Individualized Functional Finger Prosthetic

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Client: Gregory G. Gion
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Outline

- Problem Statement
- Client Description
- Design Constraints
- Project Impact
- Summary of Fall 2017-2018
- Goals of Spring 2017-2018
- Additional Documentation
- Budget

Project Impact

- One in two hundred people have undergone amputation
  - 23% are due to trauma to the upper limbs
- 30-50% of estimated two million amputees prefer to either not or only periodically use prostheses
- Insufficiencies with aesthetics, movement, and sensitivity

Silva, A. F. C., dos Santos, A. J. V., Souto, C. d. R., de Araújo, C. J. and da Silva, S. A. (2013), Artificial Biometric Finger Driven by Shape-Memory Alloy Wires. Artificial Organs, 37: 965–972. doi:10.1111/aor.12227

Background

Problem statement

- Design a **mechanical prosthetic finger** to **fit inside a realistic silicone covering**
- Must be **affordable**, **aesthetic both in appearance and functionality**, and **minimally invasive**
- Ideally restore **flexion and extension** movement of an amputated residual finger
- **3D-printable**

Client information

- Dr. Gregory Gion of Medical Arts Prosthetics®
- Non-functional, highly realistic silicone/polymer based prosthetics

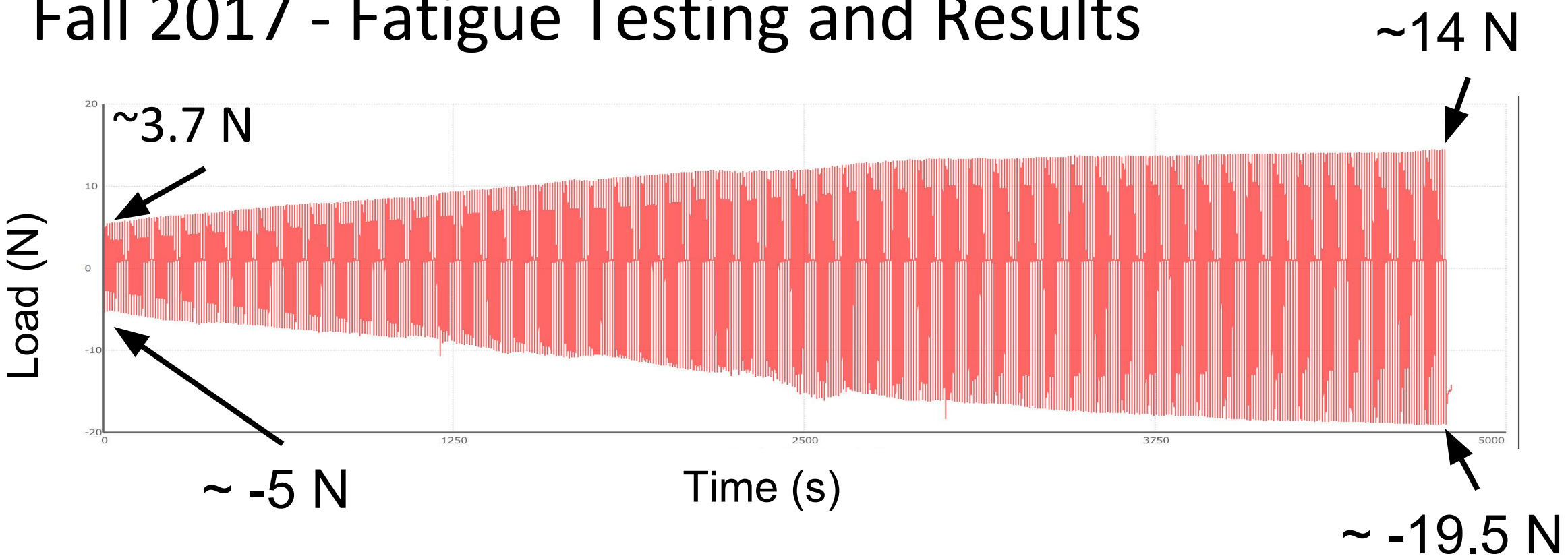
Fall 2017 - Final Prototype

(1) Polylactic Acid

(2) M2 screws + hexagonal nut

(3) 14 mm | 18 mm

Fall 2017 - Fatigue Testing and Results



- Load required to actuate digit increased over 350 cycles
- **Errors** could have resulted from:
  - Shifting apparatus components would increase mechanical resistance during the test
  - Self tightening joint screws would cause the joint to tighten over time

Next Steps

Previous design diameter was too large (18mm max)

- Client wants to experiment with shaping foams
- New design has a maximum of 10mm diameter

