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The Prosthetic Finger

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The Prosthetic Finger

By

Jose Garcia

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1: INTRODUCTION

Motivation:

This projects motivation is to be able to build a prosthetic finger that is capable of creating movement, by the help of a sensor that will interpolate a person's muscle movement. After this goal has been reached, the prosthetic finger strength will be tested to see if it accumulate the average poke, press, and pull force that a normal figure can create.

Function Statement:

An actuator is needed to interpolate the bodies muscle movement, so it can then transmit signals to its designated areas to be able to cause simultaneous movement and the required amount of force needed for the prosthetic finger.

Requirements:

The following requirements must be made: the prosthetic finger will be dimensioned to an average male finger size, once this is achieved the next task is to find the correct wire lengths diameters, hole sizes, and gears to move the finger to the correct length and angle.

- index finger needs to be 0.575inches wide and 0.5inches thick
- index finger length 6inches, index finger will weight 100grams
- number of pins needed 8
- pin height very from 2.192-7.125in
- pin diameter 0.5in
- number of Gears needed 2
- gear teeth count can be 6-12 teeth
- gear heights will be 1 inch, gear width between 1.25 and 1.75 in
- finger can extend and contract from 0 to 90 and 180 degrees, two wires
- casted material and gears are made from aluminum, some pins will be made from plastic and aluminum
- poke force needs to be 52.58N
- press force needs to be 50.90N
- Pull force needs to be 70.94N.

The cost of the project will be no more than 500 dollars, will start November 13th, finish by March 9th, and with an estimated time of 120 hours of work placed into building the prosthetic finger.

Success Criteria:

Equations that will be used to figure the prosthetic fingers movement and force involve:

Lengths of Wires 1 and 2 in relation to joint angle is by the following equations:
L2i = l20 + Ri (θ0i –θi)

$L1i = l10 – Ri (\theta 0i – \theta i)$
l1o = initial SMA Wire 1 length
l2o = initial SMA Wire 2 length
ș0i = initial joint angle of joint i
Ri = radius of rotation

Torque at joint i is given by the following equation: $\tau i = F1idi – F2di$
F1 = actuation force of Wire 1
F2 = opposing force of Wire 2
di = finger cross-sectional radius at tendon location

Stress in the wires equation: $\tau i = \sigma 1iAidi – \sigma 2iAidi$
σ 1 = actuation stress in Wire 1
σ 2 = opposing stress in Wire 2
Ai = cross-sectional area of SMA wires located at joint i

Scope of this effort:

The prosthetic finger will have at least two weeks of work put into every individual part built, with an average amount of 12 hours for every Friday that is in between the desired time line. The time line of the objects that will be made, first objective is to create a match plate and casting out the hand and finger, then the gears, pins, and actuator will be built. Finally, by January 1st the prosthetic finger will begin being assembled.

Benchmark:

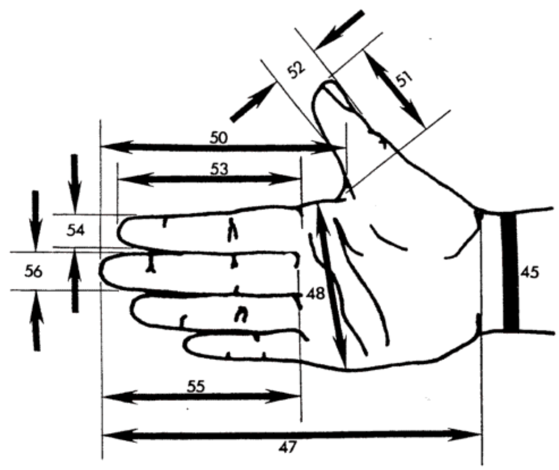
The prosthetic finger will comply and perform to match the required forces needed to poke, press, and pull once it’s built. The prosthetic finger will also be tested on how accurate it can interface without malfunctioning.

Success of the project:

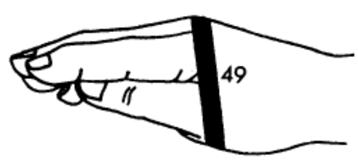
When the prosthetic finger is able to reach its required forces and movement capabilities it will become a success, while still meeting its weight requirement.

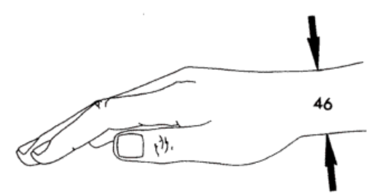
DESIGN & ANALYSIS

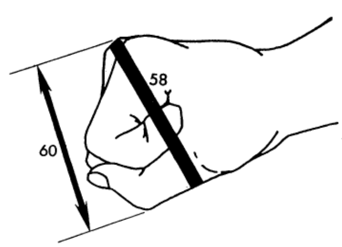
The prosthetic finger will be tested in achieving these simple motion functions like extending, contracting, making a hook, moving in a perpendicular, and lateral movement. Once this goal is achieved, the next step is to test the prosthetic fingers strength in its poke, press, and pull motion to be able to know how much it can apply and then comparing it to a normal person's force it can apply. The prosthetic finger will be created by casting small hollow finger and hand parts, then creating small gears and pins to increase rotational movement, and finally attaching a sensor on the inside of the hand so it can sense a person's muscle movement. The sensor and components attached to it will act as an actuator, so it can then choose which of the parts in the system it need to move to be able to create movement needed. All the numbers on the hand represent what will be measured with a caliper to acquire a person's average hand and finger size, to then be able to build a functioning prosthetic finger that corresponds to an average body structure.



46 Wrist Breadth
48 Hand Breadth
49 Mimimun Hand Clearance
50 Thumb Crotch-Middle Finger Length
51 Thumb Length
52 Thumb Diameter
53 Index Finger Length
54 Index Finger Diameter
55 Middle Finger Length
56 Middle Finger Diameter
58 Maximum Fist Circumference
59 Maximum Fist Breadth
60 Maximum Fist Depth







A1: Calculation of Steel Wire Size

The analysis of calculating the steel wire is that by using the shear stress and area of a circle equation the wires diameter can be found. Then from this, the diameter of the wire can be compared to an actual gage wire diameter, so the actual wire diameter can be found.

A2: Range of motion finger knuckle

The range of motion for the finger knuckle will measure and calculated to be able to receive the correct angle needed.

A3: Find the size of the gear to get the circumference

Once the size of the gear is determined and the circumference is also, then rotations of the wire rapping around the gear can be determined.

A4: Articulate movement predict how far it needs to move the finger and wire

The length and distance between the anchored pin and the gear rotating the wire need to be solved so the movement of the finger and wire can be determined.

A5: Finger Pressure to overcome the actuator

The amount of pressure needs to be determined from the actuator, so the actual amount force from the finger can be determined.

A6: Calculate the coefficient of friction

Coefficient of friction needs to be determined, so people know what exactly the prosthetic finger can grasp.

A7: Joint Friction

For each of the joints the friction in between finger knuckle needs to be determined, so the amount of movement is known correctly.

A8: Calculate press fit of the pin to the part of the knuckle

The pins and the finger joints center distance needs to be determined correctly between them so the right amount of movement and friction is needed.

A9: Actuator life time

The life time of the actuator needs to be determined, so people can be aware of how long the actuator can function and what its limitations are.

A10: Deflection at the highest load of 6Ib

This beam deflection of the finger needs to be solved for at the tip of the finger so the maximum amount of deflection can be determined.

A11: Calculating press fit pin to gear

The pin and gears center distance needs to be determined correctly between them so the right amount of movement and friction is needed.

A12: Pin Diameter

The pin diameter needs to be determined, so the right amount of force is needed to sustain the wires in the corrected areas needed.

REQUIRED:

All measurement need to accurate to an average sized finger, hand, so the prosthetic finger can be built and function properly.

Weight of the material need to be taken into consideration so the prosthetic finger doesn't weight more than its suppose to.

The design parameters that will be obtained from the analyses are the dimensions and shape of the prosthetic finger, pins, gears, and sensor material.

Able to create rotational movement, with the pointer finger.

Able to contract and extend the pointer finger.

Able to simultaneously, move the pointer finger as it has contracted.

To transmit enough power between the gears and pins to move the individual parts correctly.

To receive enough power through machine elements without malfunctioning.

Finally, these parameters will be documented in the technical drawings as the device is rendered.

Predict performance of your device:

The prosthetic finger is able to move the finger from the designated angles in between zero to three seconds. The prosthetic finger is able to rotate its finger in between zero to one minute and thirty seconds.

METHODS & CONSTRUCTION

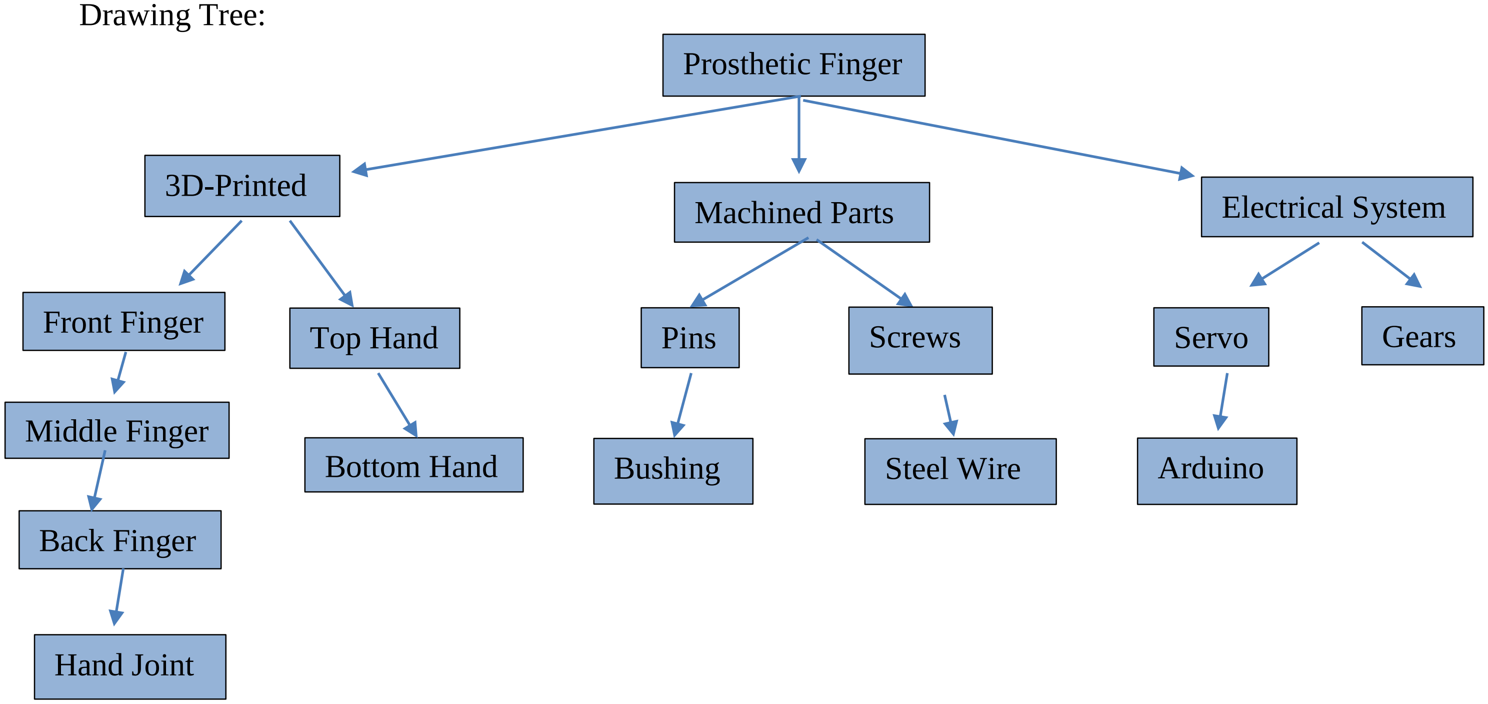
Write out how you intend to make your solution happen.

