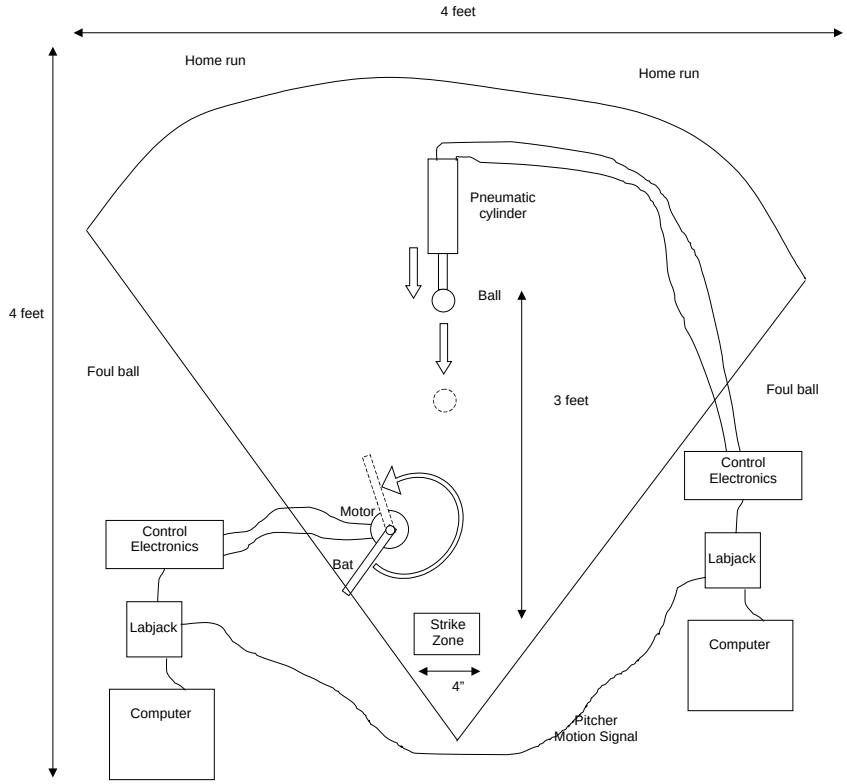
**MAE 106 Mechanical Systems Laboratory**
**Final Project Details 2005**

## HOME RUN DERBY

You will design a robotic system to play baseball. You will design a robot to bat, and a robot to pitch. The setup will be:




The pitching robot will be a pre-built pneumatic cylinder with an integrated, with a 6" stroke length, and a linear potentiometer to sense position. The air into the cylinder will be controlled with a pneumatic servovalve. You don't have to build the pitching robot, but you must write a Matlab computer program to control the servovalve, allowing air into the cylinder so that the pitching robot moves and pitches the ball. The interface to the cylinder will be through a Labjack. You will not be allowed to take the pneumatic cylinder, valve, or Labjack home with you. There will be several pratice fields set up in the lab for testing.

You will make the batting robot using a DC brushed motor and other items in a starter kit. You can control the batting robot using an op-amp circuit, using the Labjack, or using both – it's up to you. You can use a computer algorithm to control the batting robot, or teleoperate it with a potentiometer – it's up to you. To help time the swing of the batting robot, it will receive a copy of the signal from the linear potentiometer on the pitching robot. You will receive a small current amplifier to use with the batting robot (the same one that you are using in Lab7).
**Teams:** You will work in teams of two or three. If you do not have a team, email Prof. Reinkensmeyer at dreinken@uci.edu and he will assign you to a team.

**Competition Time and Place:** On the day of the scheduled final (Tuesday, March 22, 4-6 PM) there will be a tournament testing your robotic baseball player. The tournament will be held in the MAE106 Laboratory (EG 2102).

**Lab Hours:** The lab will be open from 8-12 A.M. and 1-5 P.M. on school days starting February 28th until the contest. If the lab door is locked, you must sign-in with Dave Hartwig in room EG2118 before the lab will be opened. For safety reasons, there must always be at least two students in lab for the door to be opened for you, so bring a partner. While you are in lab, do not leave the room unattended. You are responsible for all laboratory equipment while you are in the lab. Sign-out with Dave Hartwig when you leave.

