Cleaning Up the Labs Using a Resistor Sorter
E 90 Proposal

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Purpose

We would like to design and build a machine that would be able to sort resistors leftover in the lab. The labs in Hicks are always cluttered with resistors, most of which end up in the garbage at the end of the year. Our sorter would enable the department to keep the lab clean and minimize the amount of money spent on replacing the resistors.

Our thought is that this project will provide us with an opportunity to incorporate much of our engineering knowledge from programming and assembling circuits to actually designing and building something from scratch. We will be converting between analog and digital voltages to determine the value of the resistor, and then, perhaps using a program, outputting voltages to the system which we will describe in detail later in the proposal.

Materials

Plexiglass-tubing, sheets[1]	~$20.00
Motors (TM92MTR2258)[2]	9 x $9.95
Limit Switches	~$20.00
PIC Controller	$50.00-60.00
Op-Amps	Available in Hicks
Resistors	Available in Hicks
Solenoids	2 x ~$10.00
Plastic Bins	TBD
Wood	$10.00-$12.00
Total Cost	Approximately $230.00

Design[3]

[1] We are talking with Smitty about how much plexiglass we will need. Right now, plegiglass tubing is roughly $0.12/foot, and we anticipate needing a little bit less than 100 feet, totaling about $10.00, so we anticipate buying several sheets of plexiglass totaling about the same amount.

[2] www.herbach.com

[3] See attached schematic for a general layout of our initial design

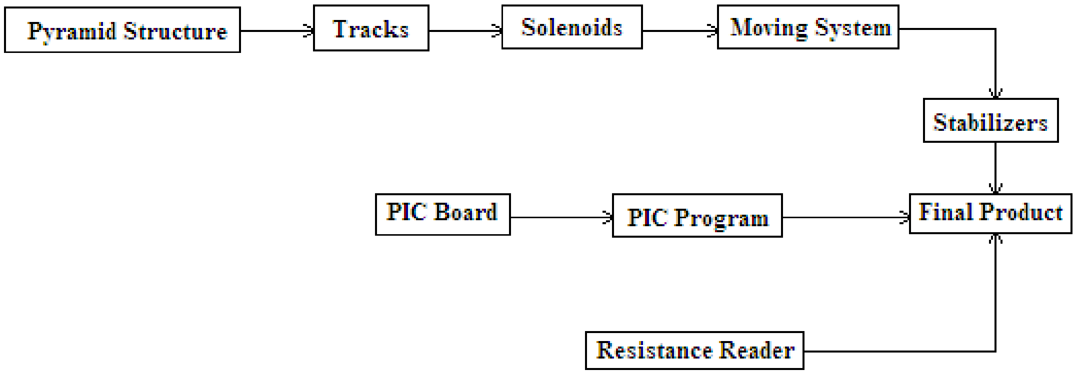


Figure 1 - This is the block diagram for our project, outlining the order of our design process.

Figure 1 shows the general order of our design process as well as the individual stages which we will complete. The stages are broken down as follows:

<u>The Pyramid Structure</u>

The pyramid structure will consist of plastic tubing with an inner diameter of 3/16”-3/8”. The tubes will be situated at angles (see schematic) in order to minimize the movement of the tubes on the first few levels. Each plastic tube will be 4” in height at each level because that is slightly longer than the longest resistor (from one end of the wire to the other). The tubes will be fitted into pieces of wood that are approximately 1” in width, and ½” in depth. The total length of the wood at each level is yet to be determined. As stated above, there will be two towers of seven levels (64 bins at the bottom of each, for a total of 128 bins). These bins will be square and made out of plastic. The dimensions of the bins are yet to be determined, but they will be long in the length-wise direction so that they can fit a large number of resistors.

<u>The Path of the Resistor</u>

The resistor will be placed on a set of solenoid clamps which will pinch the resistor when they sense its weight. The clamps will then run several test currents through the resistor and determine the output voltage using a series of op-amps and switches. We have yet to finalize this part of the design because it won’t come in to play until later in our project when we begin programming the microprocessor (see “The Microprocessor”). Once the resistance is determined, the resistor will fall into the first stage of our pyramid structure. The microprocessor will sequentially send directions to each of the seven layers of the pyramid which will dictate the path of the resistor. See “The Pyramid Structure” for details.

