

ENG H193 Engineering Fundamentals and Laboratory III

Spring Quarter 2009

Design Problem Statement and Specifications

This document is the compilation of the design problem statement, rules and specifications for the Engineering H193 course for Spring Quarter 2009. It is up to date as of this revision, Revision C, dated 05/06/2009. If changes to this document are necessary, a new version will be released. Students should note that while the basic rules and general specifications will not change, some modifications might become necessary as the quarter progresses. Every attempt will be made to make this design project as realistic as possible. Any rule changes will be communicated during the regular class periods, through e-mail to all students, and will be reflected in revisions or addendums to this document or its appendices.

Notice: It is assumed that all students enrolled in the ENG H193 course have read and understand this document. It is up to the student to clarify any points that may seem unclear. All rules given in this document will be strictly enforced. An excuse of "I didn't know" simply will not be accepted. Students are directed to contact their course instructor for official clarifications. In some cases, points needing further interpretation and explanation will be discussed among the instructional faculty before a clarifying rule explanation or change will be issued.

I. PURPOSE/BACKGROUND

The Scenario:

You and your team of engineers are known as the best in the robotics business. The Enterprise Allowing Research To Happen Which Oversees Robotic Mining, or EARTHWORM, has recently received a new mandate for automated mining operations. The EARTHWORM hopes to simultaneously gather prospecting data on mine content, via ore body sampling, and with mine maintenance activities, via structural repairs. To assist with carrying out such activities, the EARTHWORM hopes to develop a fleet of self-navigating robotic assistants that are able to aid in mining operations and reduce the time spent in dangerous subterranean conditions. The EARTHWORM has therefore commissioned The Ohio State University Research and Engineering Development (OSURED) team to help select one of the prototypes of the Delightful Research Operations Integration Drone, or DROID, being offered by several competing companies. The DROID will be commissioned for service in the Minerals In Natural Environment, or MINE, located deep below the earth's surface. This prototype will be the forerunner to the fleet of robots that will help to gather data and improve conditions in other mines in the future.

In order to determine which DROID would best serve its purpose on the MINE, OSURED has constructed a scale model of the MINE environment on which each DROID will be tested. The DROID will be evaluated on its overall design and performance in the MINE course simulator. The DROID will be expected to complete its tasks in a timely and energy efficient manner.

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The MINE scale model is designed to accommodate up to four DROIDS operating at a time, each competing against the others to successfully complete its tasks more efficiently. Each DROID will begin within its respective MINE area. At the start of the simulation, the four DROIDS will simultaneously receive a signal to begin operations. Each DROID will then move out across the surface of the MINE to complete the following tasks. Each DROID's MINE section is defined by the area upon which the DROID begins the round and the portion of the center section immediately to the left of that DROID's starting section.

In order to leave the start area, each DROID must detect the start signal and proceed down the Reverse Ascent Mining Platform, or RAMP. DROIDS will be evaluated on their ability to complete the tasks outlined below. The order of the tasks may be changed, but some tasks depend on the completion of other tasks.

Each DROID begins the simulation preloaded with a Device Yielding Noise And Making Impassable Things Explode, or DYNAMITE. The DYNAMITE must be placed within the Blaster of Large Alloy Stones To Zillions of Nice Elements, or BLASTZONE. The DYNAMITE must be placed properly so that it may be properly detonated within the mine.

Once the DYNAMITE has been placed, the DROID must proceed to the Device Effecting Total Obliteration Now Accumulates Tons Of Rocks, or DETONATOR, and activate it. The DROID must be clear of the BLASTZONE as the activation of the DETONATOR will detonate the DYNAMITE, resulting in a contained explosion that generates Distributionally Even Boulders' Resultant Inclined Slope, or DEBRIS. The explosive charge will be detonated by the DETONATOR whether the DYNAMITE has been successfully placed or not.

Each DROID should then traverse the DEBRIS and collect the Gleaming Expensive Mineral, or GEM, from the newly excavated MINE area. The GEM type (red or blue) should be determined upon collection by the DROID. This information will be used to place the GEM in the correct Receptacle Occupied by eXtraordinary Boulders or Other eXcavations, or ROXBOX. While the two ROXBOX or bin locations are fixed, the type assignment (red or blue) of each is unknown and randomized and thus must be determined by the DROID.

