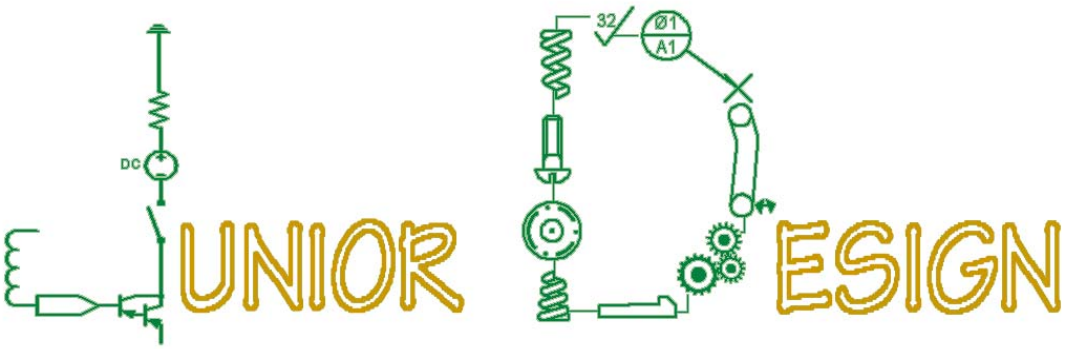
REQUEST FOR PROPOSAL
FOR ENGINEERING DESIGN

ROBO-INCHWORM

photo by Travis Stansbury



EGR 3380
Engineering Design I
SPRING 2011

Department of Electrical and Computer Engineering
Department of Mechanical Engineering
BAYLOR UNIVERSITY

1. STATEMENT OF WORK

Qualified engineering design teams are invited to submit technical proposals for the design of *Robotic Inchworm Device*, hereinafter referred to as *Robo-inchworm*. Proposals are to be submitted to the instructors of EGR 3380, hereinafter referred to as the *client*. Upon client approval of a conceptual design, each engineering design team, hereinafter referred to as the *team*, shall build, test, and evaluate a prototype device, and shall provide the client with full engineering documentation of the prototype design.

Additional instructions and schedules not included in this RFP for completing design, presentation, construction, testing, and documentation milestones will be found in the course calendar, milestone assignment documents, and other specific documents to be distributed by the client at appropriate times during the project. The design, construction, testing, and reporting of the Robo-inchworm is a requirement for completion of Engineering 3380 - Engineering Design I at Baylor University for the Spring Semester 2011.

2. DESIGN SPECIFICATION

2.2 Background

One area of robotics research that has received much attention in recent years is the development of *biomimetic robots*. Biomimetic robots are devices that mimic the behaviors and motion of biological organisms. Prestigious technological universities such as Stanford and MIT have dedicated biomimetic robotics laboratories. All manner of robots have been investigated, including ones that can swim, crawl, fly, slither, climb, and even walk on water. Applications of such devices typically involve the need to remotely access otherwise inaccessible locations with difficult terrain. For example, insect-like or snake-like devices might be designed to crawl through earthquake rubble in search of victims.

The general objective of this project will be to design a device that traverses the floor with a bi-directional inchworm-type motion (i.e., an extend-retract or undulatory-type motion). The device must meet the specifications set out in subsequent sections of this RFP. For friendly competition at the conclusion of this project, design teams will race their robo-inchworm devices.

2.3 Design Requirements

2.3.1 *General function:*

The robo-inchworm device should be able to autonomously move across the floor in a relatively straight line. Upon reaching a taped mark, it should be able to sense the mark, reverse its motion, and proceed in the opposite direction. Desired attributes include speed of travel, smoothness and consistency of motion, reliability, and aesthetic quality.

2.3.2 *Test Area:*

Devices will be tested on the floor of the lobby of Rogers Engineering Building. A rectangular track will be laid out on the black floor using white tape. The track will be up to 15 feet long and will be 3 feet wide.

