EGR 3380
Engineering Design I

FOR THE DESIGN OF A

PART STACKING MACHINE

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

Spring 2008

I. STATEMENT OF WORK

Qualified engineering design teams are invited to submit a technical proposal for the design of a *Part Stacking Machine*, hereinafter referred to as the *PSM*, to the instructors of EGR 3380, hereinafter referred to as the *client*. Upon client approval of the proposed 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 final documentation of the prototype design.

Any specific 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 *PSM* is a requirement for completion of Engineering 3380 - Engineering Design I at Baylor University for the spring semester 2008.

II. DESIGN SPECIFICATION

1. General Description

Part stacking machines are ubiquitous in the manufacturing industry. Machines are used to automate the stacking of all manner of materials ranging from paper, lumber, boxes, and pipes to cookies, crackers, and ice cream cones. See the following figures for examples.

Metal Ingot Stacking Machine
www.worswick.com/products/lift_table.html

Linen Folding & Stacking Machine
www.hjweir.co.uk/index.php?interface=gallery...

Tortilla Stacking Machine
www.graysonline.com.au/sale.asp?SALE_ID=7353

Onion Stacking Machine
sunsetonions.com/exports.shtml

Machine for stacking loads on pallets
http://www.feedandgrain.com/print/Feed-and-Grain/Considering-Automatic-Palletizers/1$38

Lumber Stacking Machine
www.woodfabtimber.ie/gallery.htm

Cracker Stacking Machine
http://www.industrysearch.com.au/Products/Biscuit_Stacking_Systems-20904

Shipping container stacking
http://www.gottwald.com/gottwald/site/gottwald/en/products/automatedstacking.html

This project calls for the design, construction, testing, and documentation of a part stacking machine (PSM) for wooden spools. The objective is to design a device that can stack wooden spools onto stacking rods as illustrated in the model at right.

2. Design Requirements

2.1 DESIGN CRITERIA

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

2.1.a.   <u>Spools</u>: The spools shall be: Lara's Crafts 3/4" x 1" or equivalent (see Fig. 1).
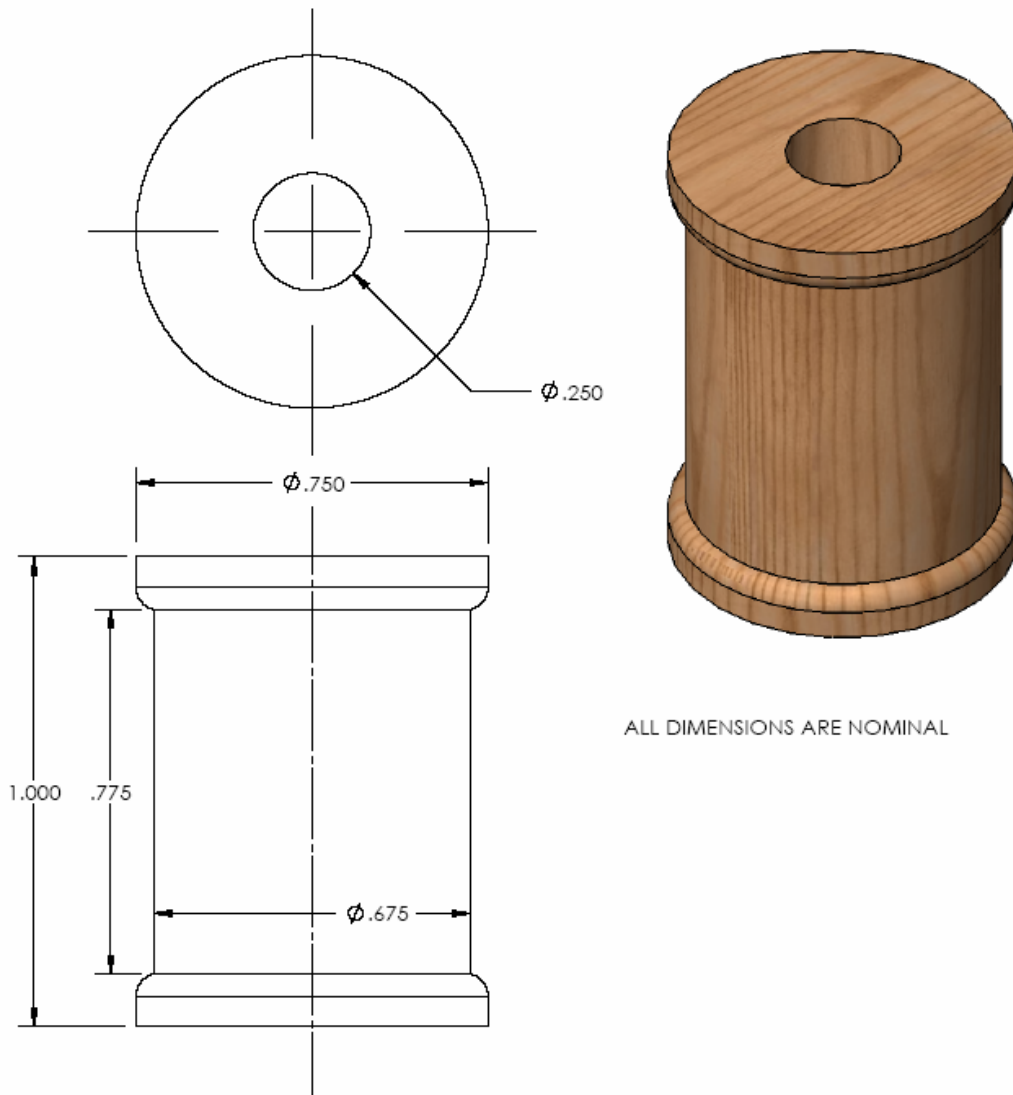