This project was conceived by first devising ideas on how to be able to create a prosthetic finger in a more time manageable manner, so it can accomplish its goals of creating the required movement and force needed. The prosthetic finger will be analyzed by meeting the specific measurements, angles, and forces requirements. The design will take place at CWU, while working within the constraints of our university resources in Hogue the parts being created will possibly be made in the computer, machine shop, casting, and electricity lab.

Describe construction of the device:

The first step will be to construct the prosthetic finger on solid works in the computer lab. The prosthetic finger itself will be built in four sections. The four sections is the distal, middle, and proximal phalanx of the index finger, and a hand with other fingers to support the prosthetic finger being created. These sections will be created from 3D printing it out of ABS Plastic, so each part can be very exact. Each part will be first created on solid works to be able to make the prosthetic finger and hand so its 3D printed correctly. Once this step has been finished, the next step will be to purchase the gears and machine the pins to size in the machine shop lab. Finally, after these steps have been made an actuator will be bought so it can be coded correctly so it can send signals to the corresponding locations to be able to move the prosthetic finger correctly.

Drawing Tree:



Refer to renderings:

You should be able to refer to the JRRD Volume 50, Number 5, 2013 Page 599 – 618 Mechanical design and performance specifications of anthropomorphic prosthetic hands, specifically on the Bebionic V2 Fingers conforming drawings in Appendix B with a drawing tree. The prosthetic finger Bebionic V2 shall be compared to an original design. The website where this information and standards have been gather is from http://www.rehab.research.va.gov/jour/2013/505/pdf/belter505.pdf

Device Operation:

The operation of the device is to use gears and pins to be able to move the prosthetic finger to certain lengths. A steel wire will be anchored at the end of the finger as there is a track leading to the hollow inside body of the prosthetic hand, this track is for the steel wire. As the steel wire follows the track it will lead to the inside on the hand which then the other end of the wire will be crimped to a pin. The wire is crimped to the pin because the pin is press fitted to a spiral bevel gear and once it rotates it will wind the wire so it can contract it or extend the finger. The spiral bevel gears that are meshed together will rotate by one of them being attached to a servo which gives off a certain amount of rpm which is told by an Arduino which is coded so it tell it what to do and the Arduino is powered by batteries which are giving off 6 volts.

Benchmark Comparison:

This project will be made mostly out of gears and pins, instead of the Bebionic V2 advance features the prosthetic finger obtains.

Performance Predictions:

The efficiency of the device is predicted to be 80% and will be tested conforming to JRRD Volume 50 standard procedures of testing the finger on a pad to obtain its required designated demands.

TESTING METHOD

Test Plan:

The prosthetic finger use a stop watch to measure how fast it will take to reach its target time, a protractor will be used to measure what angles it is able to reach, and a pad and the boards from the electricity room will be used to measure the force its able to accomplish.

Test Documentation and Deliverables:

The data will all be saved on excel, after every thing has been tested and measured. The prosthetic finger will be tested five different times to be able to represent how concentric it is and to also be able to tell what needs to be changed.

BUDGET/SCHEDULE/PROJECT MANAGEMENT

Cost and Budget:

A parts list is shown in Appendix C. The parts list details their identification, description (specifications), sources and cost as shown in Appendix D.

Some of the assemblies will require 3D printing them out.

The cost of this project will be payed out of pocket.

Labor costs are separated out and correlated to the time shown in the schedule.

The total cost of this project is estimated to be $500.00.

Schedule:

The scheduling issue has to do with creating a prosthetic finger that can meet the performance specifications within a reasonable time-frame.

The schedule for this project is constrained by the MET 495 course and is shown in Appendix E. A schedule guide has been provided, it will start on November 13th, finish by March 9th, and with an estimated time of 120 hours of work placed into building the prosthetic finger.

Create Tasks:

There is going to be five tasks to accomplish creating the prosthetic finger. The first task is to build a match plate of a hand and several finger parts, the start date is 11/13/15 and ends 11/27/15. The second task is to build gears, the start date is 11/27/15 and ends 12/4/15. The third task is to build pins, the start date is 12/4/15 and ends 12/18/15. The fourth task is to build an actuator, the start date is 12/18/15 and ends 1/1/16. The final task is to assemble the prosthetic finger together, the start date is 1/1/16 and ends 1/15/16. The amount of hours put in is 12 hours on Fridays and 2 to 3 hours every day in between the start and end date.

Create Milestones:

The cast will be the shell of the hand, the gears and actuator will act as a sensor to tell where the prosthetic finger should move and what its limitations are, and the pins will be the length of the prosthetic finger.

Project Management:

This project will succeed due to the availability of appropriate technical expertise and resources. Test equipment is available to use for in the computer, machining, and electricity lab.

Resume is shown in Appendix J.

DISCUSSION

About a week into the project, the project was adjusted from focusing on a prosthetic hand to being able to create one prosthetic finger. Throughout the process of creating the prosthetic finger, the design was changed several times because it needs to be simplified to be able to finish the project within the required time limit. The process was successful, but actually trying to build and design was not very successful at first. Attempting to create a prosthetic finger on Solidworks is rather difficult, and attempting to create the parts needed is going to be rather difficult because of how small the parts need to be. When first starting the project a lot of research was done on past prosthetic hands and it was built and assembled. The research was mainly focused on how these several types of prosthetic hands made their finger(s) and how they were able to cause movement. Most of the information was gathered from online sources and videos from youtube were also watched to be able to comprehend the steps and building process others have gone through. Since, every prosthetic limb varies in its design and values. A hand and finger were chosen at random to receive the measure ments needed to create the prosthetic hand and finger. Once the hand was chosen, it was measured by a caliper, then the measurements were put into a Soliworks drawing to build the prosthetic hand, and finger. After, this was accomplished the rest of the objects were placed inside and the calculations were solved for to insure that the prosthetic finger is functioning properly. The solidwords design is separated into fourteen different sketches; the first sketch is a full assembly drawing, the second is an exploded view of the full assembly, the third is a sub-assembly of just the prosthetic finger, the next four drawings are the four parts that make up the prosthetic finger, the seventh drawing is the pin joint that holds the fingers in their place, the next too drawings is the hollow hand separated into two parts (top and Bottom) so it can be able to hold the objects on the inside of it, the tenth drawing is a pin that is placed in the center of the wire hole that runs through the finger so it can be anchored to that point, the eleventh drawing is a pin to hold the spiral bevel gear in place, the twelfth drawing of the spiral bevel gear, the thirteen drawing is of the battery and the final drawing is of the servo.

CONCLUSION

The prosthetic finger has been conceived, analyzed and designed which meets the function requirements presented. Parts have been specified, sourced and budgeted for acquisition. With this information, the device/model is ready to be created. This proposal should be accepted and completed because the process for building the prosthetic finger can be done within a reasonable amount of time while costing less than an average prosthetic hand and finger. The project of creating the prosthetic finger should be created by the author because he has the necessary tools to finish the product. While the author attends Central Washington University, the university has all the necessary resources that can be used to accomplish this project like the computer, machining, and electricity lab. The university also has professors and classes that are able to provide the necessary guidance and appropriate skills to learn how to use the resources and how to accomplish the task at hand, while meeting all requirements.

This project meets all the requirements for a successful senior project, including:

1. Having substantive engineering merit in both heat transfer and structural areas
2. Size and cost within the parameters of our resources
3. Being of great interest to the principal investigator

The new design prosthetic finger was a success in both performance and design. It showed improvements over the benchmark in all four areas:

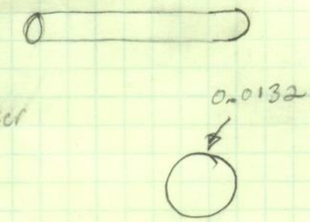
4. Cost: For example the project cost stayed in between 50 to 100 dollars while the benchmark prosthetic costed between 200 to 600 dollars depending on which type of material (plastic) was used in the process of creating and assembling it.
5. Time limit: The amount of time to build the prosthetic finger will be made in four weeks, while the benchmarked prosthetic finger took six weeks to create.
6. The cost was reduced by 50% to 60%
7. The manufacturing process was simplified from 10 to 5 processes.

ACKNOWLEDGEMENTS

In the process of creating this project, a large amount of support came from Central Washington University Engineering department. Several professors from the Mechanical Engineering Technology supported in the aid and guidance in accomplishing the project of creating prosthetic finger. Also, the machine shops in Hogue were used to create, build, and assemble the prosthetic finger together.

Jose Garcia | MET 495A | 11/23/15 | 1/1

Given: Steel wire $F = 6\ lbs$
pg 725 Material SAE 1020 Cold Drawn
Yield Strength 51 ksi



Find: Solve for minimum Steel Wire diameter

Sol'n: $51\ ksi \left(\frac{1000\ psi}{1\ ksi}\right) = 51000\ psi$

$$\sigma_{max} = \frac{F}{A_s} \qquad A_s = \left(\frac{\pi}{4}\right) D^2$$

$$A_s = \frac{F}{\sigma_{max}}$$

$$A_s = \frac{6\ lbs}{51000\ psi}$$

$$A_s = 0.000117647\ in^2$$

$$A_s = \left(\frac{\pi}{4}\right) D^2$$

$$D = \sqrt{\frac{A_s}{\frac{\pi}{4}}}$$

$$D = \sqrt{\frac{0.000117647\ in^2}{\frac{\pi}{4}}}$$

$$D = 0.01224\ in$$

Using the website Ted Pella Inc. the closes wire diameter is

No. of Wire Gage	Steel Wire Diameter Gage
31	0.0132

Figure A-1: Calc. of Steel wire Size

Jose Garcia | MET 495A | 12/28/15 . 1/1

Given:

Find: What's the range of each finger knuckle

Sol'n:

By using a Caliper the degrees of each Knuckle when its bent goes from 0 to 60 degrees

Figure A-2: Range of Motion Finger knuckle

Jose Garcia | MET 495A | 12/28/15. | 1/1

Given: Outer Diameter of Gear
$D = 1.09$ inches
Hub Diameter
$D = 0.75$ in

Find: Circumference of the Gears Outer and Hub Diameter.

Sol'n: $C = \pi D$

Outer Diameter

$C = (\pi)(1.09\text{ in})$

$\boxed{C = 3.42\text{ in}}$

Hub Diameter

$C = (\pi)(0.75\text{ in})$

$\boxed{C = 2.36\text{ in}}$

Figure A-3: Circumference of Gear Diameter

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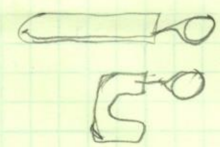
Given: Length $L = 5.107 in$
Circumference $c = 3.42 in$



Find: Articule movement predict how far Gears need to move finger and wire

Sol'n:

(Circumference)(Revolutions) = Distance

$$c \cdot R = D$$

$$R = \frac{D}{c}$$

$$R = \frac{5.107 in}{3.42 in}$$

$$\boxed{R = 1.49 \text{ rev}}$$

It will take one and a half revolutions of the gear to turn to completely contract & decontract the finger.