To ensure MINE corridor stability, each DROID must be capable of carrying out routine maintenance. To do this, each DROID should repair a section of a Wobbly Abutment for Large Loads, or WALL, that is in need of reinforcement. To do so, the WALL must be repositioned against the Really Unstable Boulders, Bumps, and Lumpy Earth, or RUBBLE, to prevent further damage.

Upon completing its research activities, each DROID must return to its starting location in the MINE within the area bounded by the RAMP and mine walls.

OSURED has contracted your design company on the basis that it is one of the best in the field. Utmost ethical behavior is expected at all times and OSURED reserves the right to deny contracts to companies that violate this trust. All rules set forth in this document, along with any additions or addendums to this document, are to be followed, but remember that successful design teams use the

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rules to their advantage. This is a competition between many independent companies and proprietary information should be kept within your company. Leaked information can ruin your technical superiority over other companies. Finally, have fun.

A NOTE TO THE STUDENT

The process of engineering design is more than just tinkering...it is the logical application of scientific principles to a tangible design. It involves creativity, dedication, thought, research, ingenuity, and work. The purpose of this design project is to introduce you, the student, to the principles and practices involved in an engineering design project. It may very well be your first experience in "real world" engineering. It is unfortunate that many students in engineering do not get this type of instruction. This course will be quite different from any you may have taken thus far, and will give you experience in areas that other courses cannot. This quarter, you will be required to design and build a robot. You will be evaluated during all phases of the development work. Your grade will reflect a combination of your performance in the design process, your demonstration of both written and verbal communication skills, your ability to work in a team environment, and the performance of your team's robot in the contest. It will be predominately a team effort. Therefore, a good grade can only be achieved by working out a competent design and then implementing it as a team.

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II. OBJECTIVES

The main objective for each team is to build a self-controlled, self-contained, and self-propelled robotic vehicle that will travel over a well-defined course. Along the way, each robot will have to start when the light in the floor of the start area turns on, navigate through the course, and complete the required tasks. Teams will be scored based on their design and how well it performs in both individual and head-to-head competition runs. Refer to the *Points Distribution for Individual and Head-to-Head Competitions* section at the end of this document.

Each team is expected to build a robot to traverse any area of the course. Extra emphasis is placed on reusability. Therefore, any external apparatus or sacrificial parts should be used with prudence. The contest officials will confiscate any parts that are not attached to the main robot frame at the end of a competition round at their discretion. It may be assumed that as many as five (5) runs during the final competition will be necessary, so a sufficient quantity of any sacrificial parts must be included for competition and must be reflected in the cost of your design. (It will probably take less than five runs in the final competition, but five will be used as the basis for determining the cost of disposable or sacrificial parts.)

III. DESIGN SPECIFICATIONS

A. Hardware

The hardware for robot construction must meet the criteria set below. No exceptions will be allowed. If any question exists, the decision of the "OSURED Enterprises" engineering staff (i.e., the H193 course instructors) will be final. **When in doubt, ask first.** The "spirit of the contest" will be used as a deciding factor if necessary.

Budget: Each team will have a discretionary budget of \$160. Each team will also be loaned a programmable controller board and issued a set of basic sensors. The actual cost of purchasing parts will be borne by the Engineering Honors project. Purchases made by a team will automatically be charged to that team. All project purchases must be made through the Fundamentals of Engineering for Honors (FEH) Program "Company Store". NOTE: If your team feels it is necessary to obtain external parts in these areas, you **MUST** have pre-approval from a member of the Engineering Honors Program instructional staff before purchasing these parts. Without prior approval, you will not be reimbursed, and the use of these parts may be prohibited in competition. All externally acquired parts must be reported to the Company Store before the part is installed on the robot. The Engineering Honors Program staff will NOT spend time troubleshooting problems caused by "external" parts. Thus, if you choose to buy them, you are on your own. As described later, there will be bonus points for those robots that are constructed under-budget, and penalty points assessed for robots that are over-budget.

Controller: Each team will be loaned a programmable controller board, issued a copy of the controller / language documentation, and provided access to the programming environment during

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Week One. Additional copies of the documentation may be downloaded from the web from the FEH website or <http://www.handyboard.com>. Any physical modification to the controllers is strictly prohibited, including the removal/remote positioning of the display screen. Teams must not attempt repair work on their controller. Controller repair request forms will be provided. The specifics of the controller and programming will be addressed separately.

Structural: Using their discretionary budget, each team may purchase for use in constructing its robot either an Erector™ Motion System 20, PVC pipe and adhesive, PVC sheet welded into structural shapes, or a combination of these. Other structural materials including wood and sheet metal are also possible.