**Contest Rules:**
1) The contest will be a single-elimination, head-to-head tournament. Two teams will take turns batting and pitching, each getting 10 pitches. The team with the most homeruns will advance to the next round.
2) The approximate dimensions of the course are shown in the figure.

3) You may not modify the mechanical structure of the pitching robot, only its software.
4) The only actuator allowed on your batting robot is the DC motor provided in your kit.
5) You will be given three minutes to set-up your robot.
6) The strike zone will be 4" wide.
7) There will be no wall in the outfield.
8) There will be a connector that can quickly plug the Labjack into your protoboard on the trainer kit. The connector will provide 2 DA channels, 2 AD channels, ground, and the pitching signal.
9) You will receive a specification sheet describing the pneumatic cylinder and valve.
10) The batting robot must be stationary when the "pitch" signal is given (i.e. it can't spin continuously)

**Starter Kits:** Starter kits may be purchased from David Hartwig in EG2118 for $20 beginning Monday February 28, 8 AM – 12 PM, 1 PM – 5 PM. You may pick up the motor today. ***IMPORTANT!: You must return the kit in order to receive your final grade. If the motor or trainer kit is carelessly damaged, you will be required to pay for them (~$200).***

**Other Parts:** You may wish to purchase other components for your project. Suggested vendors are:

- Radio Shack: 4716 Barranca Parkway, Irvine (949)552-1091 (and other locations)
- Marvac Electronics: 2001 Harbor Blvd., Costa Mesa (949)650-2001
- Fry's Electronics: 10800 Kalama River Ave., Fountain Valley (714)378-4400 (and other locations)
- C&H Sales (Pasadena), Ultimate Hobbies, Hobby Shack, Gyro Hobbies, Wright Hardware
- Digikey: www.digikey.com
- Newark Electronics: www.newark.com

**Grading:** The final project is worth 25% of your grade. You can score a maximum of 120 pts on your final project. Your points will be based on:

1. The performance of your robot on the day of the contest
   - +10 pts if you have a plausible circuit and robot, but it doesn't work
   - +20 pts if your robot works
   - +30 pts if you finish in the final four
   - +40 pts if you win the competition
2. A written final project report (80 pts maximum)
   - The goal of the written final project report is to describe your design as clearly as possible, and the effort you put into building and testing the robot.
   - One write-up should be turned in per project group.
   - Your final project write-up should have the following sections:

1. Overview (brief summary of the design project and your controller design) (10 pts)
2. Block diagram of the controlled system (10 pts)
3. Circuit diagrams for the circuits that you built (10 pts)
4. Equations relating circuit and block diagram to controller (10 pts)
5. Methodology for choosing controller gain values (10 pts)
6. Mechanical design features (10 pts)
7. Parts list (10 pts)
8. Testing (Any tests that you performed to calibrate/verify/improve performance -- with graphs) (10 pts)

**INTRODUCTION** by Matt Traum

There it sits, glistening in the morning sunlight. Representing weeks of tears and tedium, a P-controlled car capable of maintaining constant velocity sits upon the drywall track. Every battery has been charged in full, every MOSFET has been tested and retested, and even Op-Amp has a particular gleam to it. The gauntlet was tossed down ten weeks before, and now this tiny warrior is ready to meet the challenge: steady velocity control.

The signal is given. The little racer is off! With calculated precision it accelerates to its predetermined velocity. It passes the first photo gate as it's tires meet the edge of the cliff, the 30 degree sheer incline that must be traversed. The motor screams with all its will as the small warrior climbs the mountain before it. Like the Little Engine that Could, the car puffs its way to the summit.

At the top there is a brief flat rest and beyond, the treacherous downhill. The car begins its decent, nearly slipping on the slick drywall surface. At the bottom, it manages to clear the second photo gate and is free to head for home. Like the finish of a marathon, the termination of a long journey, or the closing scene of a romance novel, the little fighter drives to victory. Its motor purrs with the satisfaction of a task completed and well done. The end of the track is centimeters away; almost within reach.... WHAM!!!