Figure A-4: Articulate Movement in finger

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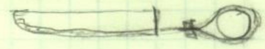
$1\ Pa = N/m^2 = N/mm^2$

Given: Theoretical Values $1in = 25.4mm$



Fixed-Fixed $K = 0.5$

Diameter $D = 0.685in$ or $17.399mm$

Yield Strength $S_y = 6330psi$ or $43643813.67 Pa$ or $43,64381\ N/mm^2$

Modulus of Elasticity $E = 2.25 GPa$ or $2.25 \cdot 10^9 N/m^2$ or $326334.78 psi$

Length $L = 5.107in$ or $2250 N/mm^2$

Find: Compute critical Load for the column for finger pressure to overcame actuator

Sol'n:

Effective Length equals the actual Length

$KL = (0.5)(5.107in) = 2.5535in \left(\frac{25.4mm}{1in}\right) = 64.86mm$

Solid round section $r = \frac{D}{4} = \frac{0.685in}{4} = 0.17125in \left(\frac{25.4mm}{1in}\right) = 4.34975mm$

Slenderness Ratio $\frac{KL}{r} = \frac{64.86mm}{4.34975mm} = 14.91$

Column Constant $C_c = \sqrt{\frac{2\pi^2 E}{S_y}} = \sqrt{\frac{2\pi^2(326334.78psi)}{6330psi}} = 31.90$

$KL/r < C_c$ Column is Short. Johson Formula should be used

Area $A = \frac{\pi D^2}{4} = \frac{\pi(17.399mm)^2}{4} = 237.76mm^2$

Critical Load

$$P_{cr} = AS_y\left[1 - \frac{S_y(KL/r)^2}{4\pi^2 E}\right]$$

$$P_{cr} = (237.76mm^2)(43.64381\ N/mm^2)\left[1 - \frac{(43.64381\ N/mm^2)(14.91)^2}{4\pi^2(2250\ N/mm^2)}\right]$$

$P_{cr} = 9242.61\ N$

$P_{cr} = 9.24 \cdot 10^3\ N$

$\boxed{P_{cr} = 9.24\ kN}$

This is the critical buckling Load. Apply design factor to determine allowable load

$N = 3$ $P_a = \frac{9.24kN}{3} = 3.08kN$

Figure A-5: Finger Pressure to Overcome Actuator

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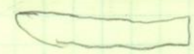
Given: Finger Length $L = 5.107in$
Load Force $F = 6lbs$



Find: Calculate Coefficient of friction

Sol'n:

$$6lbs\left(\frac{4.448N}{1lbs}\right) = 26.688N$$

$1N = 1kg\ m/s^2$

$$5.107in\left(\frac{0.0254m}{1in}\right) = 0.13m$$

$$26.688N\,(0.13m) = 3.47N\cdot m$$

$$F = uN$$

$$u = \frac{F}{N} = \frac{26.688N}{3.47N}$$

$$\boxed{u = 7.69m}$$

Figure A-6: Calc Coefficient of friction

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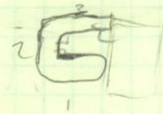

Given: $F = 6$ lbs $= 26.688$ N

Degrees $\theta = 60$

1st Length $L = 1.2979$ in

2nd & 3rd Length $L = 1.6208$ in

4th Length $L = 0.9200$ in

Find: Calculate the joint friction

Sol'n:

$$\circlearrowleft + \Sigma M = 0$$

$$u + (1.2979in)(\sin 90) - (1.6208in)(\cos 90) + (1.6208in)(\sin 90) - (0.9200in)(\sin 90) = 0$$

$$u = \frac{2.9187 \sin(60)}{-2.9187 \cos(60)}$$

$$u = -1 \tan(60)$$

$$\boxed{u = -1.732}$$

Figure A-7: Joint Friction

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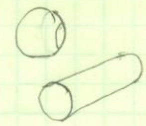
Given: $F = 6 lbs$

Area Shaft $A = 0.1434 in^2$

Area Pin $a = 0.4304 in^2$



Find: Calculate Pressfit of the Pin to the part of the Knuckle

Sol'n:

$$6 lbs \left(\frac{4.448 N}{1 lbs}\right) = 26.688 N$$

$$0.1434 in^2 \left(\frac{0.0254 m}{1 in}\right)^2 = 0.000092516 m^2$$

$$0.4304 in^2 \left(\frac{0.0254 m}{1 in}\right)^2 = 0.000277677 m^2$$

$$P = \frac{(A \cdot a \cdot F)}{2}$$

$$P = \frac{(0.000092516 m^2)(0.000277677 m^2)(26.688 N)}{2}$$

$$\boxed{P = 0.000000343 N \cdot m^2}$$

Figure A-8: Calc Pressfit of Pin to Knuckle

Jose Garcia | MET 495A | 12/28/15 | 1/1

Given: Voltage $V = 6.0V$
Load $F = 6 lbs = 26.688 N$
Velocity $V = 77.11 m/s$
Farad $\mu F = 0.155496$

Find: Actuator life time

Sol'n:

Mechanical Power

$P_o = F \cdot V$

$P_o = (26.688 N)(77.11 m/s)$

$P_o = 2057.79$

Electrical Power

$P_i = E \cdot I \qquad I = \frac{P_i}{E}$

$I = \frac{2057.79}{6V}$

$I = 342.97$

Resistance

$R = \frac{V}{I} = \frac{6V}{342.97} = 0.0175$

Capaciter

$C = \frac{Q}{V} = \frac{0.155496}{6V} = 0.025916$

Life time

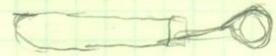
$T = rc$

$T = (0.0175)(0.025916)$

$\boxed{T = 0.00045353 \text{ sec}}$

Figure A-9: Actuator Life time

Jose Garcia | MET 495A | 12/28/15 | 1/1



Given: Load $F = 6\ Ib$
Length $L = 5.107in$
Modules of Elasticity $E = 326334.78psi$
Diameter $D = 0.685in$

Find: Calc Deflection at the highest Load

Sol'n: $I = \frac{\pi D^4}{64} = \frac{\pi (0.685in)^4}{64} = 0.01081 in^4$

$$Y = \frac{-PL^3}{3EI}$$

$$Y = \frac{-(6Ib)(5.107in)^3}{3(326334.78psi)(0.01081in^4)}$$

$$Y = -0.076in$$

$$\boxed{Y = 0.076in \downarrow}$$

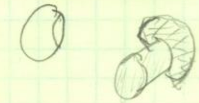
Figure A-10: Calc deflection at the highest Load

Jose Garcia | MET 495A | 12/28/15 | 1/1

Given: $F = 6\ \text{lbs}$

Area Shaft $A = 0.08835729\ \text{in}^2$

Area Pin $a = 1.4726\ \text{in}^2$



Find: Calculate Pressfit of the Pin to the Gear

Sol'n:

$$6\ \text{lbs}\left(\frac{4.448\ N}{1\ \text{lbs}}\right) = 26.688\ N$$

$$0.08835729\ \text{in}^2\left(\frac{0.0254\ m}{1\ \text{in}}\right)^2 = 0.000057005\ m^2$$

$$1.4726\ \text{in}^2\left(\frac{0.0254\ m}{1\ \text{in}}\right)^2 = 0.000950063\ m^2$$

$$P = \frac{(A \cdot a \cdot F)}{2}$$

$$P = \frac{(0.000057005\ m^2)(0.000950063\ m^2)(26.688\ N)}{2}$$

$$\boxed{P = 0.000000723\ N \cdot m^2}$$

Figure A-11: Calc Pressfit Pin to Gear

Given: $F = 6\ lbs$

Yield Strength Abs Plastic

$S_y = 6330\ psi$

Find: Pin Diameter

Sol'n: $\sigma_{max} = \frac{F}{A_s}$

$$A_s = \frac{F}{\sigma_{max}}$$

$$A_s = \frac{6\ lbs}{6330\ psi}$$

$$A_s = 0.000947867\ in^2$$

$$A_s = \left(\frac{\pi}{4}\right) D^2$$

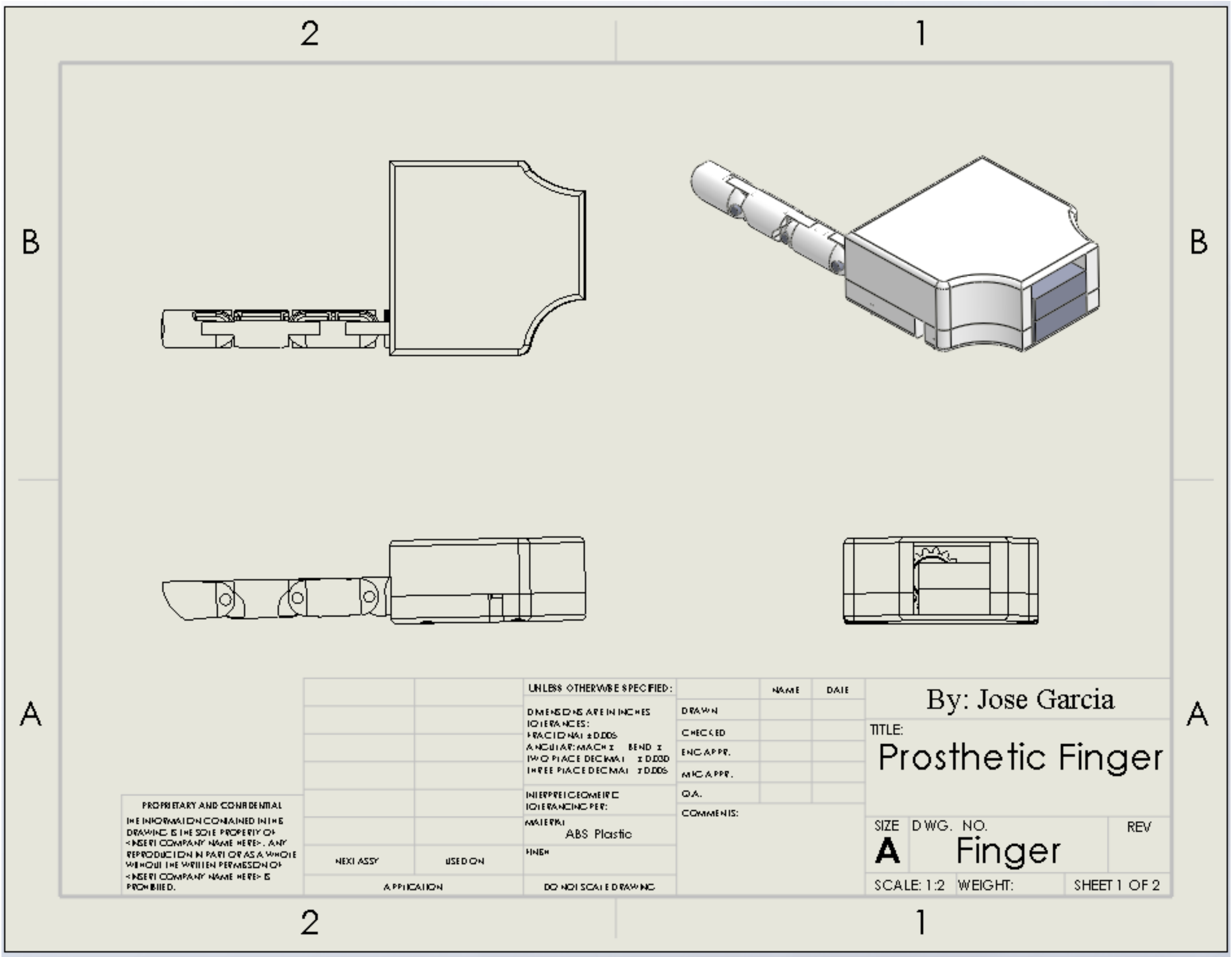
$$D = \sqrt{\frac{A_s}{\frac{\pi}{4}}}$$