Adhesives and paint: Adhesives like hot glue or duct tape are not intended for use as primary structural material and should be used sparingly. This is not a competition in duct tape or hot glue. Since unanticipated design modifications may likely require some disassembly, it is reasonable and recommended to use standard fasteners that may be removed to facilitate assembly and disassembly of various robot components. An example of an allowable (but not necessarily recommended) use of adhesives is the mounting of some sensors. Contest officials will usually have hot glue, wood glue, PVC adhesive, and common white glue available. The "Company Store" has lengths of solder and small packets of epoxy available at a nominal cost, and if these are purchased through the "Company Store", they will be charged to the team budget. These items and any other adhesives or paint may be independently obtained by a team as it deems appropriate, and when either adhesives or paint are independently obtained, the cost will not be charged to the team budget but must be shown in the robot parts list.

DC Motors: The Engineering Honors Program staff has identified certain motors that are relatively reliable and which, with modifications or voltage adapter kits, will not cause controller board reset problems. Some of these are in stock, and others can be special ordered and will arrive reasonably quickly. Other motors may be used, but prior faculty approval must be obtained and making them reliable will be the responsibility of the team choosing such motors.

Parts: **All parts** will be obtained through the purchasing system set up by Engineering Honors Program. Certain items will be "in-stock" at the Engineering Honors Program "Company Store," while others may have to be obtained by special order. Be sure to order parts early to ensure timely delivery. When parts are special-ordered through the "Company Store," only the cost of the parts will be charged to the team budget. No part should be placed onto a robot until a Company Store order form has been filled out and placed on file with the Store.

Motors/Sensors/Gears: A sensors kit will be provided that includes a CdS cell, an RF receiver, an optosensor, two microswitches or touch sensors, and an IR beacon. A DC motor and a servomotor will be provided for the three hands-on laboratory exercises, but they must be returned unless purchased by the team. All motors, other sensors, gears, and other non-structural parts will be obtained through the "Company Store" purchasing system. A selection will be available for immediate purchase. Catalogs will be available for finding specific special order items, or teams may search the Internet. However, delays due to shipping or availability will be the team's problem.

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Reproducibility: The main criterion in the hardware design will be reproducibility from team drawings. Drawings must show all features of the robot. Contest officials will review each team's drawings, and undocumented features may cause deductions in the overall team score.

B. Robot Design and Construction

The robot must be self-propelled, and all movements must be made independent of outside signals, except those signals purposefully generated by devices that are part of the course. The contest officials will have the final word in deciding what constitutes self-propelled and independent.

Definitions: The following definitions will be used in discussing the robot design and construction.

- * Structure: All structural parts providing support and strength to the robot and the subframe. This includes all cosmetic structures.
- * Sensors: Any mechanical or electronic device used in gathering or distributing information within the environment.
- * Drive System: The direct energy transfer system from the power source (battery, solar, chemical reactor, or fusion or fission reactor device) to the wheels (or application of force to the outside world via other drive surfaces). This includes all housing pieces, but does not include mounts to the chassis. Any means may be used to propel the robot, providing that the robot is safe to operate and does not damage the course or the laboratory environment.
- * Size/Shape: The robot, in its starting configuration, must be able to fit within a footprint no larger than 9 x 9 inches and must be no taller than 12 inches.
- * Starting Action: The robot will start at rest in the starting area of the competition course. It should start upon recognition of a light signal emanating from a high-intensity light in the floor of the starting area.
- * Photocell Sensor: Each team will be issued a photocell (CdS) cell that may be used as a light sensor. It is recommended for use as a light detecting device, although it may be used in place of an optosensor under certain lighting conditions.
- * Optosensor: Each team will also be issued an optosensor that may be used to determine whether a surface is dark colored (non-reflective or “black” surfaces) or light colored (reflective or “white” surfaces). The controller program may, for example, use the signal from the optosensor to determine when the robot crosses over certain navigational aids or markings on the floor of the course.
- * RF receiver: Each team will be given a RF receiver that is prewired to the Handy Board expansion board. Documentation and a code library will be provided describing how to use the RF receiver. Several pieces of important information will be transmitted via RF to the robots

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during competition, some of this information must be used by teams and other information is optional but helpful. UNDER NO CIRCUMSTANCE MAY A ROBOT EMIT AN RF SIGNAL that interferes with the RF system used to transmit contest scenario information.

