Assignment: Design and build a robot to compete in the 2002 Mechanical Engineering Jumping Robot Olympics. Events include the High Jump, Long Jump, and Modified Hurdle Race. During fall semester your assignment will be to design and build a working jumping machine with satisfactory performance for these events. The spring semester assignment will then be to implement computer control to create a robot that can compete autonomously in these events.

Grading: In both Fall and Spring, your grade for the project will be based upon your group's progress throughout the semester, your final robot, and your final presentation (Fall Semester) or final poster (Spring Semester). An individual's project grade will be adjusted based upon that individual's contribution to the team, if necessary.

Groups: Sixteen (16) teams preferably with five (5) students per team. The same teams will be used in both fall and spring semesters.

Event Descriptions:

1. Long Jump: During the long jump event each robot will have two chances to jump as great a distance as possible. As shown in Figure 1, the robots will start 0.5m from the jump line. At the start of the event the robots will jump towards the line. Before crossing the line the robot will jump and attempt to travel as great a distance as possible before contacting the ground again. Forty-five seconds is the time limit each time a robot attempts this event.
2. High Jump: During the high jump each robot will have three chances to jump over a bar raised to a variable height. Similar to the Long Jump, the robot will begin 0.5m away from the bar. It will then jump towards the bar and jump over it. Each team will set the height of the bar at a level that they think they can achieve. The time limit is identical to the Long Jump.

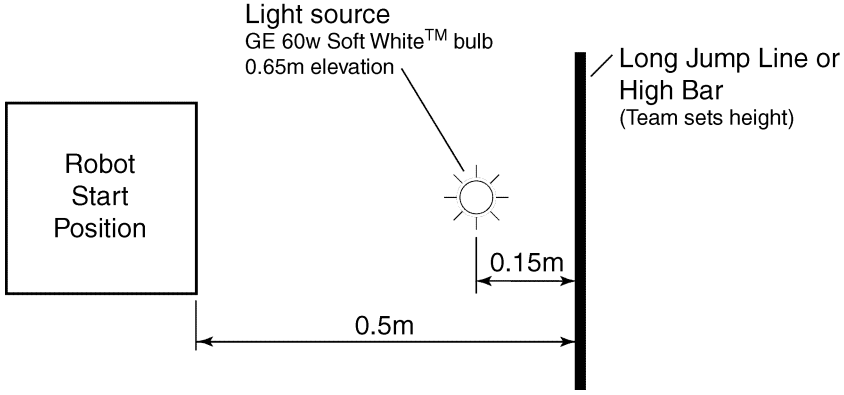

Figure 1. High Jump and Long Jump diagram.

3. Modified Hurdle Race: The modified hurdle race provides the robot with a variety of obstacles that must be maneuvered as quickly as possible. As shown in Figure 2 on the next page, the racecourse consists of a 1.9cm x 1.9cm hurdle placed 0.38m away from the robot starting position, a 20cm cube placed somewhere within the indicated Obstacle Zone, and a finish line located 1.38m from the starting position. The robot must cross the hurdle, maneuver around the cube, and then cross the finish line. This is a timed event that must be completed within 90 seconds. The robot may not leave the indicated boundary of the course. Each robot will have two opportunities to run the course.