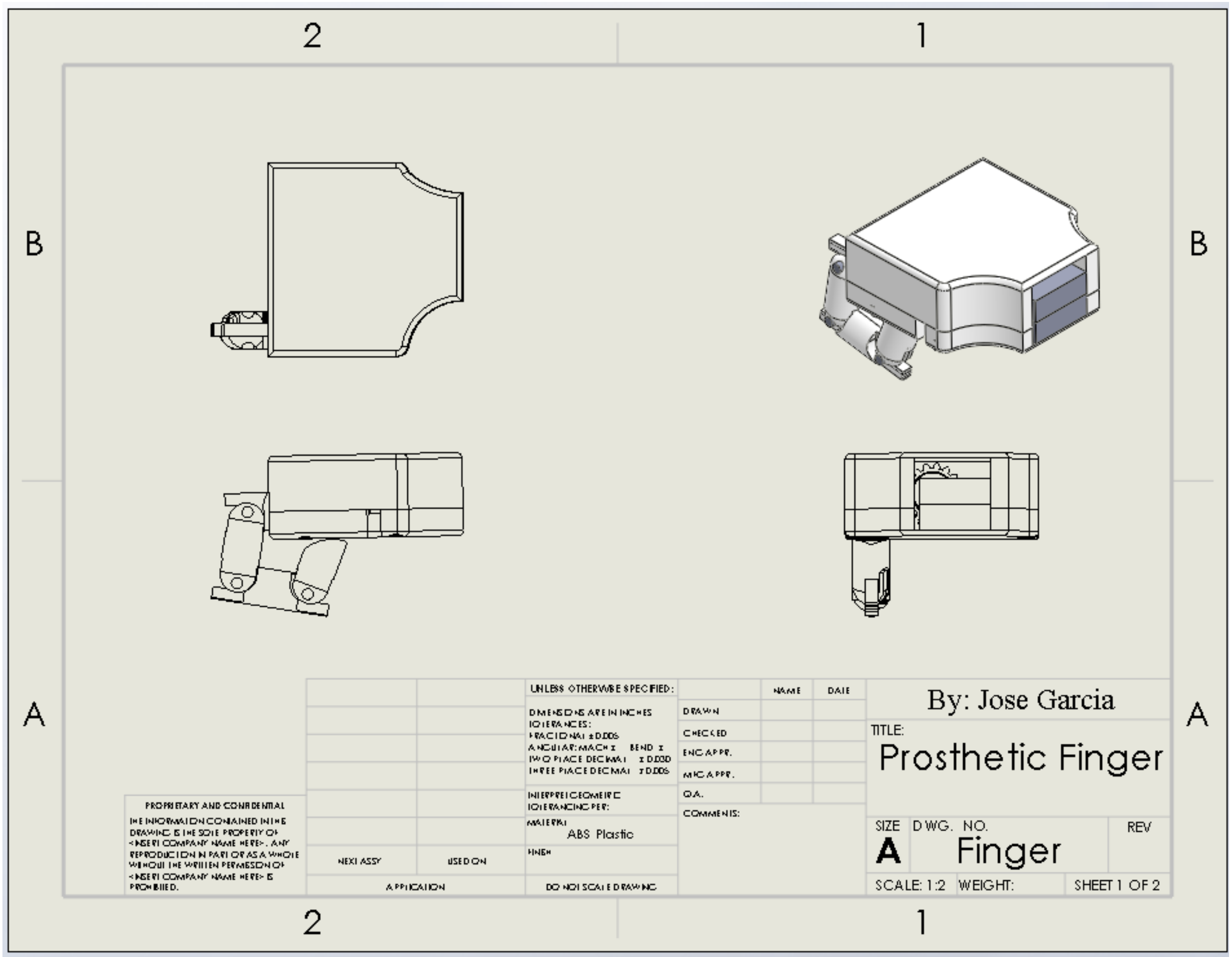
$$D = \sqrt{\frac{0.000947867\ in^2}{\frac{\pi}{4}}}$$

$$\boxed{D = 0.03474\ in}$$

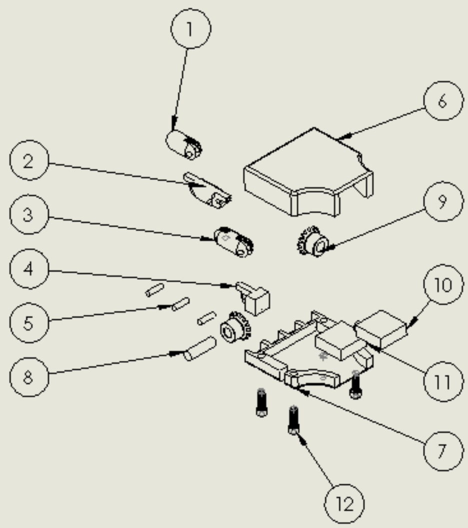
Figure A-12: Pin Diameter

APPENDIX B – Sketches, Assembly drawings, Sub-assembly drawings, Part drawings





2
1
B
A
UNLESS OTHERWISE SPECIFIED:
NAME
DATE
By: Jose Garcia
DRAWN
CHECKED
ENG APPR.
MFG APPR.
Q.A.
COMMENTS:
TITLE:
Prosthetic Finger
ABS Plastic
NEXT ASSY
USED ON
APPLICATION
DO NOT SCALE DRAWING
PROPRIETARY AND CONFIDENTIAL
SIZE
A
DWG. NO.
Finger
REV
SCALE: 1:2
WEIGHT:
SHEET 1 OF 2



ITEM NO.	PART NUMBER	DESCRIPTION	Exploded View/QTY.
1	Front_Finger_1		1
2	Middle part finger		1
3	End part finger		1
4	Hand_Joint		1
5	Pin_0.20		3
6	Hand_Bottom		1
7	Hand_Top		1
8	Pin_0.375		1
9	Spiral_Bevel_Gear		2
10	Servo		1
11	Battery		1
12	91221A965		4

