Budget Justification

Table 1 shows the list of requested budget items, personnel and equipment, for the entire project. Table 2 shows the list of equipment items that will be purchased by the School of Engineering for its cost sharing portion. The entire project is anticipated to span two years.

Requested Budget Items	Total Cost of Item
2 Months Summer Salary & Fringe Benefits for C. Karacal	$19,671
2 Months Summer Salary & Fringe Benefits for J. Weinberg	$19,829
1.5 Months Academic Year Salary & Fringe Benefits for J. Weinberg	$14,545
2 Month Summer Salary & Fringe Benefits for A. Hu	$16,090
2 Graduate Assistants Salary	$5,400
LEGO Mindstorms Invention Building Kits	$5,000
Handy Board Robot Controllers	$7,500

Table 1: Budget Requests

Because of the multidisciplinary nature of the project and its effects on multiple departments we are requesting release time for faculty in multiple areas. Dr. Karacal has developed the course on Engineering Problem Solving, a freshmen level course on critical thinking, analysis, and design. It has an integral lab component. During the last year Dr. Karacal has introduced a team robotics projects. With his experience, he will be developing the problem analysis and definition, and integrated systems design components of the course. Further, Dr. Karacal will be working with Dr. Weinberg to design, build, and test the larger team project of the course.

Dr. Weinberg is the founder of the Robotics MPAG. He has introduced robotics projects in the AI course and outreach programs. Besides working on the CS course material and the team project, he will be coordinating the activities of the MPAG. This will include course design meetings, material review meetings, organizing the teaching schedule for the first offering, overseeing the equipment set-up, and directing the graduate student’s work.

Dr. Hu's area of expertise is Mechanical Engineering with industrial experience in robotics. He will be developing the Mechanical Engineering lecture components as well as the hands-on lab activities for this portion of the course.

The Graduate Assistant will be needed prior to the course to set-up the lab equipment, develop and test exercises, and help build the robot project environment. During the class she will help to run labs and provide a resource for students.

Cost Shared Items	Total Cost of Item
Interactive C Software	$900
Additional LEGO Motors	$1300
LEGO Motor Wires	$250
IR Distance Sensors	$1050
LEGO Shaft Encoders	$850
Lever Switches	$50
Photo Cells	$208
LEGO Light Sensors	$100
CUcam Kits	$2,800
Polaroid Sonar Kits	$1,200
Handy Board Expansion Kit	$1,500
Materials for Building Robot Project Environment	$1000
Various Electrical Components such as soldering wire and capacitors	$500

Table 2: Equipment List of Cost Share Items

The equipment budget was developed by referencing the list of materials at CMU's General Robotics Course [24, 29], Swarthmore's Robot Building Lab Project [4, 5], and personal communication with R. Harlan who is the PI on the NSF Grant "Undergraduate Robotics Laboratory" (DUE PIRS #9980999). LEGO blocks are currently the most accessible structural platform that allows students to explore a wide range of design alternatives. LEGO are easy to construct and they have gears and hinges that provide for transfer of energy. They lack the structural support that other building materials would have, but this can be seen as a design challenge as well as an experience of dealing with real-world factors such as stress and friction.

While the RCX controller is very easy to connect motors and sensors, and to program, it has a number of limitations that make it less desirable for an upper level course on robotics [30]. Specifically it has severe limits on the type and number sensors, and the operating systems available for it severely restrict the type and number of variables that can programmed. The Handy Board provides for a larger number and type of sensors. The open nature of the architecture makes it easier to have students create sensors and implement the interpretation code. Further there are number of useful third party tools available, such as those developed at Drexel's Robot Building Lab by L. Greenwald (NSF CISE #9986105).

We note that Kumar and Meeden [5] recommend having a research grade robot for exercises and demonstrations of production and research level robotic control architectures. While the LEGO platforms are good for student lab exercise, they lack structural precision, sensor accuracy, and processing power for such uses. For example, the drift factor of the structural LEGO robots is significant, and the lack of redundant sensor input to account for drift makes accurate navigation impossible. Through a generous state grant last year we were able to purchase two Pioneer Robots by Activmedia, which are a staple in research labs. These will allow us to demonstrate advanced robot control concepts.