- * GPS: A Geological Positioning System, or GPS, transmits position and orientation information via RF to each robot. The accuracy of the position information will no worse than ± 1 inch. The accuracy of the orientation information will be no worse than $\pm 10^\circ$. The GPS information will be refreshed and transmitted to each robot at least once per second. Documentation describing how to receive the GPS data will be provided.
- * IR Beacon: Each team must attach an IR locator beacon to its robot to allow the GPS system to detect and track the robot. The IR beacon must remain ON for the entire match and must meet design constraints that will be provided in the GPS documentation. Use of the data provided by the GPS tracking system is optional, but the IR locator beacon must be installed and activated. The position data will be referenced to point centered between the two IR emitters on the IR beacon. Note that other electrical system components such as optosensors and shaft encoders also emit IR and must be shielded to prevent any interference with the IR Beacon. UNDER NO CIRCUMSTANCE MAY A ROBOT EMIT AN UNSHIELDED IR SIGNAL that interferes with the GPS system.
- * Robot-to-Robot Interaction: Robots may be designed to interact within the rules set down in the section governing the Robot-to-Robot Interactions during the head-to-head competition.
- * Loose or Disposable Parts: Any parts that were intentionally or unintentionally dropped or lost during a single run may be confiscated for the rest of the run at the discretion of the course officials. This definition includes robot parts that are loosely connected to the robot at the end of a match. All non-disposable parts of the robot must be able to be removed from the course by lifting from a single point. Anything dangling while the robot is lifted in such a way will be considered disposable. (Your team will need to account for the cost of five (5) copies of each part intentionally dropped and the cost of the five copies must be included in your robot cost.)
- * Construction: The team members must perform construction of the robot. No outside help is allowed, except for approved consultation or direction. Consult with the Engineering Honors Program staff before soliciting ANY outside help. Use of unauthorized outside help may result in team disqualification.
- * Etceteras: Robots may not perform any action that could potentially cause harm to the viewing audience. Also, robots may have no outside influence or assistance. Any such outside interference may result in immediate team disqualification. In any case, a robot's run shall be considered terminated at the point where it is first touched, assisted, or influenced by a team member.

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IV. CONTEST RULES

The contest rules current as of this revision are as follows. Teams will be notified of any changes or revisions. Students needing clarification on rules should direct their questions to the course instructor or GTA. Major questions requiring the attention of the OSURED Executive Board can take up to a week to be answered.

A. Overview

The contest will be divided into two distinct sections. Each team will have a chance to demonstrate their robot's capabilities in an individual competition. The individual competition will be used to seed the teams for the head-to-head competition. A head-to-head competition will be held to determine the robot with the best performance. Both competitions will contribute points to the overall team score as a component of the ENG H193 course grade.

The individual competition section of the contest will be held during the eighth week of the quarter. The head-to-head competition will be held during the ninth week of the quarter. Each team will receive a schedule of events for the head-to-head competition day during the first week in May. The contest is open to the public. However judges, teams, and officials will have the right to move any spectators or participants out of the way if necessary.

B. Contest Course

The contest course layout will be shown in drawings supplied separately. Key features of the course are described in the following sections. The course is roughly in the shape of a "plus" sign with an enlarged center, which fits within a 12' x 12' footprint. It has been constructed primarily of wood, plastic, plywood, and Lexan sidewalls. It has relatively smooth, plastic horizontal surfaces. A Lexan wall surrounds the course on all sides. Each course contains four essentially identical sections. The course is built to be as precise as possible, given the materials. Some minor variation is to be expected and it is the responsibility of each team to accommodate for these discrepancies. All measurements detailed below are approximate.

Starting Areas: A robot will start on one of four designated starting areas in an orientation determined by the robot team. Embedded in the starting area floor is a high-intensity light, the "starting light". Activation of the light in the floor will signal the beginning of a run. A robot's starting location for any run will be chosen randomly just prior to the beginning of that run. Each robot will need some way to determine the side of the course on which it has been placed. (See "Starting of a Run" in Section D below.)

DYNAMITE: The DYNAMITE to be deposited by each DROID is simulated by three .625" diameter by 3.125" red cylinders held together by two black bands. The DYNAMITE may be loaded anywhere on the DROID prior to the beginning of the simulation. The DYNAMITE must fit within the starting configuration of the DROID.

