

Michigan State University

ECE480 Pre-proposal

Design Team 1

Fall 2008

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Problem to be Addressed

One of our sponsors, Michigan business Lettuce Duit, has many manually operated machines in their factory that are used for general purpose cutting of materials. Currently, workers are cutting pleated ribbon material to length manually by hand. Lettuce Duit would like to see an automated machine made that can efficiently handle this task. It is also required that the machine to be built be operable by individuals with disabilities (mainly seeing, hearing, and learning disabilities). Also, in terms of production volume, the machine should be able to at least match the production speed of the individuals who are currently doing the task by hand.

Sponsor Specifications:

- Machine will be manually fed material by the user initially, and the machine can then take over automatically with minimal aid from the user
- Machine can accurately cut material to a length of zero to seventeen inches, with 1/10 inch resolution
- Machine accessible to disabled persons
- Machine has simple user interface, with audio/visual feedback for the impaired
- Material to be cut will have width no greater than two inches
- Machine will be electrically and mechanically safeguarded
- Machine must be reasonably portable

MSU Design Team 1 Proposed Solution

The task our machine is to replicate involves many simple repeated motions. We are proposing the use of an arrangement of stepper motor driven belt drives, actuators, a rotary cutting device, and mechanical clamps to handle the motion requirements of the machine. The expected operation of the final machine is as follows: Two clamps will hold the material, one to pull the material to length and the other to secure the material for cutting. Initially, both clamps will be open and adjacent to each other. The user must place the material in the open jaws of the clamps, and then run the machine. First, the movable clamp will close on the end of the material and pull the material from the feeder. Once the material has been pulled to length, the stationary clamp will close to secure the length of material. Then the machine will send the rotary cutter (located adjacent to the stationary clamp) across the material, cutting the material. The movable clamp will then open, releasing the material to be collected. The movable clamp will then return to its initial position, grab the exposed end of material now being held by the stationary clamp,

and repeat the process. The coordination of these devices will be handled by a central microcontroller. For the audio/visual feedback requirement of the machine, we will implement a large LED display to show the current material cutting length, and a digital audio device with a speaker to read aloud the current material cutting length. The microcontroller will control these devices in addition to the mechanical components. A simple keypad will allow the user to increase/decrease the cutting length, power up/down the machine, and to read aloud the currently selected cutting length.

Summarized Operating Sequence:

- System is powered on
- User feeds material into opening, and places material into open clamps
- User initiates automation
- Movable clamp secures end of material and pulls it to length
- Stationary clamp closes
- Rotary cutter engages and cuts the material
- Movable clamp opens, releasing the material to be collected
- Movable clamp returns to its initial position
- Process repeats

Technical Summary of Expected Final Design

- The position of the two linear motion stages will be controlled by stepper motor driven belt drives. The linear stages will lay parallel equivalent planes, and the axes of motion of the two drives will be perpendicular.
- The linear motion stages will be constructed with a configuration of timing belts, pulleys, and stepper motors.
- The angular position of each stepper motor will be controlled via the microcontroller, which will send the appropriate signals to a stepper control IC (one for each stepper motor, requiring two control bits apiece), which will drive the motor.
- The 120 AC power required for the rotary cutter will be controlled by a relay via the microcontroller, requiring one control bit.
- Any time the cutting length is adjusted via the pushbutton pad, the movable clamp will return to its initial position before enacting the new length

- The display is a collection of three large seven segment displays, which will always show the currently selected cutting length.
- Multiple sound samples will be recorded on our audio chip, which contains its own memory. Each sound sample can then be addressed by the microcontroller to be played.
- The Microchip PIC microcontroller provided for ECE480 will be used as the central processor for this machine.
- The software used to program the PIC will be Microchip's own MPLab IDE.

Projected Total Cost for Complete Design

- \$39.99 Stepper Motor (1) – probotix.com
- \$3.98 Stepper Driver IC (3) – digikey.com
- \$9.99 DC Linear actuator (1) – local junkyard/salvage shop
- \$5.99 20" Timing Belt (2) – local hardware shop
- \$25.00 Shipping Charges
- ***Total:** \$98.90

*Our sponsor, Stephen Blosser, will be custom making many components for us at no charge, including the linear motion stages and clamps. He also provided the rotary cutter.

References

1. Digikey (stepper driver IC's and information)
www.digikey.com
2. Probotix (stepper motors and information)
www.probotix.com
3. Microchip (software support, various products and information)
www.microchip.com
4. Wikipedia – Stepper Motors (information)
http://en.wikipedia.org/wiki/Stepper_motor
5. Control of Stepper Motors (information)
<http://www.cs.uiowa.edu/~jones/step/>
6. Anaheim Automation (information)
www.anaheimautomation.com