

# The History of 6.270

The origins of this course begin with Woody Flowers in MIT's Mechanical Engineering department. Woody Flowers had the idea that teaching should be interactive and not just lecturing. He developed the famous "Introduction to Design" class (course number 2.70). In 2.70, undergraduates use scrap parts---metal, plastic, and wood---to build machines that go on to compete in a head-to-head contest at the end of the course.

Michael B. Parker, an undergraduate in MIT's Electrical Engineering and Computer Science (Course Six) department, had just taken 2.70. Mike liked the course so much that he was jealous: "Why should there be a course like this for Mechanical Engineering students, but not for the students in his department?" he thought.

So in 1987, Mike organized the first 6.270 contest as "Course Six's answer" to the 2.70 course. The contest was a programming competition in which students wrote programs to control computer-simulated robots. In the first two years of the contest, the goal was to design a simulated robot that tried to find and destroy other robots. Unlike the machines that are built in the 2.70 course, there was no human control of the simulated robots (in 2.70 the students control the machines through a joystick and some switches). This was what separated the 2.70 course and the 6.270 contest.

A couple years later, Mike saw a project at MIT's Media Laboratory called "LEGO/Logo," in which children build robots and other mechanized devices out of LEGO bricks, motors, and electronic sensors, and then write programs to control them using a special version of the Logo programming language. Mike wanted to provide the 6.270 students with similar technology so they could build real robots, not just the computer-simulated robots that been done in the past.

Mike recruited Fred Martin and Randy Sargent to be the technical consultants to the upcoming 6.270 contest (which was starting in just a few weeks). It sounded like a fun way to spend IAP. (MIT's "Independent Activities Period" is a one-month break between the fall and spring semesters.)

Randy and Fred spent most of their holiday break designing an interface board that connected to a PC or Macintosh computer, controlling motors and providing input from a few simple sensors. The budget was tight and time was short as they scurried about the local Radio Shack stores, buying electronic parts for the twenty teams of students who had preregistered for the course.

Everything went wrong that month: the LEGO parts showed up late; the server would not give approval for 6.270 to use its workstations and mix-ups in room scheduling forced groups of students wielding soldering irons to wander about campus looking for available classrooms.

The robots were powered and controlled through a tether connected to a personal computer. A lounge was transformed into a workshop, and only the students' excitement carried the contest through the month and into a competition at the end of IAP. Students who were building robots contributed their time to making the contest a reality. The contest lasted about four hours---it was a long, drawn-out affair---but the students enjoyed it.

The unique feature of 6.270 was that the students were running the course themselves. The learning was through mutual help. No professors or faculty members were involved with the organization or teaching of the course. Students learned from interaction with other students, and this formed the basis for future 6.270 contests.

After the contest was over, Pankaj ("P.K.") Oberoi, who had been a student in the contest, called a meeting of interested past participants. P.K. thought the class had great potential as a learning project and wanted to help organize it for the upcoming year. He felt that given some organization and structure, the contest could be transformed into a course in which the students could learn more than just how to "hack" something together.

P.K. had already worked on key administrative aspects, like recruiting corporate sponsors. Microsoft had donated some money to the course previously and was willing to up the ante for another year. P.K. also got the support of Motorola, which agreed to donate valuable semiconductor parts. He also gained the support of the Course 6 faculty to allow the contest for another year, with a more structured environment. Randy and Fred were recruited once again by P.K. to help develop technology for the course. Hesitant at first, they laid out artwork for a custom printed circuit board that used a new Motorola microprocessor with more control features than the tethered machines. The original board was based on a microprocessor board designed at the MIT AI Laboratory by Henry Minsky.

P.K. and Fred wrote handouts for the students telling them how to build sensors, a battery charger, and other robotics components. The contest was transformed from a group of students wandering around looking for a place to work into a course with lectures and labs where the students could learn more technical aspects in addition to the hands-on exposure they were getting.

Eighty students, organized into thirty teams, took the course that year. Even before the contest that year, it was evident that the course was a success. As students carried their robot kits around campus, interest and excitement spread. The contest was a hit.

By the end of that year, Fred was interested in the course not only from a technical perspective, but from a special educational perspective. Students at MIT were choosing to pull all-nighters building robots rather than taking ski trips. In doing so, they were learning about engineering design and robotic technologies from first-hand, experiential involvement in a project-based course. The course seemed to fill a gap in the students' education.