<u>Motion of the Pyramid’s Levels</u>

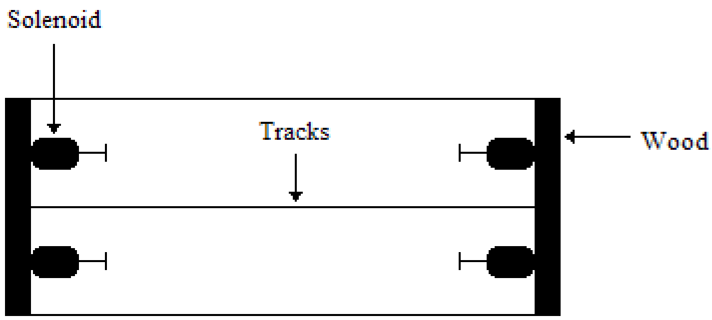


Figure 2 - This shows the frame of the moving system.

Track System

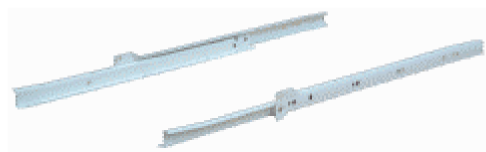


Figure 3 - Sample ball bearing sliders

Each row of the pyramid structure will move independently of the other eight rows. Since each row consists of plexiglass tubes imbedded in two wooden blocks (one at the top and one at the bottom), we need a relatively low friction material so that each row can move left or right depending on the value of the resistor. Figure 2 shows an approximate schematic of the frame for our system. We will describe the solenoids' function in the movement of each level in the next section. The tracks labeled in the figure will simply be ball bearing sliders (similar to the sliders found in many drawers) which will attach directly to the wood and will enable each level to move smoothly. Figure 3 shows a sample set of ball bearing sliders which will be the type we use in our system.

Solenoids

Figure 4 - Sample solenoid.

The solenoids labeled in figure 2 will drive each level left or right depending on the value of the resistance. A sample solenoid is shown in figure 4. Each row will have three states: left, right and center. The left/right positions are used to allow a resistor to move to the next level in the system, while the center position is a holding position meaning that no resistor will fall through to the next level.

Once the tracks and solenoids have been setup and attached to the pyramid structure, we will have the complete moving system, a section of which is shown in figure 2.

Stabilizers

Stabilizers will be two wood blocks placed at the four corners of the pyramid structure to make sure the structure will stand properly and be very durable.

<u>The Microprocessor</u>

PIC Board (Chip)

To create the PIC chip, we will use two programs: Multisim (to create the schematic) and Ultiboard (to determine the PCB layout).