2.3.3 *Power:*

Power is to be supplied by an 18V DC (1A max) source (such as a Jameco 206958 AC/DC Power Supply Single-OUT 18V 1A 18W). The device may receive power through a tether. The tether may not affect the operation of the device in any way except by supplying electric power. Any energy storage devices such as springs, batteries, raised masses, or capacitors must be fully discharged (i.e. in their lowest energy state) at the time autonomous operation begins.

2.3.4 *Automation:*

The device must be controlled by the Arduino microcontroller. It shall be activated by a single electrical switching action, after which it shall operate autonomously.

2.3.5 *Sensing:*

In order to determine when to reverse direction and/or stop, the device shall sense the tape at the ends of the course.

2.3.6 *Size:*

In the starting position, the device must fit into a volume bounded by a box 12-in wide, 12-in high, and 18-in long.

2.3.7 *Locomotion:*

The device shall move on the basis of an inchworm-type motion. Drive wheels are not permitted (i.e., no part of the device shall be propelled by a directly-driven wheel in contact with the floor surface). Wheels are permissible, but only as passive components.

2.3.8 *Operation:*

The device is to move back and forth over the course laid out along the floor. The device shall start at one end, move to the other end, reverse direction, return to the start, and then stop.

2.3.9 *Setup, Operation, & Reset:*

When the team is called upon to test their device, they will have three minutes to ready it for operation. After completion of a trial run, the team will have up to five minutes to make any adjustments before their next run.

2.3.10 *Safety:*

The device must be deemed safe by the client. This includes, but is not limited to, to the following considerations with respect to the operator and others nearby: safety from electrical shock hazards; safety from pinch points; safety from sharp edges and points; safety from flying debris; safety from chemical contaminants. The device shall also operate without damaging the floor or any part of the room.

3. SAFETY REQUIREMENTS

The team shall conduct all construction and testing with safety as the paramount consideration. Failure to observe workplace safety rules will lead to penalties in performance evaluation. Egregious or repeated safety violations, or disregard for Safety Officers, can result in dismissal from the course.

Cleanliness in the workplace is expected at all times and in all work areas. Failure to observe workplace rules will lead to penalties in performance evaluation. The design team shall clean all work areas with each use.

4. REPORTING & DOCUMENTATION REQUIREMENTS

The team shall document the design by use of manuscripts, calculations, schematics, flowcharts, computer code, and design models/drawings. Specifications for required documentation and due dates not otherwise contained herein will be contained in the course calendar and/or will be distributed by the client at appropriate points during the project.

4.1 PRELIMINARY CONCEPTUAL DESIGN REVIEW (PCDR)

4.4.1 *Date*

2/10/2011

4.4.2 *Objective*

The PCDR is a formal presentation. The client should be apprised of your conceptual design progress; i.e., you should describe one or more solution concepts that your team is considering. The main goal is to foster constructive discussion of possible design approaches for the purpose of advancing the team toward concept selection.

4.4.3 *Format*

- Duration: 4-6 Minutes
- Given by one team member.
- Visual aids using PowerPoint and/or Elmo
- Business casual dress.
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4.5 CONCEPTUAL DESIGN REVIEW (CDR)

4.5.1 *Date*

2/17/2011

4.5.2 *Objective*

The CDR is a *top-down* formal presentation to the client of the selected design concept. The client should understand how your proposed design will meet the specifications in this RFP. The client should gain a clear picture of the major components/systems and their overall arrangement/function. Furthermore, the client should understand your team's implementation plan for completing the project.

4.5.3 *Format*

- Duration: 7-10 Minutes
- Given by two team members, with approximately equivalent contributions.
- Professional quality visual aids (PowerPoint as primary platform); other visual aids as appropriate
- Business casual dress.

4.6 PRELIMINARY DESIGN REVIEW 1 (PDR 1) & DRAWING SET 1 (DS 1)

4.6.1 *Date*

2/24/2011

4.6.2 *Objective*

PDR 1 & DS 1 is for the purpose of communicating the detailed design of a major *subsystem* through a presentation and drawings.

