

Howie Choset's Education Statement

Choset's multi-disciplinary educational efforts have two inter-related goals: inject basic mathematics into fundamental engineering and computer science education and tie basic theory together with pragmatic implementation. The idea here is that we use construction experiences to reinforce and allow for the exploration of fundamental topics. Perhaps, the best example of this is a new course Choset developed entitled General Robotics (<http://generalrobotics.org>). This course differs from other overview courses in robotics in that students get to build a LEGO robot every other week, as part of their homework assignments. Not only does this seriously motivate students, it also allows the students to do significantly more. These labs are designed to strike a balance between giving students enough information so that they do not spin their wheels each week, but not enough information so that they have to seriously think about the course material and explore creative options to complete the assignments. Unlike conventional chemistry labs, to borrow a term from Fred Martin, these labs are both hands-on and heads-on. Students are seriously motivated to think.

General Robotics exposes, or perhaps forces students, to undergo a rigorous process where they must tie high level ideas to low level realities of making robots work. For example, one of the labs teaches path planning for robots and explains the difficulties in positioning error, but it is not until the students build the robots and then try to make them follow the paths, do they realize how friction, gearing, and dynamics tie into a theoretical idea taught in class. Students learn that going from theory to implementation is not a mindless venture and that implementation can guide theory.

The labs also tap into the students' inherent "tinkering abilities" to further explore topics on their own. However, these labs go beyond the topics taught in class. They provide students with a design experience that allows them to be creative and work in teams. However, it should be made clear that these labs do not trade off design experience for mathematical rigor. Instead, we are able to exploit the design experience to reinforce rigorous materials taught in class. Currently, we have developed extensive web pages so that other Universities and high schools teaching robotics can use our ideas.

Each year, the capstone design experience changes. In the Fall of 2002 and 2003, we gave the students a mock search and rescue experience where they had to design a robot to traverse a rough terrain. Students drove the robots, but only using images from a camera on-board the robot. The students were not in the same room directly watching the robots as if they were in a real search and rescue scenario. This provides the students with a deeper lesson in tele-operation, one which could not be taught, but rather experienced. It is worth noting that some of the feedback from the class actually will influence the design of future search and rescue robots. In fact, Jean Stoltz from the NIST came to interview our students to learn more about the search and rescue robots.

The General Robotics course is one of the requirements for the Undergraduate Robotics Minor at Carnegie Mellon. Choset developed a curriculum for undergraduate robotics education that sits on top of virtually any major at Carnegie Mellon. The minor also exposes students to the multi-disciplinary nature of robots while at the same time preserving each of the major's identity. For

example, the Mechanical Engineer gets a “mechanical” robotics minor while at the same time learns and understands the problems of the computer scientist; here, the student learns how to talk with people in another discipline, see how his discipline meshes with the others, and understands how the discipline fits into a bigger picture. One of the grand visions of this minor is to endow undergraduates with a broad understanding of robotics fundamentals while giving them some hands on experience.

Choset also teaches a multi-disciplinary course at the graduate level: mechatronics, the symbiosis of Mechanical Engineering, Electrical Engineering and Computer Science. Here, we teach students a new design philosophy that allows for tradeoffs among all three disciplines. In both the undergraduate robotics and graduate level mechatronics classes, groups of three students -- nominally an ME, EE, and CS -- complete assignments together. This provides a unique experience for students who normally do not work with people from other disciplines and hence will build team and communication skills for students that today's job market demands.

Choset also teaches a fundamental mathematics course for engineers and basic kinematics. Beyond the classroom, Choset has organized and co-lead many reading groups at Carnegie Mellon. Starting in 1999, with Messner, Choset directed a reading group on Distributed Manipulation. This reading group led to the formation of a workshop that Choset co-chaired with Karl Bohringer of the University of Washington at the 1999 International Conference on Robotics and Automation. A book, edited by s Bohringer and Choset, on this topic has been published by Kluwer as a result of the workshop.

To further inject basic mathematics into engineering education, Choset has co-authored a book on Motion Planning with Kevin Lynch, Lydia Kavraki, Seth Hutchinson, Wolfram Burgard, George Kantor, and Sebastian Thrun. This book builds upon Jean Claude Latombe's book in reporting the new results since Latombe's book was publish, as well as making the fundamental mathematics accessible to the newcomer to the field. The book also brings together aspects of conventional path planning and control theory, as well as emphasizes implementation. Latombe wrote the foreword for the book and it is currently being edited by the MIT Press. This book should be published in 2004.

Outside of the University, Choset's research goals include educating robotics researchers on urban search and rescue and carrying the philosophy of the LEGO labs to the K-12 levels. In February of 2003, Choset and Robin Murphy at the University of Southern Florida organized and ran the first IEEE Workshop on Safety Security and Rescue Robots. This workshop included presentations and live field demonstrations, including Choset's group's snake robot, in a rubble pile. Roughly 80 people attended this workshop and it will continue as an annual tradition for the foreseeable future. In August of 2003, Choset and his students participated on a field exercise with the Center for Robotic Assisted Search and Rescue, the Indiana Task Force I, and the Chemical Biological Response Force unit of the Marines with his group's robots. In this exercise, a building was imploded and the robots were used to find “trapped survivors” in the buildings. Choset is also a member of a response team for urban search and rescue. Choset has also given numerous talks to junior and high school students on robotics and science as well as participated as a judge in the US First Junior LEGO League.