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BLASTZONE: For maximum points, the DYNAMITE must be deposited within the BLASTZONE, which is demarcated by three aluminum rails and the edge of the undeployed DEBRIS ramp. The area of the BLASTZONE is approximately 6.5” by 22”. DYNAMITE counts as being within the BLASTZONE if it is entirely within the planes of the outer edges of the BLASTZONE rails, excluding the wires.

DETONATOR: The DETONATOR is a 2” red cube with an approximately 1.25” tall black ‘T’ at the top. The DETONATOR is pressed by moving the ‘T’ from its original position downwards approximately .5”.

DEBRIS: The DEBRIS is a 9.5” by 27.5” ramp that begins the simulation in the vertical position. Upon depression of the DETONATOR, the DEBRIS will deploy within two seconds, creating a ramp that allows access to the GEM. If the DYNAMITE is placed poorly, it may prevent the full deployment of the DEBRIS, making GEM access difficult or impossible.

GEM: The GEM is a crystalline rock in a traditional round diamond shape, approximately 1.5” in diameter. The GEM is accessible once the DEBRIS has been deployed by the DETONATOR and is positioned on top of a 1.38” diameter circular setting, which is a steel eye-bolt approximately 2” above the surface of the raised platform. A 1” diameter red or blue light located in the floor directly in front of the GEM indicates which type of GEM is present. The color of the light will change each round and is randomized.

ROXBOX: The ROXBOX is two bins, approximately 5” by 4” each, which share a common wall. Each bin has either a red or blue 1” diameter light directly in front of it, and each DROID must deposit the GEM in the bin that has a light corresponding to the color associated with the GEM. Which light corresponds to each bin will change each round and is randomized.

WALL: The WALL is approximately 3.75” by 12” and approximately .75” thick at its maximum. It begins the round in a horizontal position and is attached to the course by a hinge. DROIDS must repair the WALL by raising it to a vertical position. The WALL must remain in the vertical position after the DROID loses contact.

MOM: Throughout the simulation the Mining Operations Manager, or MOM, will be transmitting information via RF to each robot. Several pieces of important information will be transmitted via RF. Some of this information must be used by teams and other information is optional but helpful. The RF transmission will start at the beginning of the match and will contain the following data:

1. Whether the DEBRIS ramp has been deployed
2. Position and orientation data for robots
3. Stop indicator

Using the GPS data for position and orientation for navigation is optional. The MOM will transmit a stop indicator to all of the robots at the end of the two minute simulation.

Fortunately for the OSURED teams, an Interactive C function for receiving the RF signal data has been written and will be provided with documentation. This code must be loaded on all DROIDS.

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MINE control system: The MINE is computer-controlled by the Little-appreciated but Very Involved Executive Wizard System (LabVIEW System). This system controls the starting lights, the MOM's RF transmitters, the GEM type, the ROXBOX type designation, and the detonation that releases the DEBRIS. For testing, teams will be given access to a LabVIEW System as part of the testing course so that they can test and debug their robots. Any attempt to modify or affect the behavior of the LabVIEW System will result in disqualification from the competition. Tampering with course wiring or control circuitry is strictly forbidden.

C. Time Limits

Individual Competition: Each team will have one minute to set up their robot before each run. Each run will last 120 seconds from the time that the start light/signal is activated. One minute will be allowed for removal of the robot and any disposable parts after run completion while the next run is being set up.

Head-to-Head Competition: The time limits will be the same as in the individual competition. However, the run start will be coordinated so that the robots start simultaneously.

In the head-to-head competition, all robots will be required to run the "RF Signal Code," which enables the MOM to restrict a robot's running time to the specified time limit. The "RF Signal Code" and instructions for its usage will be available from the H193 Resources web site. Failure to load and execute the "RF Signal Code" may be grounds for disqualification from the competition.

D. Starting of a Run

To start a run, a team will receive a go-ahead signal from the starting official or course master. After that signal, a team member will be allowed to perform the start preparation action(s). The team member will then be directed where to place the team robot. It can be placed anywhere within the starting area and in any orientation at the discretion of the team, provided some portion of the robot's footprint is located directly over the starting light/signal. ONCE THE ROBOT HAS BEEN POSITIONED AS DESIRED AND THE START PREPARATION ACTION(S) HAS (HAVE) BEEN PERFORMED, NO FURTHER INTERACTION WITH THE ROBOT WILL BE PERMITTED.