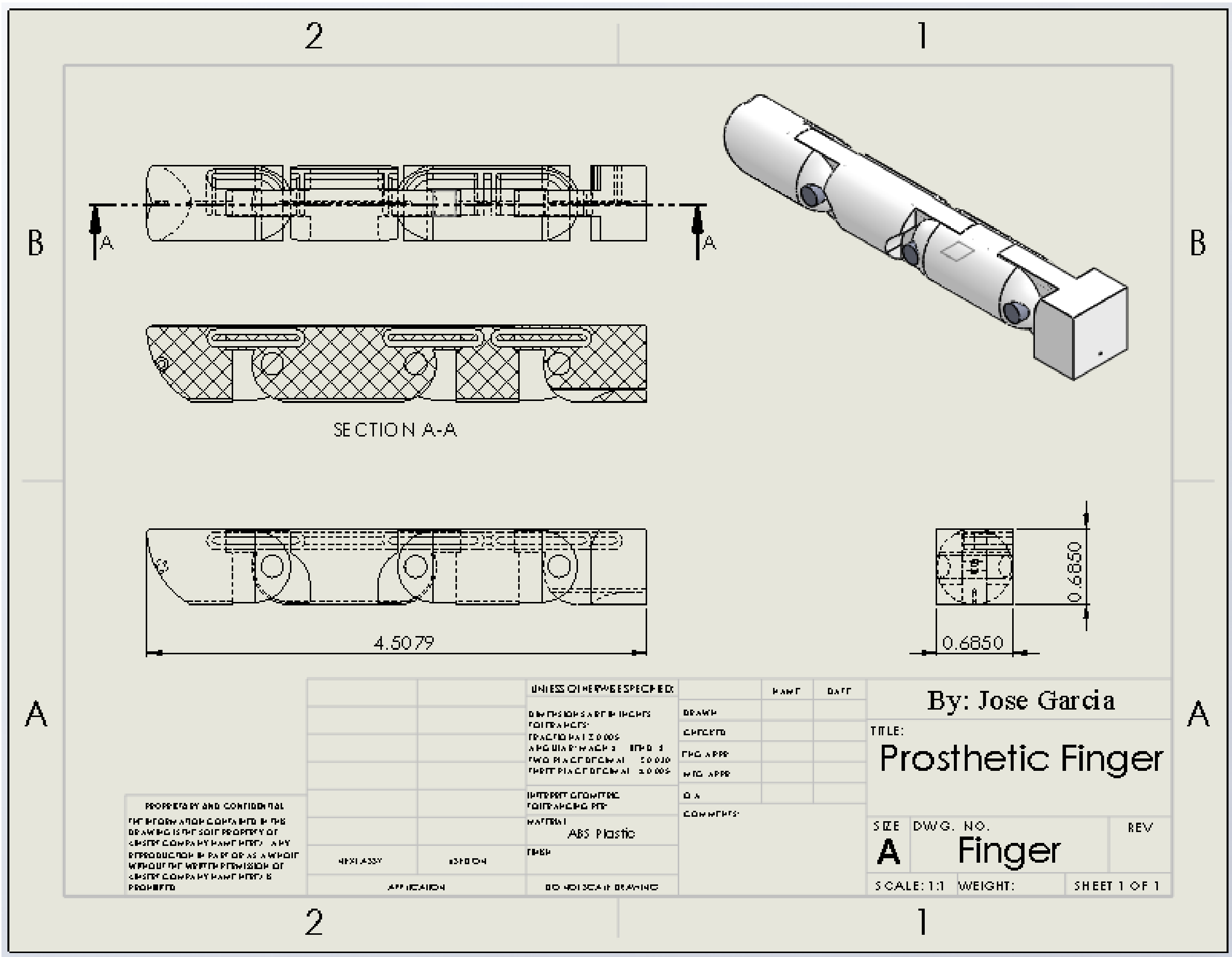
By: Jose Garcia

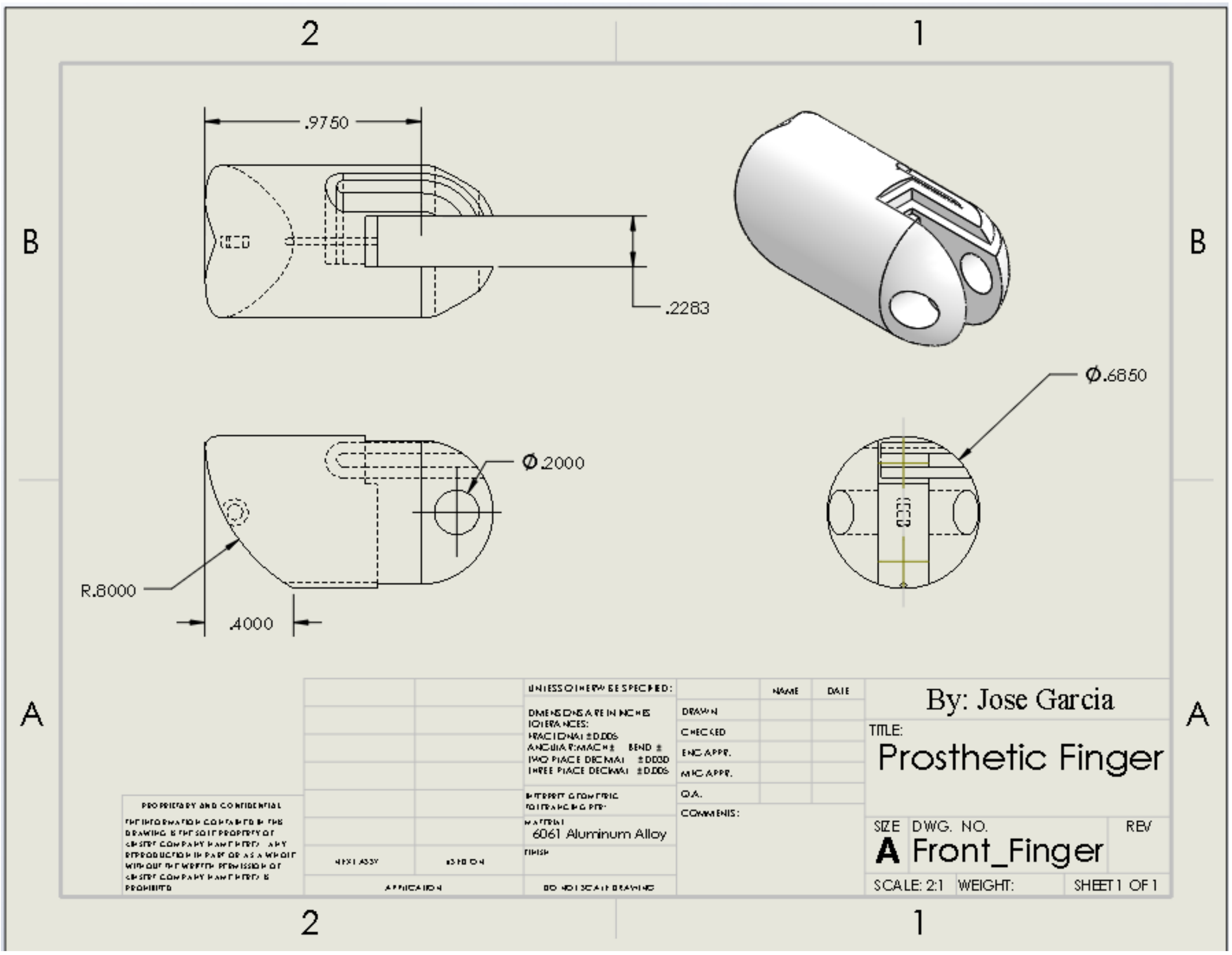
TITLE: Prosthetic Finger

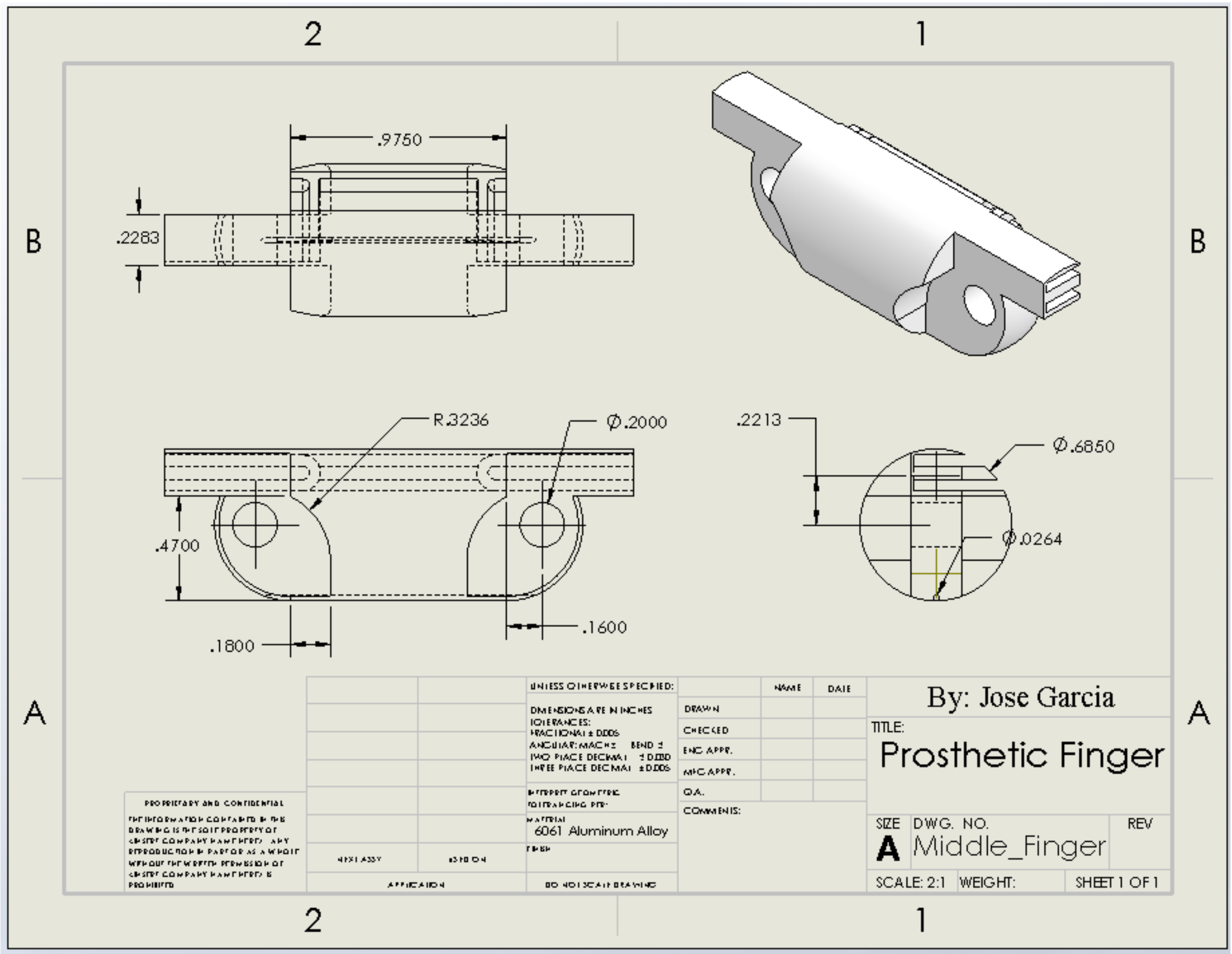
MATERIAL: ABS Plastic

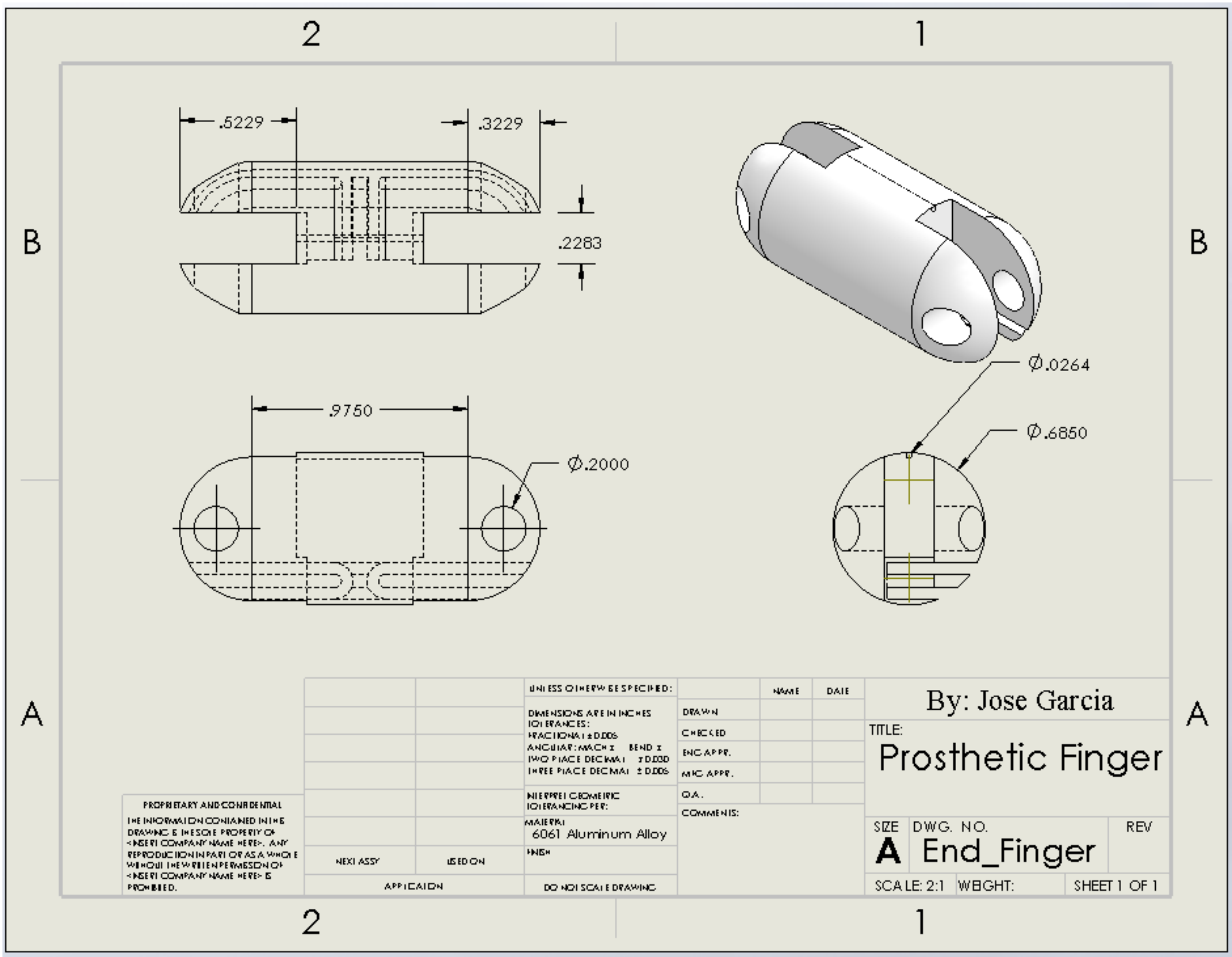
SIZE A DWG. NO. Finger REV

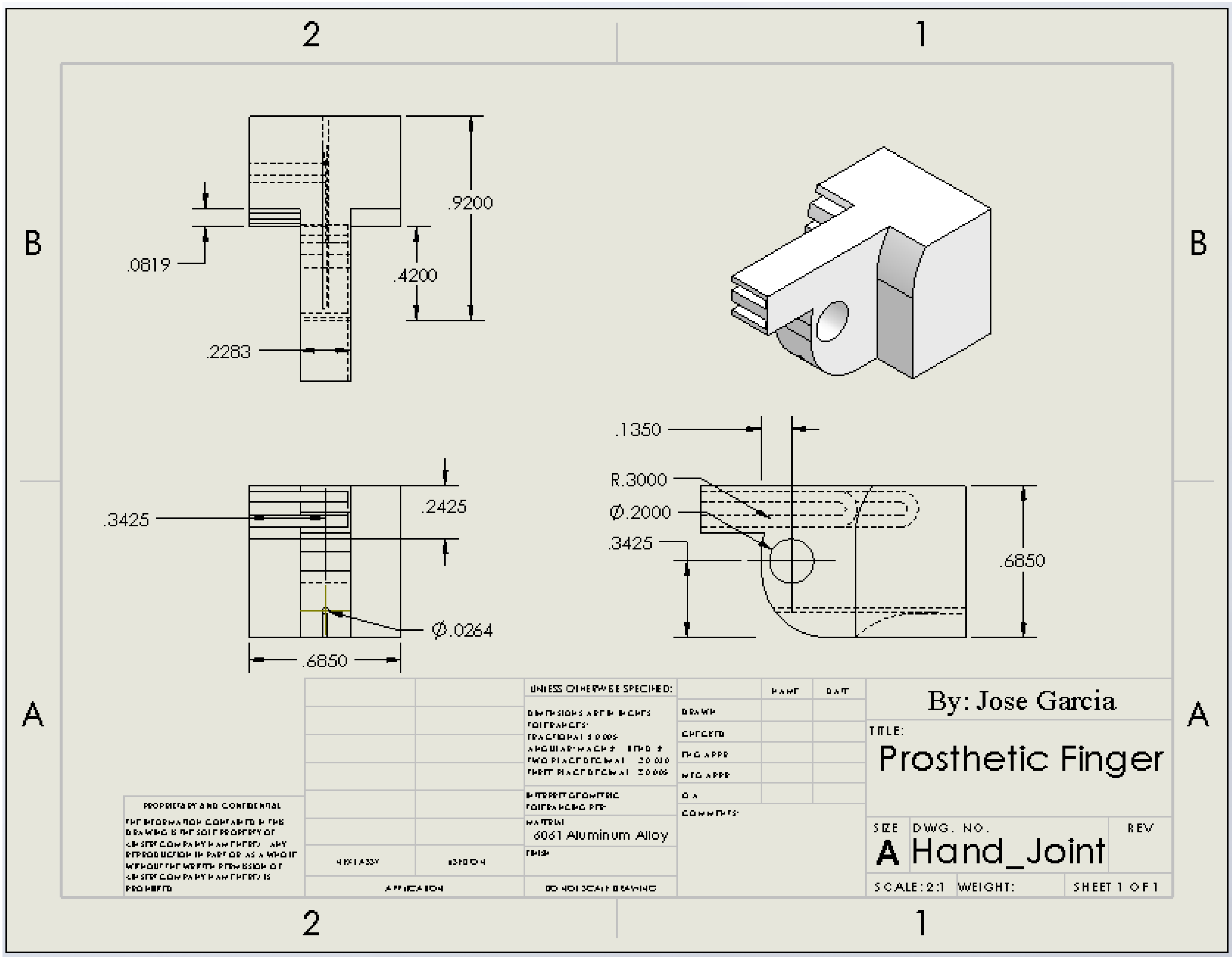
SCALE: 1:2 WEIGHT: SHEET 2 OF 2


SECTION A-A
4.5079
0.6850
0.6850
By: Jose Garcia
TITLE:
Prosthetic Finger
ABS Plastic
SIZE
A
DWG. NO.
Finger
REV
SCALE: 1:1
WEIGHT:
SHEET 1 OF 1