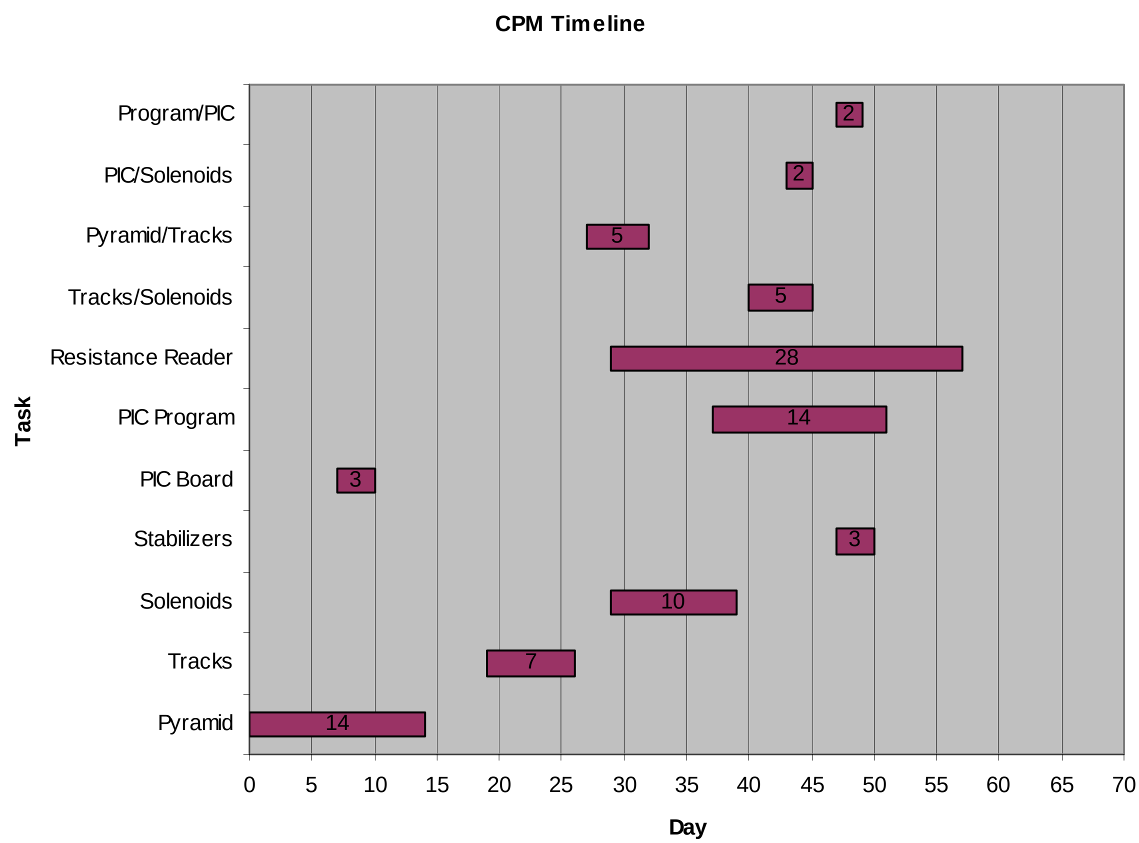
PIC Program

Once we have the PIC chip, we will write a program using the programming language *C* which will determine the path of the resistor. Our program will take the voltage across the resistor as its input (which will correspond to different input currents) and use the outputs of the various comparators as a specific binary sequence to input to the solenoids at each level. The sequence delivered to the solenoids will have a built in delay to ensure that there is at least one level of separation in the system between any pair of resistors at all times to ensure that the resistors follow the correct paths and are not biased in their path choice by the path of the previous resistor passing through the system.

Resistance Reader

The Resistance Reader will contain two clamps in between which the resistor will be placed. The clamps will close automatically when the clamps are shut, and then different currents will be fed through the resistor to determine its resistance. Because the resistors have approximately 6 orders of magnitude in difference from the smallest to the largest, the system will be able to feed in six different currents. For example, the first current will be around 1μA, so that a 10MΩ resistor will output 10V. Any larger of a voltage would output a voltage that would be too high. If the voltage is less than 1V however, the system will then input 10 μA to see if that would output something higher than 1V. This process continues until an input current outputs something between 1 and 10V. This voltage, along with current being input, will be sent into the PIC chip. This will be done using comparators.

Critical Path



Possible Extensions

One aspect of our design which we would like to improve, but are not sure is feasible, is to eliminate the human element almost entirely. Our extension would be to put the ball of entangled resistors onto a shaker table, which by design would separate all of the resistors so they could be individually picked up and fed into our system. The easiest way to transport the resistors theoretically would be to use a robot arm with some sort of vision device to easily detect resistors. However, this device is extremely complicated and likely far out of our E90 budget. Another potential for transporting the resistors would be to design the shaker table so that its top could fold up, effectively pinching the resistors, and then slowly drop them into our system by angling the folded board. We feel that we will likely be too consumed with the design of our system this year to be able to fully explore these extensions, but they might be useful in inspiring future E90 projects which would "piggy-back" on our initial design.

Post-Project Applications/Goals

We hope that after our E90 project is complete, it will not only be useful in cleaning up the labs in Hicks, but we hope that it can be used to market engineering to younger generations. We plan on paying special attention to our design to make it aesthetically pleasing and exciting to watch in hopes to inspire other people to become engineers.