4.6.3 *Presentation Format*

- Duration: 4-6 Minutes
- Given by one team member
- Professional quality visual aids (PowerPoint as primary platform); other visual aids as appropriate
- Business casual dress

4.6.4 *Drawing Format*

- Subsystem Drawings
  - Assembly drawing(s) of subsystem including *bill(s) of materials*.
  - Circuit schematic(s) for subsystem.
  - Detailed drawings of subsystem parts that must be manufactured

4.7 SUBSYSTEM TEST (SST)

4.7.1 *Date*

3/3/2011

4.7.2 *Objective*

The subsystem test is a hardware demonstration of the performance of the subsystem described in the PDR 1 & DS 1.

4.8 PDR 2 & DS 2

4.8.1 *Date*

3/17/2011

4.8.2 *Objective*

PDR 2 is for the purpose of communicating the detailed design and integration of two major *subsystems* through a presentation and drawings.

4.8.3 *Presentation Format*

- Duration: 4-6 Minutes
- Given by one team member
- Professional quality visual aids (PowerPoint as primary platform); other visual aids as appropriate
- Business casual dress

4.8.4 *Drawing Format*

- Subsystem Drawings
  - Assembly drawing(s) of all subsystems involved, including *bill(s) of materials* (and including revisions of DS 1).
  - Circuit schematic(s) for subsystems.
  - Detailed drawings of subsystem parts that must be manufactured

4.9 SYSTEM INTEGRATION TEST (SIT)

4.9.1 *Date*

3/24/2011

4.9.2 *Objective*

The system integration test is a hardware demonstration of the integrated performance of the two subsystem described in the PDR 2 & DS 2.

4.10 PDR 3 & DS 3

4.10.1 *Date*

3/31/2011

4.10.2 *Objective*

PDR 3 is for the purpose of communicating the detailed design of the entire device through a presentation and drawings.

4.10.3 *Presentation Format*

- Duration: 4-6 Minutes
- Given by one team member
- Professional quality visual aids (PowerPoint as primary platform); other visual aids as appropriate
- Business casual dress

4.10.4 *Drawing Format*

- System Drawings
  - Assembly drawing(s) of entire system and all subsystems including *bill(s) of materials*.
  - Circuit schematic(s) for entire system.
  - Detailed drawings of parts that must be manufactured

4.11 PRELIMINARY SYSTEM TEST (PST)

4.11.1 *Date*

4/7/2011

4.11.2 *Objective*

The preliminary system test is a preliminary hardware demonstration of the performance of the entire system as described in the PDR 3 & DS 3.

4.12 COMPLIANCE TEST (CT)

4.12.1 *Date*

4/21/2011

4.12.2 *Objective*

The compliance test is the final and critical hardware evaluation. System performance will be evaluated against all specifications. Data will be collected and analyzed.

4.13 FINAL DESIGN REVIEW (FDR)

4.13.1 *Date*

4/28/2011

4.13.2 *Objective*

The FDR is a public presentation of the design to a general audience including the client, other design teams, invited faculty, students, and guests.

4.13.3 *Presentation Format*

- Duration: 3 minutes ±20 seconds
- Given by one team member
- Professional quality visual aids (PowerPoint as primary platform); other visual aids as appropriate
- Professional dress

4.14 Final Report and Final Drawing Set (FR&FDS)

4.14.1 *Date*

5/2/2011

4.14.2 *Objective*

The Final Report and Drawings are archival documents that provide a complete and permanent record of the design.

4.14.3 *Report Format*

The format for the final report will be communicated to the design teams by the client by 4/15/2011

4.14.4 *Drawing Format*

- Subsystem Drawings
    - Assembly drawing(s) of entire system and all subsystems including *bill(s) of materials*.
    - Circuit schematic(s) for entire system.
    - Detailed drawings of parts that must be manufactured