.9750
.2283
Ø.6850
Ø.2000
R.8000
.4000
By: Jose Garcia
TITLE:
Prosthetic Finger
SIZE
DWG. NO.
REV
A
Front_Finger
SCALE: 2:1
WEIGHT:
SHEET 1 OF 1
6061 Aluminum Alloy
UNLESS OTHERWISE SPECIFIED:
NAME
DATE
DRAWN
CHECKED
ENG APPR.
MFG APPR.
Q.A.
COMMENTS:
PROPRIETARY AND CONFIDENTIAL
NEXT ASSY
USED ON
APPLICATION
DO NOT SCALE DRAWING


.9750
.2283
R.3236
Ø.2000
.2213
Ø.6850
Ø.0264
.4700
.1600
.1800
By: Jose Garcia
TITLE:
Prosthetic Finger
MATERIAL
6061 Aluminum Alloy
SIZE
A
DWG. NO.
Middle_Finger
REV
SCALE: 2:1
WEIGHT:
SHEET 1 OF 1
NAME
DATE
DRAWN
CHECKED
ENG APPR.
MFG APPR.
Q.A.
COMMENTS:
NEXT ASSY
USED ON
APPLICATION
DO NOT SCALE DRAWING
PROPRIETARY AND CONFIDENTIAL


.5229
.3229
.2283
.9750
Ø.2000
Ø.0264
Ø.6850
By: Jose Garcia
TITLE:
Prosthetic Finger
6061 Aluminum Alloy
SIZE A
DWG. NO.
End_Finger
REV
SCALE: 2:1
WEIGHT:
SHEET 1 OF 1
PROPRIETARY AND CONFIDENTIAL
DO NOT SCALE DRAWING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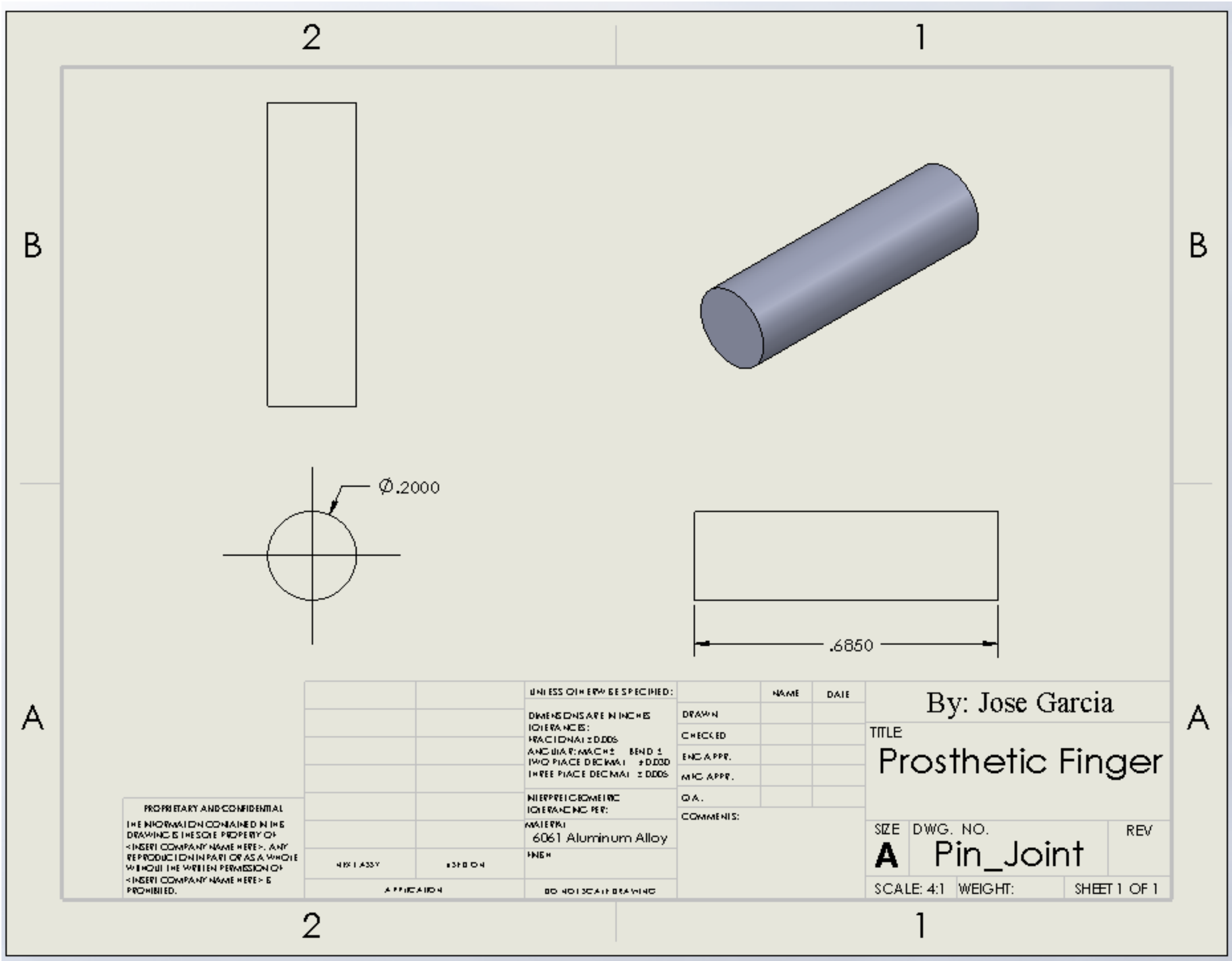
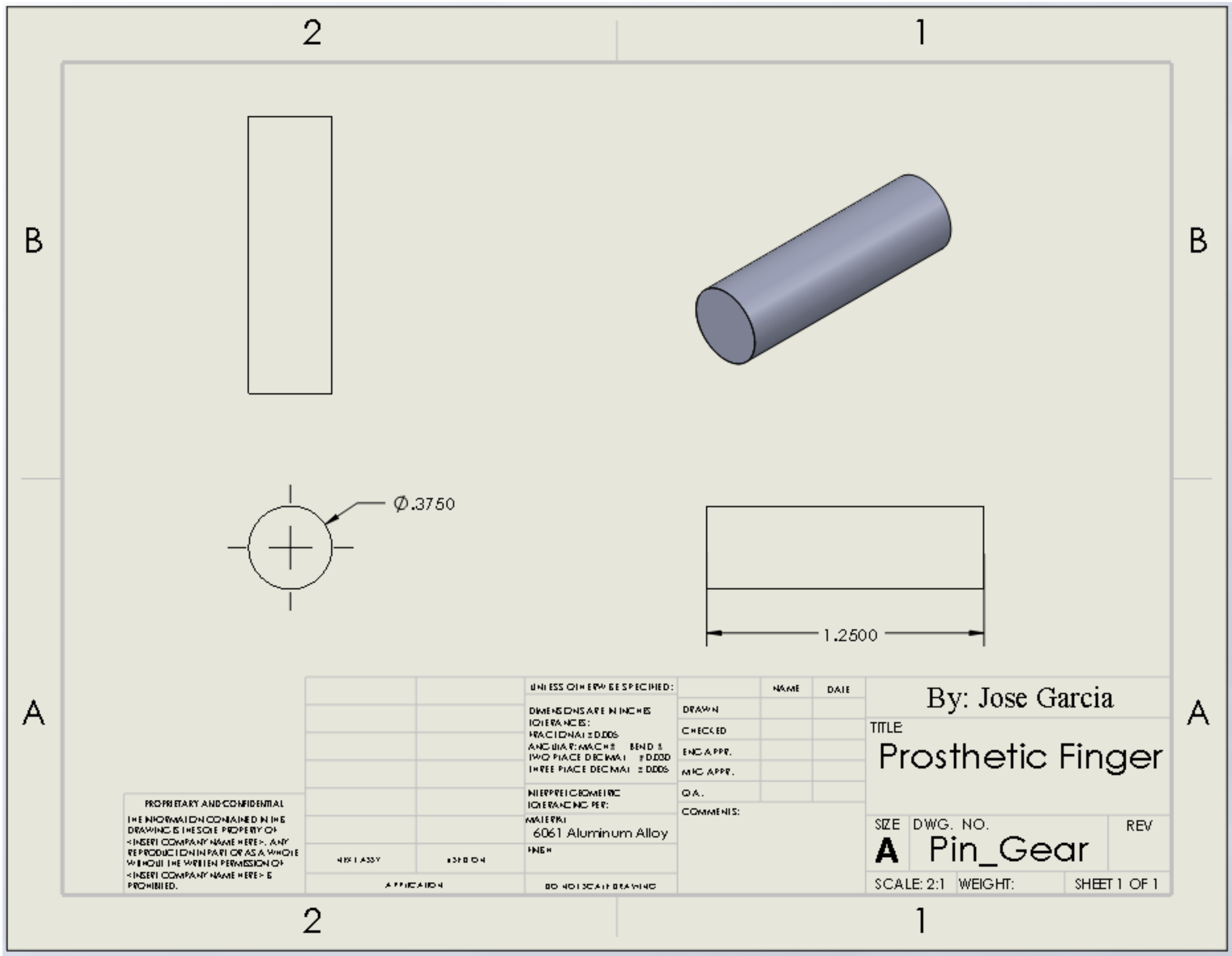
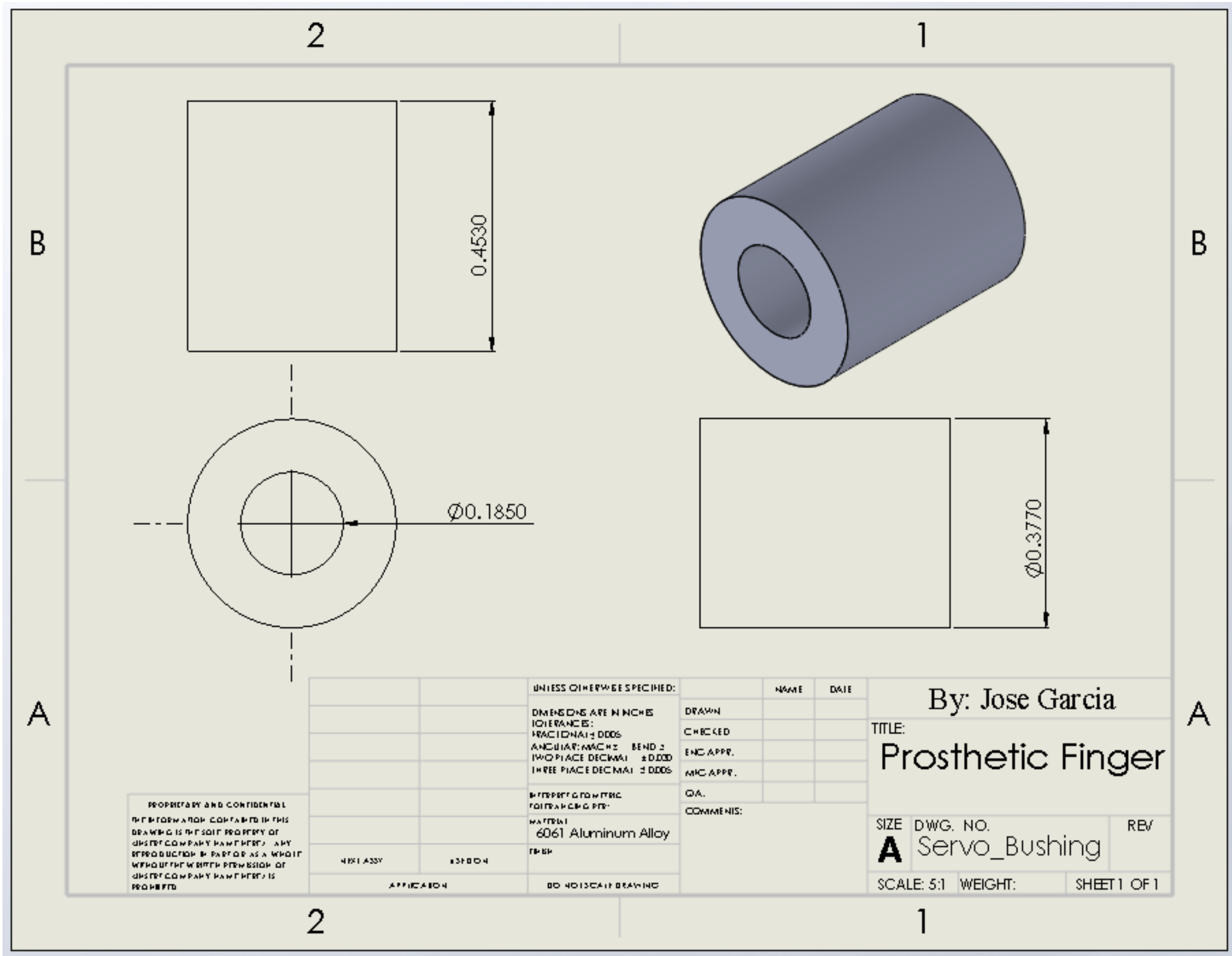
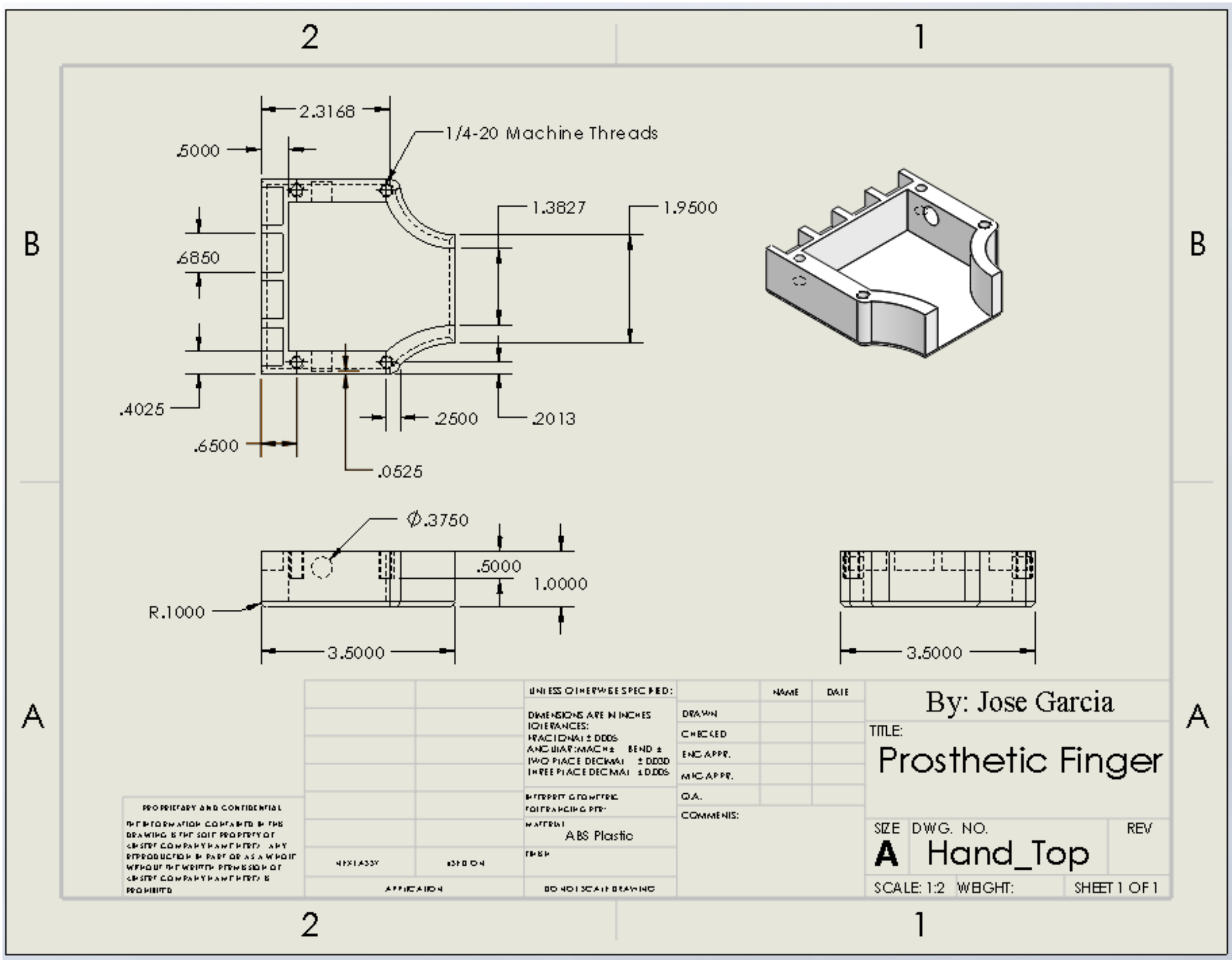
.0819
.4200
.2283
.1350
R.3000
Ø.2000
.3425
.3425
.2425
.6850
Ø.0264
.6850
UNLESS OTHERWISE SPECIFIED:
NAME
DATE
DRAWN
CHECKED
ENG APPR.
MFG APPR.
Q.A.
COMMENTS:
MATERIAL
6061 Aluminum Alloy
FINISH
NEXT ASSY
USED ON
APPLICATION
DO NOT SCALE DRAWING
PROPRIETARY AND CONFIDENTIAL
By: Jose Garcia
TITLE:
Prosthetic Finger
SIZE
DWG. NO.
REV
A
Hand_Joint
SCALE: 2:1
WEIGHT:
SHEET 1 OF 1

