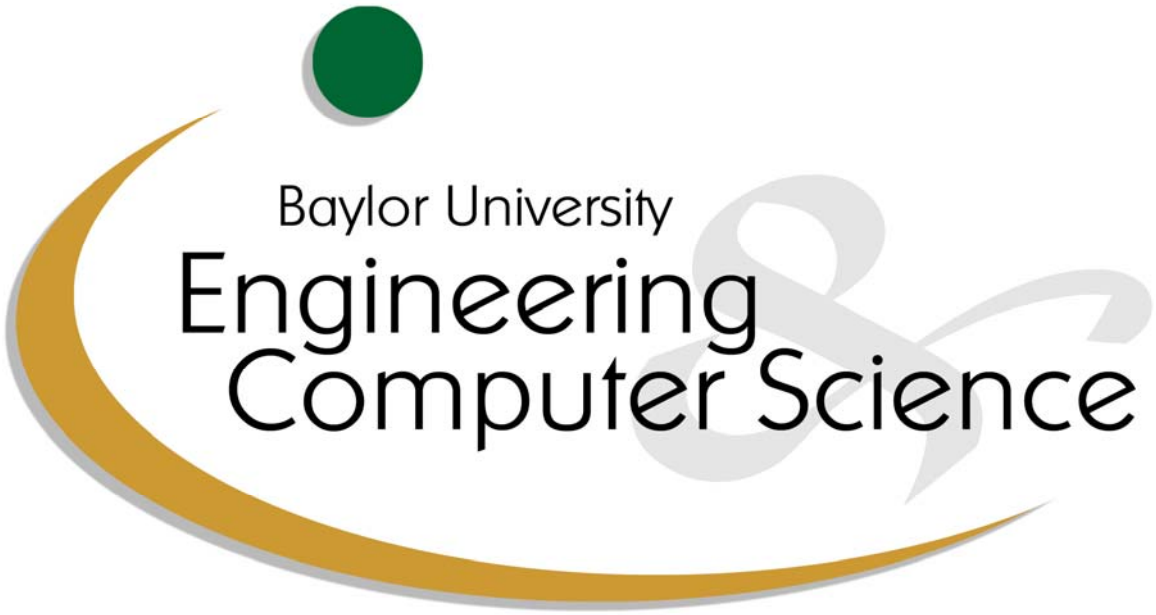
EGR 3380
Engineering Design I

REQUEST FOR PROPOSAL
FOR THE DESIGN OF AN

Automated Waste Material Sorter



Baylor University
Department of Electrical and Computer Engineering
Department of Mechanical Engineering

Fall 2009

1 STATEMENT OF WORK

Qualified engineering design teams are invited to submit technical proposals for the design of an *Automated Waste Material Sorter*, hereinafter referred to as the *Sorter*. 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 Sorter is a requirement for completion of Engineering 3380 - Engineering Design I at Baylor University for the fall semester 2008.

2 DESIGN SPECIFICATION

2.1 General Description

The U.S. National Academy of Engineering has fostered discussion of what it calls the *grand challenges* facing engineers in the 21st Century. One area of *grand challenges* the NAE identifies is that of *sustainability.* The concept of sustainability encompasses many things, including the sustainable use of resources (both energy and material) and the limiting of waste production to types and amounts that can be safety absorbed by the environment. The recycling of materials is one obvious strategy that can reduce both raw material consumption as well as waste production. However, a major hurdle for recycling efforts is the efficient identification and separation of different types of materials. It is this sorting problem that is the motivation for this RFP. The RFP calls for the design of a device that can sort, as quickly as possible, four types of waste materials into four corresponding waste receptacles.

The requirements given in this RFP are related to those of the 2010 ASME Student Design Contest problem as described online at: http://www.asme.org/Events/Contests/DesignContest/2010_Student_Design_2.cfm . While similar, the two sets of requirements differ in several important details. Nonetheless, engineering lessons learned in this EGR 3380 project should be directly applicable to the development of entries for the ASME contest. Project participants are therefore encouraged to use the knowledge gained in EGR 3380 to enter the ASME contest.

2.2 Design Requirements

The team shall design a device to meet or exceed all of the criteria listed below.

2.2.1 *Materials sorting:*

The device shall sort waste objects comprising four types of material: aluminum, steel, plastic, glass. The device shall handle up to 30 waste objects at one time. When the objects are loaded into the device, and the device is activated, the objects are to be sorted and deposited into their respective waste receptacles as quickly and accurately as possible.

2.2.2 *Waste objects:*

The waste objects to be used for the purposes of this project shall consist of the following:

a) Plastic bottle caps from common water and/or soda bottles. As a point of reference, these are approximately 1/2" in height, 1 1/8" in diameter.

b) Steel hex nuts with dimension 1±1/4" across the "flats".

c) Aluminum tealight cups approximately 1.5" in diameter. These items are available at Hobby Lobby Stores. (Item #477232 is a package of 100 which costs $4.95.)

d) Semi-spherical glass beads used in floral arrangements. These items are approximately 1" in diameter and are available at Hobby Lobby Stores. (Item #769133 is a 2 lb. bag which costs $2.77.)