ALL DIMENSIONS ARE NOMINAL

FIGURE 1

2.1.b.   Function: For the following, refer to Figure 2. The PSM shall stack spools onto four stacking rods. Each stacking rod shall be 1/8-inch in diameter and between 5 ¼ to 5 ½ - inches in length. Each stacking rod shall hold five spools for a total of twenty spools. The twenty spools shall start in a standing position within a circular area 6-inches in diameter. The surface of the circular area must be solid. At the start of device operation, nothing other than the spools may be in the volume defined by the perimeter of the circle extended upward two inches. At completion of device operation, the four rods shall be mounted vertically within a 3-in x 6-in rectangular area that is placed a minimum of 6-inches from the center of the circle. Prior to device operation, the circular area shall be at a vertical level equal to or below that of the rectangular area where the spools are stacked.
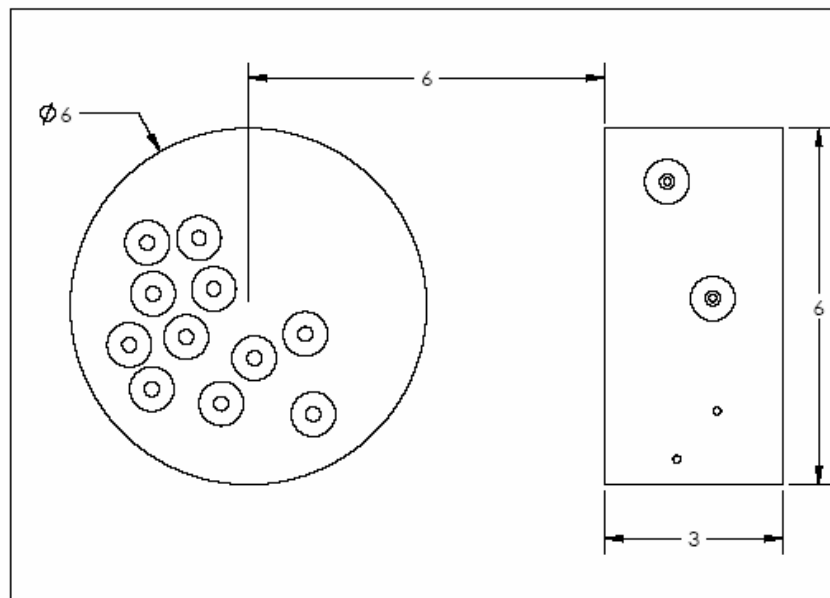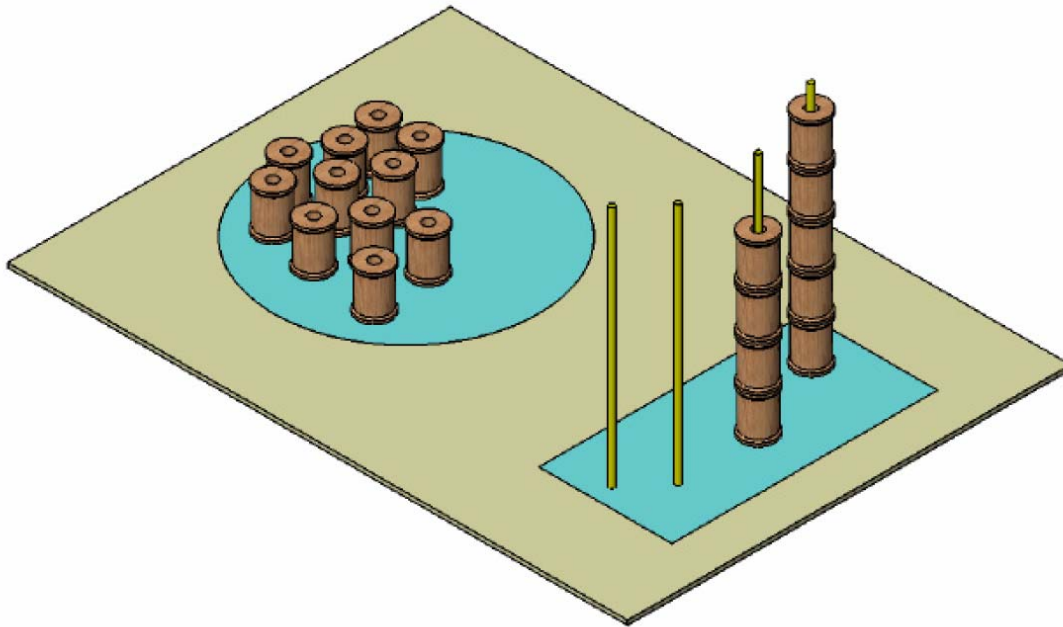
Figure 2

