

Silicone Tube Cutter

Project Proposal

Assistive Technology Development
Financial Assistance Program
ASEE/DEED – NISH

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November 2, 2007

Objective

Currently, those utilizing prosthetic arms have two choices for the prosthetic prehensor, either an anthropomorphic hand, used for aesthetic purposes, or a hook, which provides functionality (Meeks and LeBlanc 1988). Those who choose terminal hooks require the use of hook tension bands to keep the hook closed. Unfortunately, users report that commercially available tension bands are poorly designed, fail quickly, and require frequent replacement (The Open Prosthetics Project 2007).

Therefore, the Open Prosthetics Project, which seeks to provide free and useful innovations in the field of prosthetics, is attempting to develop more effective tension bands. They have determined that bands cut from silicone tubing are a better alternative. To mass produce these bands, the Open Prosthetics Project has partnered with OE Enterprises, a private, non-profit organization whose mission is “to assist people who face employment barriers to achieve vocational potential, from the beginning of work until retirement, by offering services that allow individuals to attain the greatest level of vocational success of which they are capable” (OE Enterprises 2007).

Our main objective, then, is to design a safe and efficient cutting device that can be operated by the employees of OE Enterprises to cut silicone tubing into hook tension bands. Not only will these bands contribute to improving the quality of life for people with amputated arms, but these bands will also provide fulfilling vocational opportunities for the workers at OE Enterprises.

Work Scope

As part of our design course, BME260: Devices for People with Disabilities, we have begun working on this project. A prototype of our assistive device has been built; however, a large amount of refinement and testing still remains ahead of us.

A standard protocol of the design process was adopted to design, fabricate, and test our device. We began by meeting with our clients at both the Open Prosthetic Projects and OE Enterprises to clarify the need of this device. For example, worker capabilities, device operation safety, and other logistical needs were addressed to formulate the functional specifications of the device. This list of functional specifications was prioritized and served as a checklist towards achieving our design goals.

Formal brainstorming sessions then took place to discover possible solutions to the design problem. All possible solutions were recorded to serve as an idea bank. The feasibility of each of these ideas was then evaluated. Meeting the functional specifications, fabrication possibility, and realistic profitability were important criteria considered.

A preliminary design was adopted after narrowing down the possible solutions. This design was fabricated recently using materials found in our design lab after considering budget limitations. Several versions of the device were machined to address unforeseen design challenges before arriving at the current design. A working prototype of the cutting apparatus was recently presented to representatives at OE Enterprises, and they have given us positive feedback. There are many issues that still remain. For instance, ejection of the cut pieces of tubing remains a major challenge. A collection bin and lever are also part of the device design and still need to be designed and built.

If our budget allows, we plan to construct and deliver three, high quality devices to OE Enterprises by the end of this year. However, we expect revisions to be made as their employees begin using the devices early next year.

Schedule

The schedule is shown below. Dark gray denotes tasks that have been completed, while light gray denotes tasks that have yet to be completed.

Year Month	2007				2008			
	9	10	11	12	1	2	3	4
Client Meetings	Dark Gray							
Brainstorming	Dark Gray	Dark Gray						
Backgrounds	Dark Gray							
Objectives/Aims	Dark Gray							
Preliminary Design		Dark Gray						
Detailed Design		Dark Gray	Light Gray					
Purchase Materials			Light Gray					
Machining		Dark Gray	Light Gray	Light Gray	Light Gray			
Assembly		Dark Gray	Light Gray	Light Gray	Light Gray			
Prototyping		Dark Gray	Light Gray	Light Gray	Light Gray	Light Gray		
Testing w/ Clients		Dark Gray	Light Gray	Light Gray	Light Gray	Light Gray	Light Gray	
NISH Paper						Light Gray	Light Gray	Light Gray

Figure 1. Gantt chart of proposed schedule.

Budget

The budget breakdown is shown below. Please note that we would like to deliver three of these devices to OE Enterprises.

Item	Cost
Spring mechanism	\$20
Aluminum Chassis	\$85
Blades	\$10
Silicone tubing	\$70
Collection bin	\$25
Lever attachment	\$25
Miscellaneous (e.g. screws, etc.)	\$50
Subtotal (1 Device)	\$285
Total (3 Devices)	\$855

Table 1. Proposed budget breakdown.

Department Co-funding

Currently, a budget of four hundred dollars (\$400) is allotted for each group of three students enrolled in the design course, BME 260: Devices for People with Disabilities, in the Department of Biomedical Engineering. This funding is provided by a National Science Foundation (NSF) grant for this course. Additional university funding may be possible, if necessary.

Project Team

The primary design team is comprised of three senior undergraduate students in the Department of Biomedical Engineering. These are (1) Meagan Gray, (2) Pallavi Kansal, and (3) Jason Liu.

The primary faculty advisor for this project is Dr. Laurence N. Bohs, Department of Biomedical Engineering. Secondary faculty serving as advisors are Dr. W. Neal Simmons, Department of Mechanical Engineering; Dr. Marcus Henderson, Department of Biomedical Engineering; and, Mr. Joe Owens, Department of Biomedical Engineering.

External Collaboration

We have two main external collaborators: Jonathan Kuniholm, representing The Open Prosthetics Project, and the representatives of OE Enterprises, Inc., including John Wiltshire, Jr., Director of Production; Alan Pitstick, Contract Sales Manager; and, Ken Miller, Production Manager.

The Open Prosthetics Project is a non-profit organization started by Jonathan Kuniholm in order to provide free prosthesis designs and improvements for prosthetists or users in order to solve their specific needs.

OE Enterprises, Inc. is a “non-profit community rehabilitation organization whose mission is to maximize the vocational potential of citizens of Orange, Alamance, and Caswell Counties [North Carolina] who have disabilities” (OE Enterprises).

Faculty Advisor Contact Information

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References

D Meeks and LeBlanc, M. “Preliminary assessment of three designs of prosthetic prehensors for upper limb amputees.” *Prosthetics and Orthotics International*. 1988 Apr;12(1):41-5.

“Orange Enterprises, Inc.” <<http://www.oenterprises.org>> 30 Oct. 2007.

“The Open Prosthetics Project.” <<http://www.openprosthetics.org>> 30 Oct. 2007.