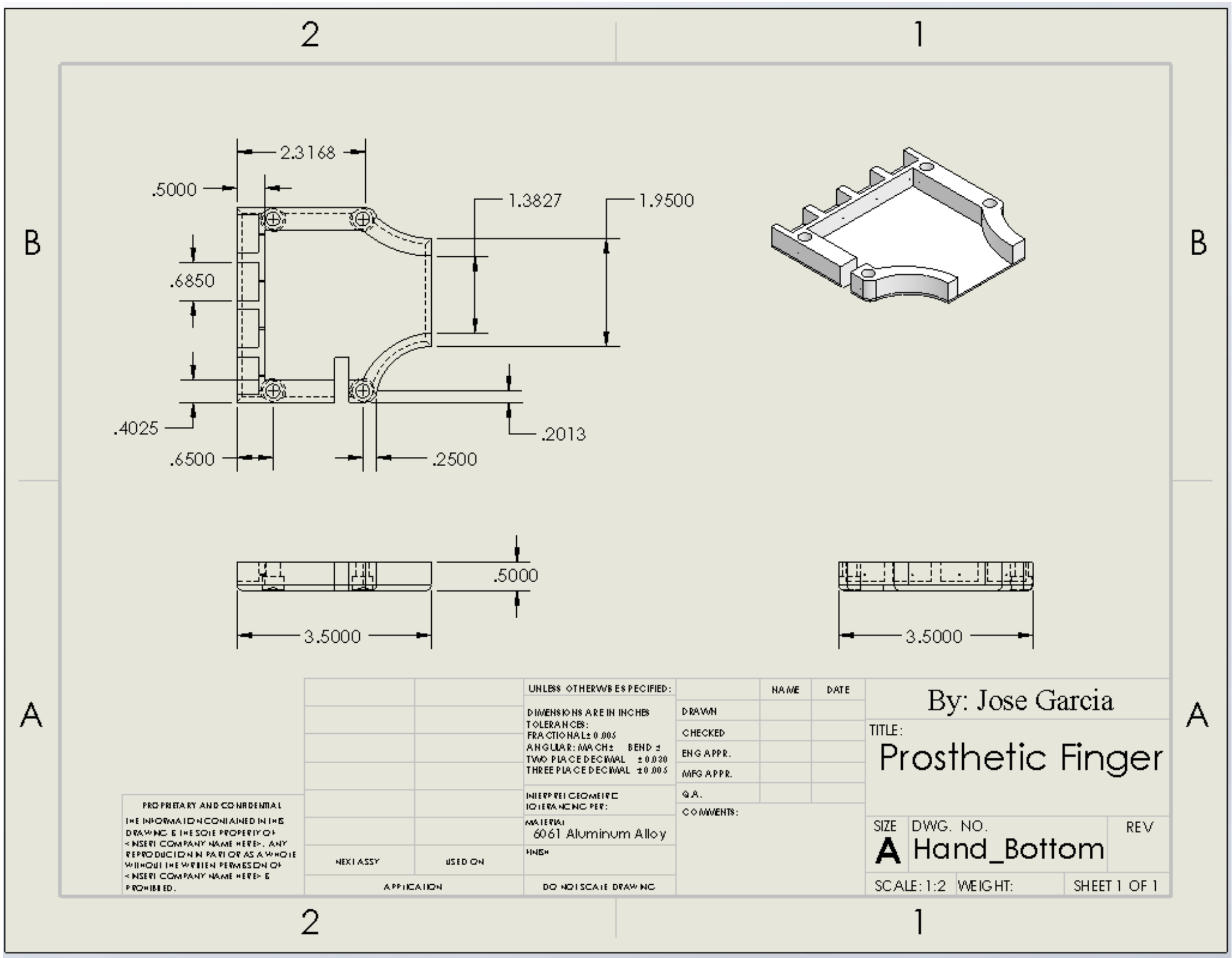


Ø.2000
.6850
By: Jose Garcia
TITLE:
Prosthetic Finger
SIZE
A
DWG. NO.
Pin_Joint
REV
SCALE: 4:1
WEIGHT:
SHEET 1 OF 1
MATERIAL
6061 Aluminum Alloy
UNLESS OTHERWISE SPECIFIED:
NAME
DATE
DRAWN
CHECKED
ENG APPR.
MFG APPR.
Q.A.
COMMENTS:
PROPRIETARY AND CONFIDENTIAL
DO NOT SCALE DRAWING
APPLICATION


2
1
B
B
A
A
Ø.3750
1.2500
UNLESS OTHERWISE SPECIFIED:
NAME
DATE
DIMENSIONS ARE IN INCHES
TOLERANCES:
FRACTIONAL ±0.005
ANGULAR: MACH ± BEND ±
TWO PLACE DECIMAL ±0.030
THREE PLACE DECIMAL ±0.005
DRAWN
CHECKED
ENG APPR.
MFG APPR.
Q.A.
COMMENTS:
INTERPRET GEOMETRIC
TOLERANCING PER:
MATERIAL
6061 Aluminum Alloy
FINISH
NEXT ASSY
USED ON
APPLICATION
DO NOT SCALE DRAWING
PROPRIETARY AND CONFIDENTIAL
THE INFORMATION CONTAINED IN THIS DRAWING IS THE SOLE PROPERTY OF <INSERT COMPANY NAME HERE>. ANY REPRODUCTION IN PART OR AS A WHOLE WITHOUT THE WRITTEN PERMISSION OF <INSERT COMPANY NAME HERE> IS PROHIBITED.
By: Jose Garcia
TITLE:
Prosthetic Finger
SIZE
DWG. NO.
REV
A
Pin_Gear
SCALE: 2:1
WEIGHT:
SHEET 1 OF 1
2
1