2.1.c   Control: the PSM shall use a client-specified microcontroller. In addition, operation may proceed with user input of electrical signals through buttons, switches, or other input devices that convey user instructions electrically. Users cannot apply inputs that manually convey mechanical forces from user to moving parts.

2.1.d.   Time & Scoring: The stacking operation shall occur within a maximum time of five minutes. The number of spools correctly stacked at the five minute mark from start of operation will be used to calculate the device performance *figure of merit*. If all twenty spools are correctly stacked in less than five minutes, the amount of time under five minutes will contribute to the *figure of merit*. If the device ceases to function prior to the five minute mark, but without all spools stacked properly, a default time of five minutes will be assigned to the device. The figure of merit will be calculated according to the following formula:

Figure of Merit: $F_m = N^2 + (300 - T_c)$

where N is the number of correctly stacked spools ($0 \le N \le 20$) and T_c is the completion time of the device in seconds ($T_c \le 300$). $T_c = 300$ for $N \ne 20$.

Examples:

N=20, T_c=215: $F_m = 20^2 + (300 - 215) = 400 + 85 = 485$

N = 16, $T_c \equiv 300$ $F_m = 16^2 + (300 - 300) = 256$

2.1.e.   Power: the PSM 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 110 VAC.

2.1.f.   Size & weight: when set up for operation, the PSM shall fit within a volume defined by a 20"x20" base x 24" height (excluding power cords and/or hand-held controller). The PSM weight shall not exceed 20-lbs.

2.1.g   Setup: the PSM shall be capable of setup and operation on any typical classroom desk/table top with no requirement other than access to a 110VAC wall outlet, if required. A five minute setup time is allowed for compliance testing.

2.1.h.   Reset: after completion of a stacking operation, the PSM shall be capable of being reset and performing another stacking operation within 1 minute.

3. Design Documentation

        The team shall document the project by use of manuscripts, calculations, schematics, flowcharts, computer code, and design models/drawings. Specifications for required documentation and due dates are contained in the course calendar and/or will be distributed at appropriate points during the project.

4. Safety Requirements

        The team shall conduct all construction and testing with safety as a paramount consideration. Failure to observe workplace 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.