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Project Oriented Robotics Course for Engineering Students with a Hands on Approach

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Abstract

In this article we will review the changes that we've made to the curriculum of our robotics lab in order to transform and evolve a task oriented lab into a semester long hackathon where students work in small teams to design and build mechatronic devices.

Keywords: Engineering, Robotics, Higher-Education, Lab Work, Hackathon, LEGO, Project Oriented Learning, Mechatronics.

How it was

When we were first called to take over the robotics lab, we found a fairly standard and uninspired syllabus. Out of 5 weekly hours, 3 were devoted to theoretical studies (Introduction to Robotics) and the remaining two hours were lab work.

In the lab, students used Lynxmotion Robot Kits (which are gentle, fragile, and really suited aren't fit to serve eager and enthusiastic students) and LEGO NXT robotics kits. It was a static course with a very technical approach. Each week, a few pre-defined tasks were given and the students were under a weekly build-run-deconstruct cycle.

The next level

After close examination of the existing coursework, and taking into account the feedback from the students we've decided it was time for some changes. Technology and innovation are always fueled by creativity, and engineering is a result oriented field, we wanted to see what our engineering students will be able to achieve when put to the test.

We kept the theoretic college level Introduction to Robotics part of the course, and compressed it to 2 hours a week instead of three. The lab was now 3 hours long, and during a 13 week semester Students were required to work in small teams to invent and develop a working prototype from the ground up.

We wanted to give the students a sprint development experience in a controlled environment and to create an atmosphere of effective learning by letting them iterate solutions to real engineering problems (mechanical, software, integration) and crack project management challenges.

We also made sure that the course will be open for students from every field of engineering to enroll (this was originally a mechanical engineering only course). We always encourage the students to form teams with teammates from different fields of engineering so that each group will have a diverse portfolio of skills and an interdisciplinary knowledgebase.

We provide the students with guidance, equipment, infrastructure, and mentoring. The students bring in creativity, innovation and hard work. Figure 1 showing assorted projects ready for demo day.



Figure 1: Assorted projects made by the students ready for demo day

Making robots

The first three weeks of the semester are devoted to introduction of the requirements. We give the students the opportunity to familiarize themselves with the lab equipment (LEGO robotics

kits) through some basic challenges and a competitive build contest.

Using what they learned about the possibilities of the equipment, the students use weeks 4 and 5 for open brainstorming, discussing ideas, and for the initial project presentations.

Weeks 6-11 are devoted to actual R&D and hacking (most of the thinking and planning happens at home, and the limited lab time is usually devoted for testing ideas and designs). This timetable gives the students approximately 15 hours (net) to build a working prototype from scratch.

Each group receives its own basic kit (including a controller, motors, sensors, basic Technic parts and some special goodies). There is also a poll of shared elements that can be used by everyone (shared elements are acquired based on actual needs demonstrated by the students in their work).

Week 12 is our D-day, and all of the projects are presented and evaluated without exceptions.

Finally, in week 13, we sadly take apart everything and then rearrange thousands of LEGO parts so that everything is ready for next semester (identical basic kits are assembled, and all the shared parts are returned to their place). Weekly break down of the semester as shown in Figure 2.

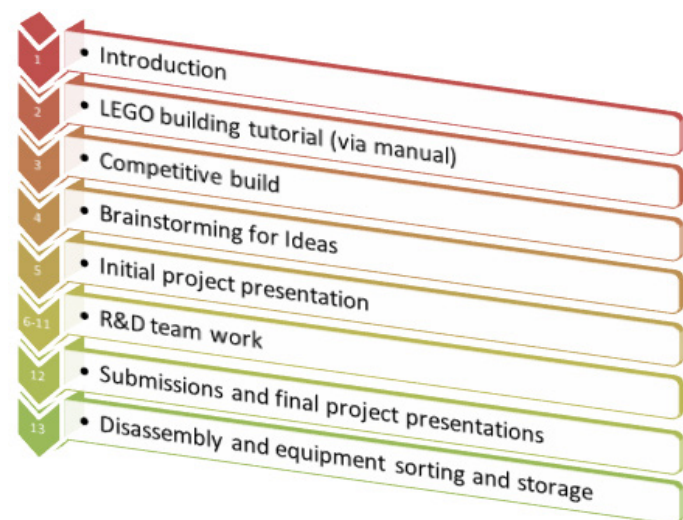


Figure 2: Typical weekly break down of the semester

Academic requirements

Time is a key-element on our lab, and in order to balance the great degree of freedom that the students enjoy in managing their own tasks, we've created a rigid timetable for academic evaluation and project delivery.

The students decide what to do and how to do it, they get all the power but are also required to take all the responsibility.

Early In the semester students are required to make a detailed presentation about their project, laying out what they plan to accomplish and how they intend to do it (including basic architecture, time table, team responsibilities and basic risk management). This presentation is binding, and plays a key role later when the project is being evaluated.

In the end of the semester each team is required to make a closing presentation, detailing what was done and exactly how it was done. In addition, there is a mandatory live demo in front of the class.

Each team also creates a short film depicting their project in action. All movies are uploaded to our YouTube channel (<http://afekarobotics.com>).

Our equipment

We started with LEGO Mindstorms NXT Edu. robotics kits, and graduated to the much more advanced and open platform of EV3. These are specialized robotics sets with a wide variety of sensors and mechanical components.

The minimal initial investment (entry level for 15 students) is about 4K-5K USD for basic kits and an entry level amount of shared parts (computers are also required).

Community involvement

The Afeka Robotics Lab is in cooperation with the Bloomfield Science Museum in Jerusalem. Selected students present their work at the annual Mini Maker Faire.

Interns and guests are always welcomed to join the engineering teams, share ideas and get inspired by the creativity and ingenuity of our students.

Afeka robotics YouTube channel

You can watch most of the projects in action on our YouTube channel (usually updated every semester): <http://afekarobotics.com>.