By providing the tools and materials for students to work with complex electronic, mechanical, and software ideas, 6.270 gives the students a place to explore and learn about key ideas in technology, engineering, and design. Teamwork, learning-by-doing, and learning from one's peers is primary. 6.270 provides a hands-on style of learning experience for MIT students who are used to the theoretical lecturing style presented in most of the core classes.

The 1990 class was a big success but the organizers wanted to make the class even better. The class was hampered by a controller board which had to be programmed in assembly language and only had a small amount of memory. After the contest, work began on technology that would be more powerful and more useful to 6.270 students, allowing them to get even deeper into robot design and other technological

issues.

By the start of the 1991 class, Fred and Randy had developed a robot-building kit with the high degree of power and flexibility we had wanted. Students were able to develop software for their robot using a subset of the C programming language called IC. The new embedded controller board they developed had a number of new features, including a small display screen that could be used to print debugging messages. Students were able to use powerful Unix workstations all across campus to develop programs for their robots.

The 1992 contest was organized by Fred, Randy, and P.K. joined by Karsten Ulland and Matt Domsch, two sophomores who had taken the course the previous year. New features continued to be added. Fred changed the layout of the board to include more channels of analog input for sensors; Randy improved IC to allow multiple C and binary modules to be loaded to the board; and PK, Karsten, and Matt worked staffing the labs during the day and building the contest tables at night.

The enthusiasm in the course was increasing by enormous proportions. This was evident in the increase in enrollment. Over 300 students signed up to take the course for 150 spots. Several new sponsors were recruited to participate in the course. As in previous years, many participants in the course also contributed towards helping prepare for the contest. The rapid change in technology did not allow much time for debugging or completion of the software. Anne Wright, a student in the course helped take up the slack by reporting bugs and writing software updates.

1993 organizers consisted of P.K., Matt, and Karsten joined by Anne Wright and Sanjay Vakil, two participants from the 1992 contest. They worked to update the technology and notes for the course and to organize the course for a new group of approximately 170 students divided into 55 teams. With Fred and Randy no longer active organizers, they set about to establish a new division of labor which would allow the standards of progress set by the previous contests to continue.

Matt took responsibility of class registration; P.K., Karsten, and Sanjay contacted greater support from the sponsors and ordered the kits; Karsten and Anne made changes to the controller board to fix hardware "bugs" from the previous year and some additional features (a servo); and Anne rewrote portions of the IC compiler to give it more of the features of real C. These course notes have come about from a combination of past experiences and each organizer took on the section of the notes with which they felt most comfortable.

In 1993, over 125 teams signed up to take the course. Because of the popularity and demand, the lab was kept open most evenings. To handle the demands of the course, eight TAs were hired from 6.270 alumni. Tripling the staff helped to offload the organizers.

In addition, Motorola sent a film crew to the contest to document the contest from the distribution of the kits to the final round on contest night.

1994's contest expanded once more: 10 TAs and five organizers helped to create the contest. Of the 265 registrants came fifty teams. A new weighting system was also used to try and give past registrants who were not accepted a better chance at getting into the course. Given that the boards changed minimally, the extra time was spent updating and clarifying the course notes.

1995's contest expanded yet again: around 15 TA's and 6 organizers helped to create the contest. About half of the applicants, or 140 people were accepted, creating 50 teams.

Unfortunately, due to budget and staff constraints, participation in the 1996 and 1997 contests had to be cut back to 40 teams (about 110 students).

In 1998, however, with a larger staff of organizers, the contest is being expanded back to 50 teams. Also, new hardware and teaching materials are being developed to make 6.270 an even better experience for the participants.

Over the years, the organizers of the 6.270 contest have put a great deal of thought into how to organize the class to maximize the students learning potential and enjoyment of the course. We have tried at all times to provide the best educational and technical environment we could. We have tried to schedule events such that teams have a maximum amount of time to experiment with design and programming issues with a functioning robot. But the thing which really sets 6.270 apart from all the other technical and lab courses at MIT is that despite the enormity, this project remains to be one of the largest student-run activities due to the enthusiasm of the students who have taken the course. We believe that this is 6.270's greatest strength, and we hope that this enthusiasm will continue to attract generations of student organizers to keep 6.270 alive.