Previous design does not fully tackle the problem

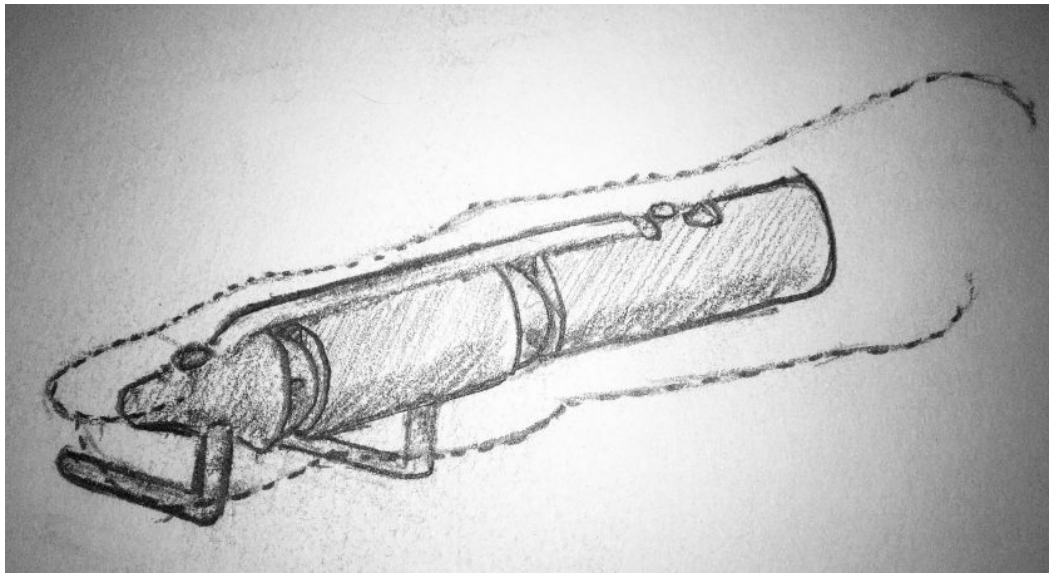
- Client's stipulated design is good, but we can do better
- Easy to use actuation of joint

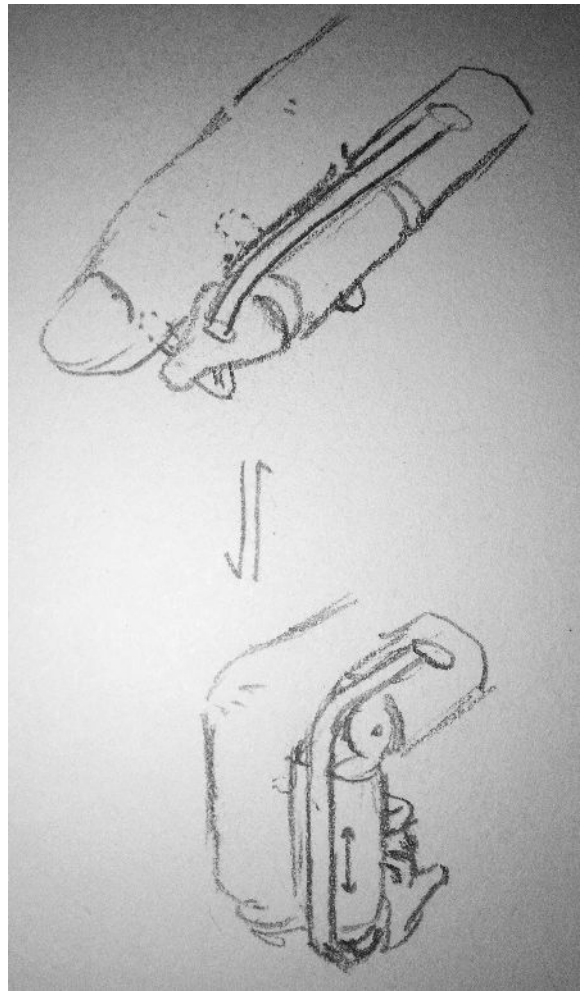
Previous testing methods are insufficient

- Testing apparatus likely affected results, created large amounts of noise in data
- Need to assess the functionality, not just mechanical properties

Spring 2018 Goals - Actuated Design

- New design: actuating bridges
  - Improves functionality with minor aesthetic reductions
  - Bridges on palmar side of phalanges allow actuation using adjacent digit
- Next: fabrication of proof-of-concept
  - 3D printed new design