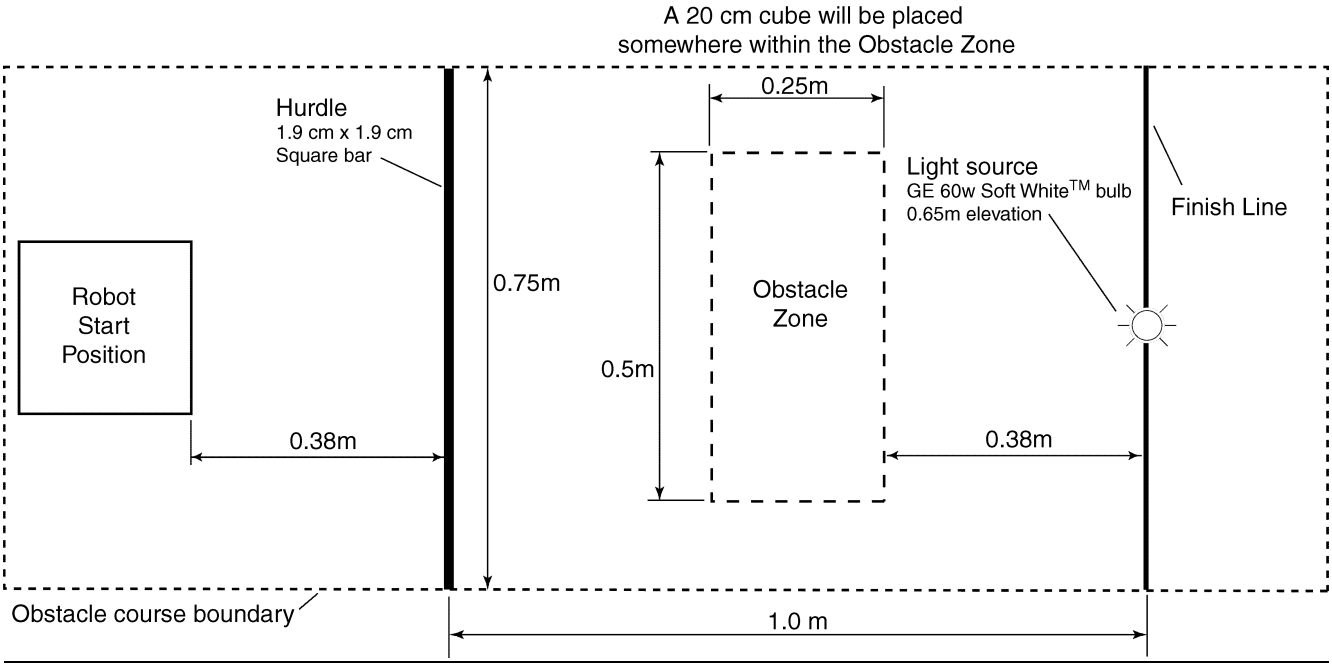

Figure 2. Modified hurdle course diagram.

Rules:

1. Jumping Locomotion Only: During a "jump" the robot must leave the ground entirely and move freely with no external support. This means that for some time period nothing may contact the robot.
2. Cushioning: The Handyboard must be protected from shock loads. Very soft foam that minimizes shock to the micro controller, or some equivalent, is required.
3. No Changes: The robots cannot be changed physically between these events. The only permissible modification is downloading computer code or flipping a switch to change the operating mode of the robot. It is also acceptable to return the mechanisms of the robot to a start position or
4. Exterior Skin: A protective outer skin is required. It must protect all interior components as well as convey the theme of the robot. It must be removable and well secured. Holes in the skin are permissible for the legs, linkages, sensors, access to the controller, etc.
5. Size: The robot must measure no larger than 250mm x 250mm x 250mm.
6. Weight: The robot may not exceed 3 kg.
7. Power source: All robots must use the provided rechargeable battery packs and batteries necessary for the micro-controller. No other energy sources are permitted.
8. Motors: Four motors will be provided for the teams. The preferred motors feature high torque planetary gearboxes that can be configured for various reduction ratios. Further information can be viewed at www.edmundscientific.com by searching for stock no. CR30524-08. Alternate geared motors can be selected from amongst stock numbers CR30813-43, CR30524-06, or CR30524-05. Selection of alternate motors must be made as soon as possible.
9. Autonomy: At the start of each event a team member will depress a switch mounted on the exterior of the robot. No further contact will be permitted. Robots must compete without any user intervention. The robots must also stop automatically after the time limit or completion of the event. See rule #13 below for details on time limits.

10. Manufacturing: Your group must design and build all functional components of your robot. This includes the jumping mechanisms, support frame, etc. Purchased components, such as fasteners, bushings, bearings, bar stock, threaded rods, and straight rods, are acceptable. If you are in doubt about an item, ask the Professor.
11. Budget: Your group is provided with a budget of $100 during Fall Semester and an additional $100 during Spring Semester for buying supplies and components. Motors and gearboxes will be provided. Be sure to check the available resources in the Mechatronics lab and Student Machine Shop before spending money. Net expenditures must not exceed $150 per semester and must be proven via a cost analysis included in the final presentation.
12. Appearance: High quality craftsmanship and finishing is expected. Wires must be neatly harnessed, circuits well organized, and the exterior skin visually appealing (transparency is preferred). A skin that conveys the robot theme as well as showing some interior features is encouraged.
13. Time Limit: A maximum of forty-five seconds will be allowed for setup prior to each event. A separate time limit is provided for completing each event. Forty-five seconds is provided for the long and high jumps, and 90 seconds is allowed for the hurdle race. After the time limit, the robot must cease moving automatically.
14. Automatic Shutoff: After completing each event the robot must stop jumping automatically. This means that after the robot has crossed the finish line it must shut off. Likewise, after completing the long and high jumps, the robot must stop.
15. Points: During each event a robot will earn points based on its performance according to the following equation.

