Kevlar composite
- Dual Cooling System – for each of the land and water powertrains
- Electrical System - used Castle Creation electronic speed controllers with approximately 2MJ (555 Wh) Thunder power LiPo batteries

The MBARC competition

Conclusions
- Undergraduate MBARC students arrived at robust solutions to complex design problems with the aid of modern engineering design tools- Cyphy ML, modelica, and Creo/CAD
- This course was firsthand training for our young engineers to navigate 21st century design challenges
- They completed several dynamics models to predict the vehicle behavior on the future trials for the four challenges
- They completed several versions of the amphibious vehicle in hardware that was used to validate their computational models and improve their design
- The 100% student fabricated design ran exceedingly well during the MBARC competition.