Purpose:
The purpose of this project is to provide an opportunity to apply all that you have learned in CMPE-118 to solve an open-ended problem. The task is to design an autonomous machine that will destroy the most recently completed Death Star, using the Rebellion's deadliest weapon: small foam balls.
Background Briefing:

Remarkably, 25 years later, the Rebellion is still trying to destroy Death Stars. You thought they were home free after the first Death Star went nova in 1977, but another Death Star has been constructed except this time it's got more formidable opposition: CMPE118. However, in a stellar example of bumbling bureaucracy (apparently inevitable in any organization the size of the Empire), exactly the same blueprints were used for both Death Stars, so the new one has the same Achilles' heel as the old one: the garbage chute.

Your mission has a familiar ring: place a bomb into the garbage chute at precisely the right moment. Not only will the target be small and heavily guarded, but you will have to accomplish the task using only your wit, cunning, and recently acquired (or reawakened) mechatronics design skills.

Since each human life is too precious for the Rebellion to risk (and the new stealth X-Wing Fighters have proven too easy to shoot down), this time the Rebellion leaders have decided to hire a design team to build an autonomous vehicle to accomplish the mission. Your CMPE118 team has secured the contract for the project. Following are the specifications for the droid, supplied by the Rebellion Leaders.

Project Specifications:

The droid must be a stand-alone entity, capable of meeting all specifications while connected only to power and ground. Your code must be flashed into the HC12, and for setup purposes, you may be able to communicate to your droid using a standard terminal program. Once operational status is complete, the computer will be disconnected. To make use of this feature, you must be prepared to provide the file to be downloaded to the class TA’s.

The portion of the Death Star that you are attacking is a trench that runs along the equator of the Death Star. (It provides the Death Star Sanitation Department with access to all trash pick-up points.) The trench to the garbage chute consists of a 3’ x 8’ plywood board uniformly covered with green felt. The sides of the trench are constructed of 1” x 6” pine boards, secured firmly to the plywood floor. The trench is heavily guarded by 5 Tie Fighters, spaced down the length of the trench on both sides. Down the center of the trench, there is a strip of black, non-reflective tape, with hatch-marks denoting the 2’, 4’, and 6’ points.

The Tie Fighters are 10” wide and ¼” thick, and carry infrared beacons located at their centerlines, at a height of 13”. Your objective is to shoot the Tie Fighters when they are vulnerable with small yellow foam balls (supplied). A shot will be considered a valid hit if the foam ball makes contact with any part of the Tie Fighter (except the beacon) before the ball bounces. Your machine will be placed in the Start Zone in a random angular orientation at the start of the round. Tie Fighters indicate that they are vulnerable by
turning on their infrared beacon, which modulates at 1200Hz, with a duty cycle of 20%. The Tie Fighter closest to the entry to the trench will become vulnerable first. Once it has been destroyed, the next closest Tie Fighter will become vulnerable. Once a Tie Fighter becomes vulnerable, it remains vulnerable until it is hit with a ball. A shot may not be re-used (i.e. once a ball is used to destroy a Tie Fighter, it can’t be used again for the same purpose). The first (closest) Tie Fighter is worth 10 points. Subsequent Tie Fighters are worth 20, 30, 40 and 50 points.

All 5 Tie Fighters must be hit while they are vulnerable before the garbage chute opens. The garbage chute is has two 12” tall doors, and an infrared beacon at its center line at a height of 13”. The garbage chute doors open to a width of 4”. Simultaneous to the garbage chute doors opening, the infrared beacon above the doors is activated (also modulated at 1200Hz). The garbage chute doors and the beacon will remain on until a yellow foam ball is shot or placed through the opening. Destroying the Death Star by successfully bombing the garbage chute is worth 100 points.

Once you place your droid at the opening of the trench, you have 2 minutes to destroy the Death Star. If you succeed in shooting a ball through the garbage chute doors before 2 minutes have expired, you will have the opportunity to repeat the process as many times as possible before your time expires. Your machine is required to occupy a volume not to exceed 13” x 13” in horizontal dimensions and 12” in height when initiated. Your machine must contain the complete supply of foam balls to be used during the event. At least three are required, but there is no upper limit, except that imposed by the total volume of the machine.

The minimum requirement for the mission is that you destroy the first 3 Tie Fighters. Scoring does not affect grading, but will be used as the basis of a competition between teams. Once your machine has been activated, the operator may not touch it until the entire sequence is complete. During operation, the machine is required to stay within the boundaries of the trench. If the machine makes contact with a Tie Fighter or the garbage chute, it is required to back away at least 3” before continuing with any other activities.

A report describing the technical details of the machine will be required. The report should be of sufficient detail that a person skilled at the level of CMPE118 could understand, reproduce and modify the design.

**Safety:**

The machines should be safe to the user, the lab and the spectators. For this project, excessively high velocity foam ball delivery will be discouraged.

Your machine should not transcend space or time in any way.
**Evaluation:**

Performance testing procedures: All machines will be operated by one of the team members. There will be one round for grading purposes, and one round for entertainment purposes.

**Level 1:** Grading evaluation. Each machine will be graded based on its performance in the testing before the class competition at the end of the quarter. Each machine will have up to 2 minutes to shoot down the first 3 Tie Fighters as their beacons are illuminated. Grading is not based on point value, but is simply a measure of successfully shooting the first 3 Tie Fighters.

**Level 2:** Class Competition. After a few trial runs, each group and machine will be entered into a single-elimination tournament. Each machine will receive points as outlined above for successful shots delivered within the 2 minutes.

**Grading Criteria:**

1. Concept (20%) This will be based on the technical merit of the design and coding for the machine. Included in this grade will be evaluation of the appropriateness of the solution, as well as innovative hardware and software and use of physical principles in the solution.

2. Implementation (20%) This will be based on the prototype displayed at the evaluation session. Included in this grade will be evaluation of the physical appearance of the prototype and the quality of construction. We will not presume to judge true aesthetics, but will concentrate on craftsmanship and finished appearance.

3. Report (10%) This will be based on an evaluation of the written report. It will be judged on clarity of explanations, completeness and appropriateness of the documentation.

4. Performance (20%) Based on the results of the performance during the evaluation session.

5. Design Evaluations (30%) Based on the three project milestone reviews.

**Project Milestones:**

**First Review:** 12-May-2005, Presented in Class (using overhead projector).

At least 5 concepts with:
- Sketches
- Time schedules
- Personnel assignments
Second Review: 19-May-2005, Presented to TA’s or Instructor

Deliverables are:
- Calculations
- System Block Diagram
- Preliminary Test Results

Third Review: 26-May-2005, Presented to TA’s or Instructor

Deliverables are:
- Working versions of all systems.
- Working software to test all systems.
- Integration of systems.

Specifications Check-Off: 02-Jun-2005, to TA’s or Instructor

Deliverables are:
- Droid must be fully functioning stand alone machine that can kill the first three Tie fighters in under two minutes.

Final Presentations: TBD, Finished, operational machines, fun performance for SOE audience.