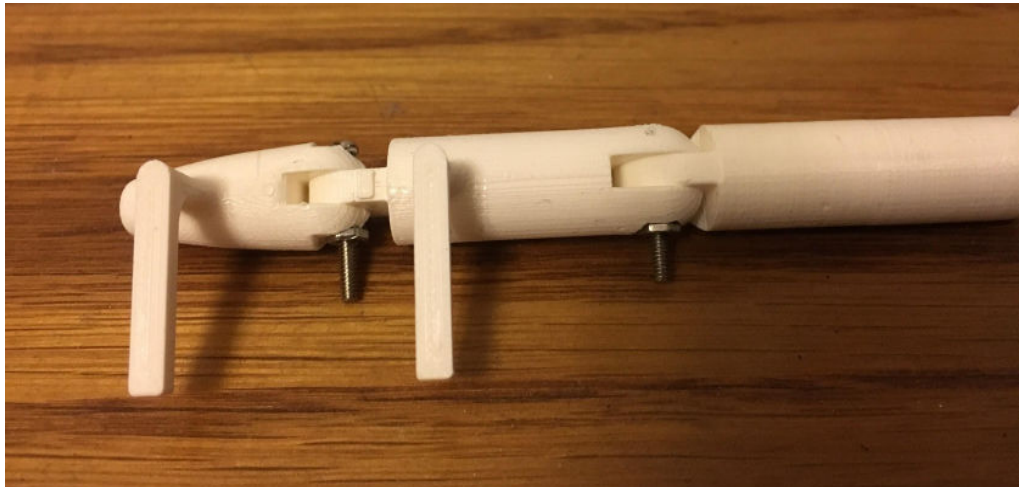


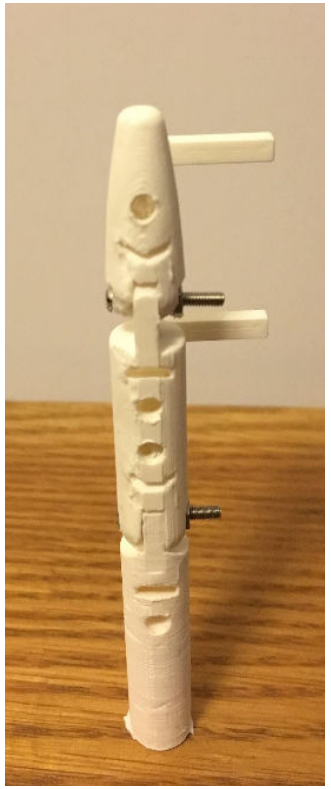


Spring 2018 Goals - Actuated Design

- 3D printed used PLA with PVA supports
  - 14mm length screws used for demonstration
  - 10mm length screws will be used in patients

- Rubber bands to be added dorsally
  - Held in place using set screws

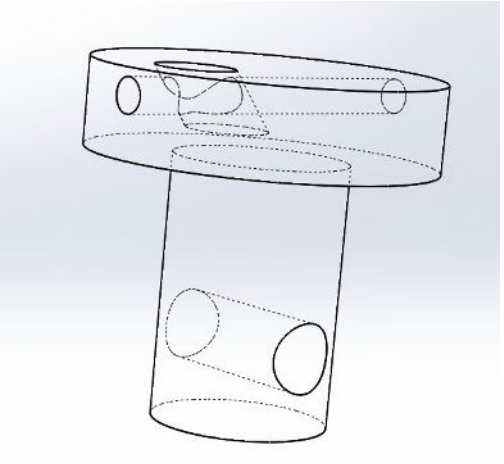




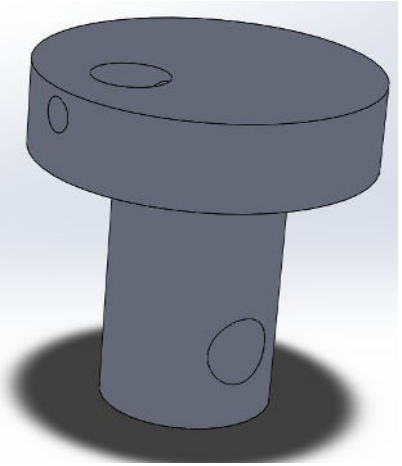
Spring 2018 Goals - Testing

Goals:

1. Proof of concept for self-actuation
2. Determine wear/deterioration over repeated usage



Hidden Lines Visible of MTS Adapter



Solid model of MTS Adapter

How will we accomplish these goals?