At the course master's discretion, the starting light/signal will be activated. This will be the start signal a robot must use to begin the run. A ROBOT THAT DOES NOT WAIT FOR THE START SIGNAL WILL BE DISQUALIFIED FOR THE RUN UPON COMMITTING ITS SECOND "FALSE" START.

Between runs, maintenance and battery charging will be allowed on a robot, but not major repairs. Screws and nuts may be tightened, but only approved parts may be added, removed, or re-attached. Controller software may be reloaded. Failure to comply with these rules may result in immediate disqualification.

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E. Individual Competition

On **Wednesday, May 20, 2009**, the individual competition will be held in the class laboratory during the regular class period. This competition will be closed, so only the ENG H193 students and instructional staff will be present. Each team will have a total of three opportunities to demonstrate robot performance on an individual basis. Only one robot will compete at a time in these demonstration runs. The objective is to display the robot's capabilities without any outside influence or interference.

Scoring for the individual competition will be based on the points earned for finishing the course including, starting on command, navigating the course and completing tasks properly. See the attached *Points Distribution for Individual and Head-to-Head Competitions*. In addition to receiving points for successfully navigating through the course and performing the specified "Robot Actions", each robot will be awarded extra points (positive or negative) according to the schedule of "Object Scoring" points in the attached *Points Distribution*. "Object Scoring" points do not count toward the ENG H193 course grade, but are counted for purposes of helping to determine a winner in the competition. Only points earned for "Robot Actions", "Penalties", and "Bonuses" as described in the *Points Distribution* document are included in the Engineering H193 course grade.

F. Head-to-Head Competition

On **Thursday, May 28, 2009**, the head-to-head competition will be held at St. John Arena. The "public" runs are expected to begin promptly at 4:00 PM and should finish by approximately 5:30 PM. At least one team member and the robot must be present at 11:00 AM to compete in three rounds of preliminary round-robin "pool" play matches. All team members should be present by 3:30 PM. These times are subject to modification.

The head-to-head competition, with seeding to be determined from the results of the individual competition held a week earlier, will be a single-elimination championship round. Four robots will compete simultaneously in each run. The winner will be the robot that has accumulated the most points during the run. In the event that two or more robots accumulate the same points, the robot correctly completing the tasks in the shortest amount of time will be declared the winner.

Scoring for the head-to-head competition will be based on points for completing various tasks including: starting when a signal light goes on, navigating through the course, and completing prescribed tasks as specified. Points will be determined according to the attached *Points Distribution for Individual and Head-to-Head Competitions*. In addition to receiving points for successfully navigating through the course and performing the specified "Robot Actions", each robot will be awarded extra points (positive or negative) according to the schedule of "Object Scoring" points in the attached *Points Distribution*. "Object Scoring" points do not count toward the ENG H193 course grade, but are counted for purposes of helping to determine a winner in the competition. Only points earned for "Robot Actions", "Penalties", and "Bonuses" as described in

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the *Points Distribution* document are included in the Engineering H193 course grade. In the event that no robot is able to complete all prescribed tasks within the allotted time period, the robot that accumulates the most points, which may generally correspond with furthest progress along the course, shall be declared the winner of the match. In the case of a numerically tied score, judges may consider whether one robot made "further progress" than any other robot. Judges may elect to declare a winner or declare the match a tie. If a tie is declared between two or more robots, the match will be re-run from the beginning with all four robots. The decision of the judges will be final.

IMPORTANT: On a day to be announced, all robots will be subject to a **TECHNICAL INSPECTION** by the Engineering Honors Program staff. Robot dimensions will be measured for compliance to regulations. Also for this inspection, each team must produce a complete list of parts contained on the robots, with suitable prices for each item or kit of items if they were part of a kit or set. Prices for small items such as glue, string, tape, etc. will be assigned by the Engineering Honors staff and should be handled prior to the inspection. Any parts not included on the parts list must be removed from the robots immediately. Absolutely **NO** modification of the hardware is allowed following the technical inspection through the final competition event or from the event until the technical inspection without approval of the judges. Violation of this stipulation will be cause for disqualification and may constitute academic misconduct.