$$P = P_{Long} + P_{High} + P_{Race}$$
$$= 100\frac{d_i}{d_{\max}} + 150\frac{h_i}{h_{\max}} + 200\frac{t_{\min}}{t_i}$$

where h_i, d_i, and t_i are your robot's best jumping height, jumping distance, and obstacle race time, respectively. The parameters h_{max}, d_{max}, and t_{min} are the maximum jump height, maximum jump distance, and minimum race time, respectively, of all the robots in the competition.
16. Awards: Gold, Silver, and Bronze awards will be provided for the teams winning each event. The team with the most points at the end of the competition will have the option of not taking the final exam in ME3210 in spring semester. During fall semester, the team determined to have the most promising jumping machine and best presentation will also have the option of not taking the final exam in ME3200.
17. Open Forum and Subject to Change: If any questions arise regarding details of the competition, they must be addressed in class so as to benefit everyone. If an oversight has occurred, the rules may be amended.
18. Un-allowed conduct: No ejecting, launching, or throwing projectiles. Discarding (which includes dropping, launching, ejecting, or losing) any pieces, parts, components, liquids, gasses, or solid matter is also forbidden. Bottom line: your robot should finish an event with the same physical components intact that it started with.

Provided Supplies: The following will be made available for your robot. You are responsible for all damages. Many of these electronic components are sensitive to electrostatic discharge and care must be taken to ground yourself before handling them!

1. One Handyboard controller. Motorola 68HC11 microprocessor running interactive C, 4 DC motor outputs, 7 analog inputs, 9 digital inputs. See www.handyboard.com for printable manuals. Details on operation will be provided in ME3200. One per group. If it is lost or irreparably damaged, you are responsible for replacing it ($300).
2. Ultra-sonic sensors (one per group)
3. Digital compass (one per group)
4. Infra-red emitter and detectors
5. Motor control kit
6. Rechargeable power supplies
7. Basic electronic components: resistors, capacitors, op-amps, wire, etc.

Resources:

1. Mechatronics Lab: Wiring, electrical components, some fasteners, tools.
2. Student Machine Shop: Metals, tools, machinery, etc…
3. Physics Storeroom: Your TA can arrange to purchase electronics, metals, plastics, and fasteners.
4. Hardware Stores: Bolt & Nut Supply, Fred Meyer, Ace Hardware, Home Depot, Lowe's...
5. Automotive Part Stores: fasteners, adhesives, lubricants, etc. Pep Boy's, Checker Auto Supply…
6. Hobby Shops: materials, fasteners, adhesives…. Check the Yellow Pages.
7. Mechanism Parts: gears, pulleys, timing belts, bearings, etc. Berg (www.wmberg.com), Small Parts (www.smallparts.com), Stock-Drive Components (www.sdp-si.com), McMaster-Carr (www.mcmastercarr.com)
8. Robotics sites: www.mech.utah.edu/~me3200 (links to competition information and how-to pages) http://www.leang.com/robotics/ (links to many interesting robotics sites)

DUE DATES & Meetings:

1. Your group will sign-up to meet with one TA to evaluate your progress at regular intervals. A schedule of available meeting times will be discussed in class.
2. At your meetings, memos describing your progress will be due according to the following schedule. Failure to meet a due date will result in a 5% reduction per week.
3. Schedule of due dates:

Date	Task
Friday Sept 14	Group organized. (Memo due to Prof)
Week of Sept 17	Arrange meeting time with TA.
Week of Oct 1	Discuss and propose robot configurations with TA. Graded based on progress.
Week of Oct 15	Review final design with TA. Solid models and detail drawings required. Expect some suggested changes. Graded based on progress.
Week of Oct 22	Construction started. Order supplies with TA.
Week of Oct 29	Discuss progress with TA. Graded based on progress.
Week of Nov. 5	Progress meeting optional due to midterm. Notify TA if meeting is desired.
Week of Nov 12	Discuss progress with TA. Graded based on progress.
Week of Nov 19	Discuss progress with TA. Graded based on progress.
Week of Nov 26	Prototype Completed. Must demo for TA. Graded based on progress.
Nov 30, Dec 3,5	Presentation of project & demo of jumping machine capability (7-8 minutes per group; slide master due)

Fall Semester Project Grade:

Memos & Meetings	30%
Presentation & Demo	30%
Functional Jumping Machine	40%