2.2.3 *Waste receptacles:*

Design and placement of waste receptacles is at the discretion of the team. Each receptacle shall be clearly marked as to type of material to be contained. After sorting, the contents of the receptacles should be clearly accessible/visible for the purposes of performance evaluation. The receptacles shall be capable of being emptied of their contents and reset (all totaled) in less than or equal to 30+1 s.

2.2.4 *Loading:*

An assortment of up to 30 waste objects, consisting of at least three of each type of material, will be poured from a plastic pitcher into a *hopper* of the device. The design and placement of the hopper is at the team's discretion. No special abilities should be required to pour the waste objects into the hopper accurately.

2.2.5 *Activation:*

After the waste objects have been poured into the hopper, the team shall activate the device with an electrical switching action. The switching action may not directly convey useful mechanical energy to the device.

2.2.6 *Operation:*

Time will be kept upon activation of the device. After activation, the device shall operate autonomously until either i) all waste objects have come to rest in the waste receptacles, or ii) three minutes have elapsed. The time required to sort the objects will be recorded. An incomplete operation (i.e., not all objects make it into a receptacle) will be assigned a default time of three minutes.

The physical process of sorting will be performed on the basis of material properties of the waste objects. That is, no sorting based on size, weight, or shape is allowed.

2.2.7 *Reset:*

After operation is complete, the device shall be capable of reactivation within 60+1 s (inclusive of the time required to empty the receptacles).

2.2.8 *Control:*

The device shall operate under microprocessor control.

2.2.9 *Power:*

The Sorter shall be powered by a voltage source of less than or equal to 24 VDC. This voltage may be achieved either through the use of dry cell batteries or via a transformer that converts 120 VAC.

2.2.10 *Size & weight:*

The device shall weigh less than or equal to 20+1 lb. The device, fully assembled and ready for operation, shall fit within a volume defined by a cube 15+0.25-in on a side. One main power cord may be excluded from this requirement. Also, the hopper may extend beyond this volume if detachable. (That is, if the hopper is an integral part of the device, it must fit in the prescribed volume. If it is easily attachable/detachable, it may extend beyond the prescribed volume. Easily attachable/detachable is defined as able to be attached/detached in 30+1 s or less.)

2.2.11 *Safety:*

The device must be deemed safe by the client. This includes, but is not limited to, to 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.

2.2.12 *Scoring:*

At the conclusion of the sorting of all objects, or the three minute limit, a score will be computed for the device according to

$$2*N_s - N_i + (180 - t)$$

Where N_s is the number of objects sorted into the correct waste receptacle, N_i is the number of objects sorted into the incorrect waste receptacle, and t is the elapsed time in seconds.

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 Intermediate Conceptual Design Review

4.1.1 *Date*

9/24/2009

4.1.2 *Objective*

The Intermediate CDR is an informal presentation (possibly using PowerPoint or Elmo). The client should be apprised of your conceptual design progress for the purposed of providing guidance and feedback in the process of selecting a design. The main goal is to foster constructive discussion of possible design approaches.

4.2 Conceptual Design Review

4.2.1 *Date*

10/1/2009

4.2.2 *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.

4.2.3 *Format*

- <10 minute duration
- 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.

4.3 Preliminary Design Review 1 (PDR 1)

4.3.1 *Date*

10/8/2009

4.3.2 *Objective*

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

4.3.3 *Presentation Format*

- < 8 minute duration
- Given by one team member
- Professional quality visual aids (PowerPoint as primary platform); other visual aids as appropriate
- Business casual dress

4.3.4 *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

4.4 Subsystem Test

4.4.1 *Date*

10/15/2009

4.4.2 *Objective*

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

4.5 PDR 2

4.5.1 *Date*

10/22/2009

4.5.2 *Objective*

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

4.5.3 *Presentation Format*

- < 8 minute duration
- Given by one team member
- Professional quality visual aids (PowerPoint as primary platform); other visual aids as appropriate
- Business casual dress

4.5.4 *Drawing Format*

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

4.6 System Integration Test

4.6.1 *Date*

10/29/2009

4.6.2 *Objective*

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

4.7 PDR 3

4.7.1 *Date*

11/5/2009

4.7.2 *Objective*

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

4.7.3 *Presentation Format*

- < 8 minute duration
- Given by one team member
- Professional quality visual aids (PowerPoint as primary platform); other visual aids as appropriate
- Business casual dress

4.7.4 *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

4.8 Preliminary System Test

4.8.1 *Date*

11/12/2009

4.8.2 *Objective*

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

4.9 Compliance Test

4.9.1 *Date*

11/19/2009

4.9.2 *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.

4.10 Final Design Review (FDR)

4.10.1 *Date*

11/23/2009

4.10.2 *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.

4.10.3 *Presentation Format*

- < 4 minute duration
- Given by one team member
- Professional quality visual aids (PowerPoint as primary platform); other visual aids as appropriate
- Professional dress

4.11 Final Report and Drawings

4.11.1 *Date*

12/4/2009

4.11.2 *Objective*

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

4.11.3 *Report Format*

The format for the final report will be communicated to the design teams by the client by November 10, 2008

4.11.4 *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