G. Robot-to-Robot Interactions

Robot interactions will be allowed within the following framework:

- * Each robot will have a "personal space" defined as the original 9" x 9" footprint for the robot plus the space for up to two support arms or mechanisms that may extend outside the original footprint. This space will travel with the robot, relative to the center of the robot. If any question arises as to the interpretation of this space, the contest judges will have the final word.
- * A robot **MAY** interact with another robot as long as the interaction takes place within the robot's personal space, and the interaction does not violate any other rule. This may include, but is not limited to, passive interference designed to confuse, block, or impede an opposing robot. Intentional collisions may be deemed flagrant and be subject to consequences determined by the judges or course master. Under no circumstances may any robot interaction occur until after two interacting robots have each left their designated starting location.
- * At no time may a robot engage in an act or maneuver judged either to show either "a flagrant disregard for another robot's safety" or to be "intentionally damaging". This may include, but is not limited to, excessive speed, electric or magnetic charges, swinging of a support arm with intent to harm, firing or launching of projectiles directly at or toward another robot, and intentionally placing objects in the path of other robots. A robot judged to have violated this rule would suffer appropriate consequences as determined by the judges or course master.

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* Any interactions that fit within these guidelines may be considered acceptable. However teams should realize that the contest judges and course masters may interpret these rules conservatively and their decision will be final.

H. Points and Scoring

Each team's final robot performance score to be used in calculating the ENG H193 grade will be the sum of the points earned in their best individual run (but not exceeding 50 points) and in their best head-to-head run (but not exceeding 80 points), plus any bonus points for competition placement. The score from a match will be calculated after all objects have come to rest at the end of a match. Interference by competitors during competitions is grounds for disqualification from that round.

Individual Competition Bonus Points: The team whose robot earns the largest number of points or completes all the assigned tasks in the shortest period of time will be awarded 15 bonus points. The individual competition bonus points will be awarded on a per-section of ENG H193 basis.

Head-to-Head Competition Bonus Points: The team winning the competition will be awarded 50 bonus points. The second place team in the competition will be awarded 35 bonus points. The third place team will be awarded 20 points, and the fourth place team will earn 10 points.

In addition when computing a team's final grade, the robot performance score total determined above will be adjusted according to the following budget management criteria:

Cost of Project: Any robot with a cost greater than the \$160 budget amount will lose 1 point for each \$0.50 increment over-budget. As a cost-saving incentive, teams will be awarded 1 bonus point for every \$2.00 under the \$160 total budget amount. During the technical inspection, robots will be checked for any pieces or parts not accounted for in the team budget, and may be penalized for any unaccounted parts. This penalty could include disqualification or forfeiture.

Sell-Back of Unused Parts: For in-stock parts purchased through the Engineering Honors Program "Company Store", teams can "sell-back" any unused parts for 75% of the purchase price to be credited toward their budget total. Note that any special order parts receive NO buyback credit. No electronic parts, sensors, or motors may be sold back because the store has no way of testing that they are still functioning. This "sell-back" provision does not apply to any excess parts left over from any kit or set of parts such as an Erector Set or tread kit or any other such kind of kit. An unused kit complete with all its parts may be sold back. The company store employees have final say as to whether a part can be sold back.

I. Testing

Teams will have access to the course when they are ready to test their robots. Each team must keep a log of the amount of actual testing time used on the course as part of their project documentation. Entries in the log should show day and time, purpose of test, name of engineer conducting the test,

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and number of minutes used. This log must be summarized in the team's final report and included in detail in the team notebook. In many real-world situations, such testing time must usually be paid for and is often limited in availability. While there will be no cost associated with testing time for this project charged to a team's budget, and while testing time will generally not be limited, a log of testing time used is required.

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2009 FEH Robot Competition

Points Distribution for Individual and Head-to-Head Competitions

Robot Performance Grading

Robot performance will be graded according to the following actions for the Individual Competition and the Head-to-head competition as indicated below:

<u>Robot Action Scoring</u>	<u>Individual</u>	<u>Head-to-Head</u>
Start with light signal (Note 1)	5	8
Descend RAMP (Note 3)	5	8
Deposit DYNAMITE (Note 4)	5	8
Touch DETONATOR (Note 5)	5	8
Traverse DEBRIS (Note 6)	5	8
Collect GEM (Note 7)	5	8
Place GEM in ROXBOX (Note 8)	5	8
Touch WALL (Note 9)	5	8
Repair WALL (Note 10)	5	8
Return to start area (Note 11)	5	8
Maximum Possible Points (for course grade)	50	80
<u>Object Scoring (not included in course grade)</u>		
Deposit DYNAMITE in BLASTZONE (Note 12)	6	9
Push DETONATOR (Note 13)	7	10
Place GEM in correct ROXBOX (Note 14)	8	11
<u>Penalties (included in course grade)</u>		
Disturbing competitor's objects (Note 15)	-10	-20
<u>Bonuses (included in course grade)</u>		
Fastest time completing the tasks OR Farthest progress out of all teams	15	n.a.
1 st Place - Winner	n.a.	50
2 nd Place - Runner-up	n.a.	35
3 rd Place	n.a.	20
4 th Place	n.a.	10