Goal 1:

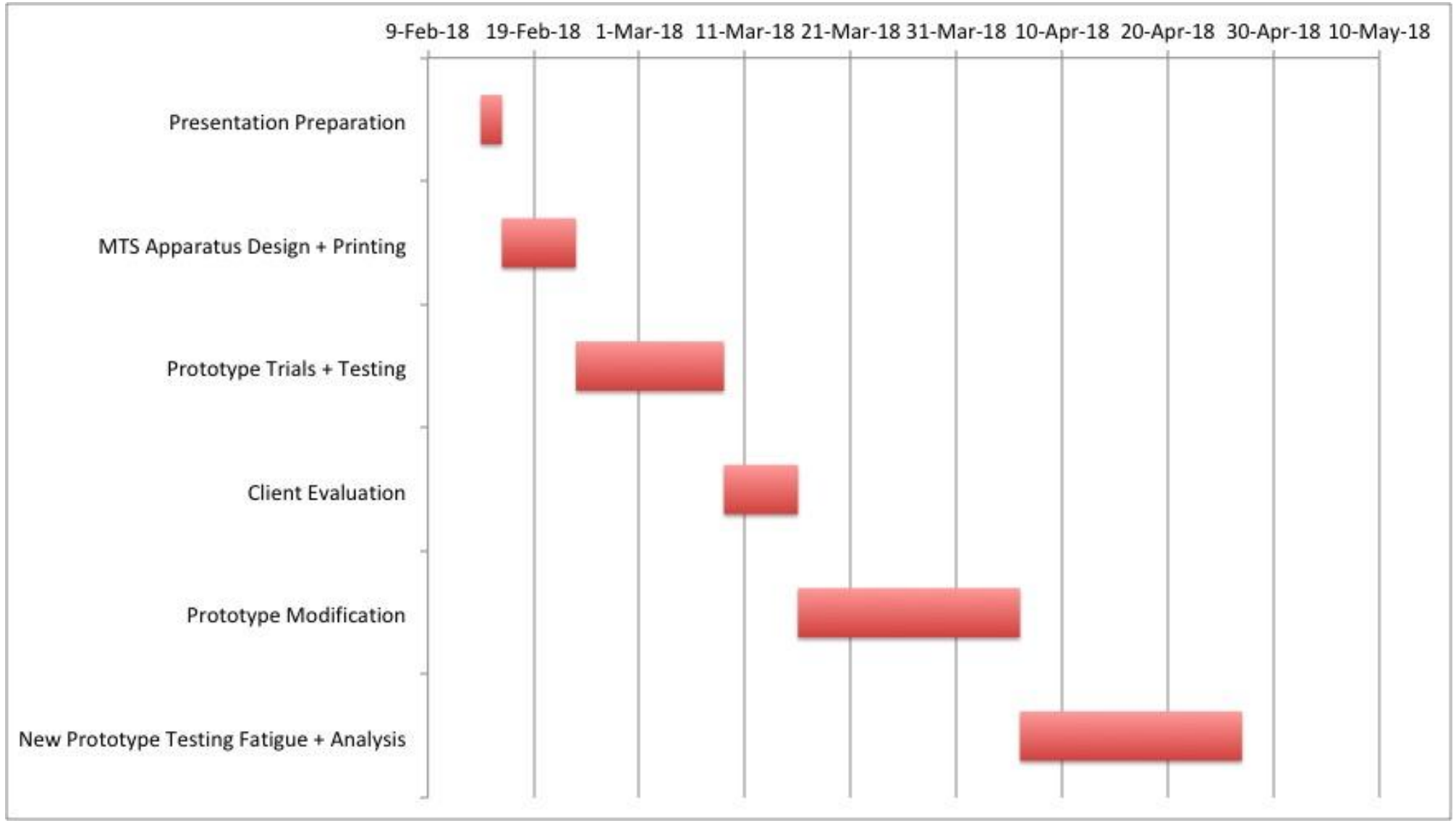
- Develop an adaptor to test actuation using anyone's hand.
- Determine ability to self actuate and user experience

Goal 2:

- MTS fatigue testing on multiple prototypes (repeatability determination)
- Determine cycles before the device does not function as a normal finger (average force exerted by finger, 45.95 N)
- Determine how to lengthen the lifetime of the prototype.
  - Changes in stiffness, areas of weakness.

http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.498.673&rep=rep1&type=pdf

Gantt Chart


9-Feb-18
19-Feb-18
1-Mar-18
11-Mar-18
21-Mar-18
31-Mar-18
10-Apr-18
20-Apr-18
30-Apr-18
10-May-18
Presentation Preparation
MTS Apparatus Design + Printing
Prototype Trials + Testing
Client Evaluation
Prototype Modification
New Prototype Testing Fatigue + Analysis

Budget

The client has offered a budget of $500.

Past Expenditures

- 3.54$ - 3D printing material costs
- 11.04$ - Screws, Nuts, Elastic Bands

Expected Expenditures

- None