2009 FEH Robot Competition

Points Distribution for Individual and Head-to-Head Competitions

Notes and Clarifications:

- 1) "Start with light signal" is defined as the robot starting immediately when the light comes on (and not before and not more than three seconds after) and moving entirely away from the starting light such that no part of the robot footprint is directly over the starting light. A robot that does not wait for the start signal will be disqualified upon committing its second "false" start.
- 2) "Start area" is defined as the raised area bounded by the RAMP and the outer Lexan course wall. The RAMP is not considered as part of the starting area.
- 3) "Descend RAMP" is defined as moving entirely out of the starting area and down the RAMP. No part of the DROID can be touching the RAMP. A DROID does not have to "start with the light signal" in order to receive points for "Descend RAMP."
- 4) "Deposit DYNAMITE" is defined as the DROID depositing the DYNAMITE in any part of the square center section. DROIDS do not have to successfully place the DYNAMITE within the BLASTZONE to receive points for "Deposit DYNAMITE."
- 5) "Touch DETONATOR" is defined as the DROID coming into contact with the DROID's assigned DETONATOR. The red cube and black handle are considered the constituent parts of the DETONATOR.
- 6) "Traverse DEBRIS" is defined as the DROID being entirely on the sloped area of the DEBRIS ramp that falls upon detonation of the blast charge. The DROID must be entirely on its assigned DEBRIS ramp, which means that all wheels and driving surfaces must be completely on the ramp.
- 7) "Collect GEM" is defined as the DROID controlling its assigned GEM. Controlling the GEM is defined by carrying or pushing in a manner such that the movement and location of the GEM is controlled by the DROID. Upon GEM collection, the DROID should determine which type (red or blue) it has collected.
- 8) "Place GEM in ROXBOX" is defined as the robot depositing the GEM in one of the two ROXBOX sections in its assigned course area. The GEM must be contained entirely within the ROXBOX, which includes the metallic ROXBOX frame.
- 9) "Touch WALL" is defined as the DROID making contact at any time with the WALL in its assigned course section.
- 10) "Repair WALL" is defined as the DROID pushing the fallen WALL segment back into alignment with the remainder of the retaining wall. The WALL must remain upright after the DROID loses contact with it for the WALL to be considered repaired.
- 11) "Return to start area" is defined as the DROID being in its start area at the end of a match. The DROID must be entirely inside the start area as defined in Note 2.

2009 FEH Robot Competition

Points Distribution for Individual and Head-to-Head Competitions

- 12) “Deposit DYNAMITE in BLASTZONE” is defined as the DYNAMITE remaining within the DROID’s correct BLASTZONE at the end of the match. DYNAMITE is considered within the BLASTZONE if it is entirely within the planes of the aluminum rails and edge of the DEBRIS demarcating the BLASTZONE, excluding the wire connected to the DYNAMITE. DYNAMITE remaining on the DROID will be awarded points only if the entire DROID is in the BLASTZONE.
- 13) “Push DETONATOR” is defined as successfully depressing the handle of the DETONATOR, which will then detonate the blast charge, allowing the DEBRIS to fall. Upon activation of the DETONATOR, the blast charge will trigger the detonation within a two-second window. NOTE: If the DETONATOR is pressed within the last two seconds of the match, the DEBRIS will fall even if time has run out.
- 14) “Place GEM in correct ROXBOX” is defined as the collected GEM remaining in the correct ROXBOX (red or blue) which corresponds to the type of GEM it collected. The entire GEM must be within the planes of the outer edges of the ROXBOX frame. The GEM must remain in the correct ROXBOX at the end of the round.
- 15) “Disturbing competitor’s objects” is defined as the DROID intentionally or unintentionally coming into contact with competitor’s DEBRIS, DETONATOR, WALL, or GEM prior to the competitor having contact with those objects. The penalty will be assessed as many times as offenses occur. (For example, hitting two DETONATORS during the Head-to-Head competition results in a 40-point deduction). Please be advised that each team has the option to pick up and remove from the course its own misguided robot at any time during a run, and each team is encouraged to do so in order to avoid this penalty.