0.4530
Ø0.1850
Ø0.3770
UNLESS OTHERWISE SPECIFIED:
DIMENSIONS ARE IN INCHES
NAME
DATE
DRAWN
CHECKED
ENG APPR.
MFG APPR.
Q.A.
COMMENTS:
By: Jose Garcia
TITLE:
Prosthetic Finger
MATERIAL
6061 Aluminum Alloy
PROPRIETARY AND CONFIDENTIAL
NEXT ASSY
USED ON
APPLICATION
DO NOT SCALE DRAWING
SIZE
A
DWG. NO.
Servo_Bushing
REV
SCALE: 5:1
WEIGHT:
SHEET 1 OF 1


2.3168
1/4-20 Machine Threads
.5000
1.3827
1.9500
.6850
.4025
.6500
.2500
.2013
.0525
Ø.3750
.5000
1.0000
R.1000
3.5000
3.5000
By: Jose Garcia
TITLE:
Prosthetic Finger
SIZE
A
DWG. NO.
Hand_Top
REV
SCALE: 1:2
WEIGHT:
SHEET 1 OF 1
ABS Plastic
NAME
DATE
DRAWN
CHECKED
Q.A.
COMMENTS:
PROPRIETARY AND CONFIDENTIAL
DO NOT SCALE DRAWING
APPLICATION
UNLESS OTHERWISE SPECIFIED:
DIMENSIONS ARE IN INCHES

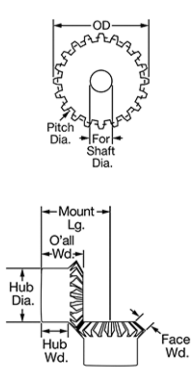


Metal Miter Gear—20 Degree Pressure Angle

Press-Fit Mount, 16 Pitch, 16 Teeth

Each — ADD TO ORDER

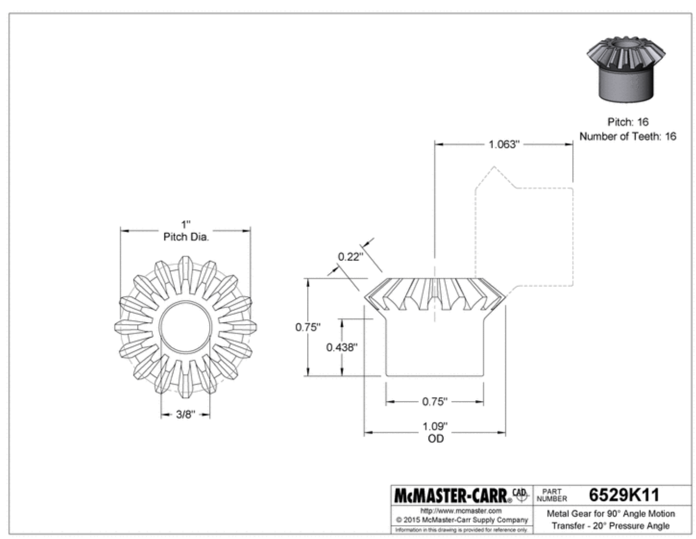
In stock
$22.08 Each
6529K11



Pressure Angle	20°
Pitch	16
Number of Teeth	16
Pitch Diameter	1"
OD	1.09"
Speed Ratio	1:1
Face Width	0.22"
Overall Width	0.75"
Material	Steel
Bore Type	Plain
Mount Type	Press Fit
For Shaft Diameter	3/8"
Hub	
Diameter	0.75"
Width	0.438"
Mount Length	1.063"

Transmit motion at a 90° angle while maintaining speed and torque. These gears are also known as miter gears.

For two gears to mesh correctly, they must have the same pressure angle, pitch, and number of teeth. Use these gears with other gears that have a 20° pressure angle.



The information in this 3-D model is provided for reference only. Details

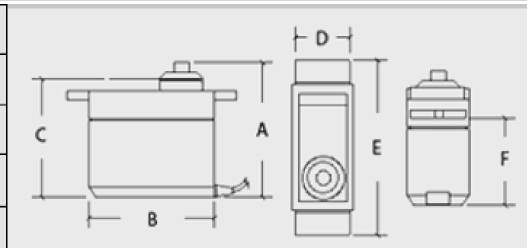
Hextronik MG-14 14g/2.6kg/0.11sec Digital Aircraft Servo

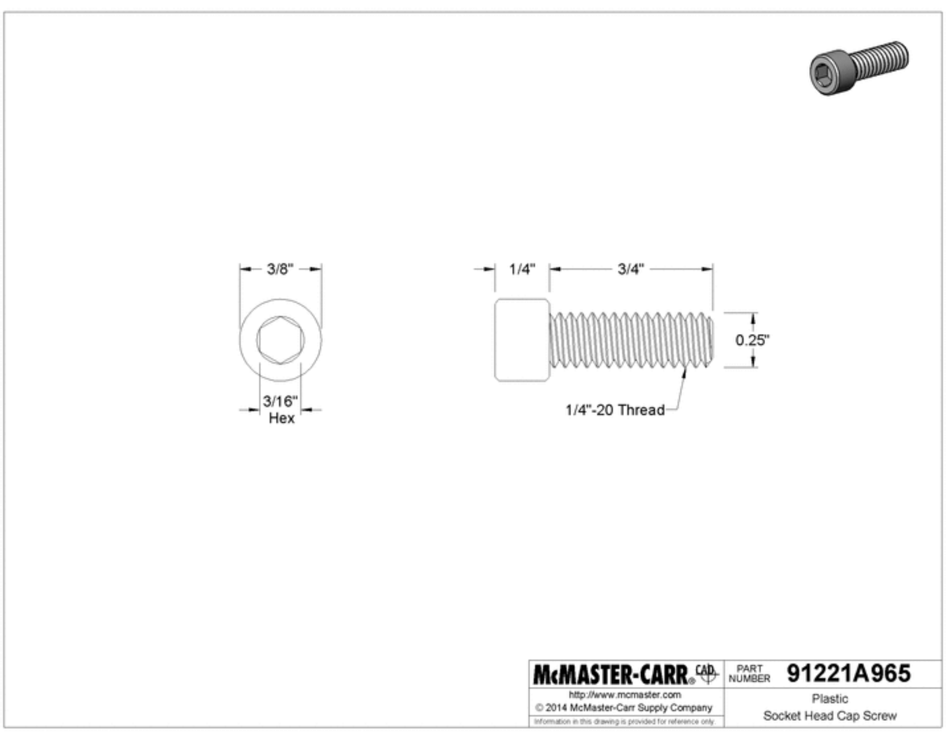
Specs:

Weight: **14g**
Dimension: **22.8x12x31 mm**
Stall torque: **2.2kg/cm (4.8v); 2.6kg/cm (6.0v)**
Operating speed: **0.13sec/60degree (4.8v); 0.11sec/60degree (6.0v)**
Operating voltage: **4.8~6.0v**
Gear Type: **Metal gear**
Bearing: **Double ball bearing**
Servo case: **Middle alloy, upper and lower plastic**
Temperature range: **0- 55deg**
Dead band width: **1us**
servo wire length: **25cm**
Servo Plug: **JR (Fits JR and Futaba)**

Product Config Table

Weight (g)	14	
Torque (kg)	2.6	
Speed(Sec/60deg)	0.11	
A(mm)	36	1.41732 in
B(mm)	23	0.905512 in
C(mm)	32	1.25984 in
D(mm)	12	0.472441 in
E(mm)	33	1.29921 in
F(mm)	23	0.905512 in





APPENDIX C – Parts List and Costs

Part Ident	Part Description	Source	Cost	Disposition
Abs Plastic	3.50 by 3.50 White shell for the Prosthetic Hand and 7.50 by 0.685 Finger	Central Washington University Computer lab	$20.00	Order 1/5/2016
Actuator	Worm Gear Motor, Rotary Actuator Part # MG-14	Hobby King	$27.08	Order 1/5/2016
Spiral Bevel Gear	20 pressure angle, 16 pitch, and 16 teeth Part #6529K11	McMaster-Carr	$55.07	Order 1/5/2016
Battery	Duracell AAA	Fred Meyer	$0.00	Order 1/5/2016
Wire	Steel wire diameter 0.0132 length 5ft	Tedpella.com	$0.00	Order 1/5/2016
Screws	Socket Head Cap Screw	McMaster-Carr	$0.00	Order 1/5/2016

APPENDIX D – Budget

PARTS LIST AND BUDGET								
SENIOR PROJECT TITLE _______ Prosthetic Finger								
ITEM ID	ITEM Description	Item Source	Brand Info	Model/SN	Price/Cost (US Dollars) ($ / pound)	Quantity (or hrs)	Subtotals	
1	Abs Plastic	CWU	Filement	15A1W50	20	1	20	
2	Actuator	Hobby King	Aluminum	MG-14	27.07	1	27.07	
3	Spirel Bevel Gear	McMaster-Carr	Aluminum	6529K11	55.07	1	55.07	
4	Battery	Fred Meyer	Duracell	AAA	0	1	0	
5	Wire	Tedpella.com	Steel wire	Gauge 31	0	1	0	
6	Screws	McMaster-Carr	Socket Head Cap Screw	91221A965	0	10	0	
							102.14	Total Est.

APPENDIX E – Schedule

SCHEDULE FOR SENIOR PROJECT:								
					December 15-17 Finals		March 9 Presentation	
PROJECT TITLE:___Prosthetc Finger_______							June 9-12 Finals	
ENG. TECH.:_______Jose Garcia__________								
TASK: ID	Description	Duratioin (hours)	October	November	December	January	February	March
1	Proposal**	42		9-Nov				
1a	Outline	2	2-Oct					
1b	Intro	2	7-Oct					
1c	Methods	2	10-Oct					
1d	Analysis	6	19-Oct					
1e	Discussion	4	24-Oct					
1f	Parts and Budget	4	4-Nov					
1g	Drawings	15		9-Nov				
1h	Schedule	4	7-Nov					
1i	Summary & Appx	3		14-Nov				
2	Manuf Plan**	50			16-Dec			
3	Device Constructed	100				14-Jan		
4	Test Plan**	15					14-Jan	
5	Device Evaluated	20						9-Mar
6	Project Report**	20						9-Mar
	Total Hours Est:	247						

March 9 Presentation
June 15-17 Spr Finals

PROJECT TITLE: Prosthetic Finger___
Engineering Technician.: Jose Garcia___

September | October | November | December | January | February | March | April

9/3/16, 9/10/16, 9/17/16, 9/24/16, 10/1/16, 10/8/16, 10/15/16, 10/22/16, 10/29/16, 11/5/16, 11/12/16, 11/19/16, 11/26/16, 12/3/16, 12/10/16, 12/17/16, 12/24/16, 12/31/16, 1/7/16, 1/14/16, 1/21/16, 1/28/16, 2/4/16, 2/11/16, 2/18/16, 2/25/16, 3/3/16, 3/10/16, 3/17/16, 3/24/16, 3/31/16, 4/7/16, 4/14/16, 4/21/16, 4/28/16, 5/5/16

TASK: ID	Description	Duration Est. (hrs)	Actual (hrs)
1	Proposal**		
1a	Outline	1	2
1b	Intro	1	2
1c	Methods	2	4
1d	Analysis	3	23
1e	Discussion	2	3
1f	Parts and Budget	3	6
1g	Drawings	5	22
1h	Schedule	2	6
1i	Summary & Appx	2	4
	subtotal:	21	72
2	Analyses		
2a	Calculation of Steel Wire Size	1	2
2b	Range of motion finger knuckle	1	1
2c	Gear circumference	1	1
2d	Articulate movement	1	1
2e	Finger Pressure	1	3
2f	Coefficient of Friction	1	2
2g	Joint Friction	1	2
2h	Pressfit pin to knuckle joint	1	2
2i	Actuator life time	1	3
2j	Highest deflection	1	2
2k	Press fit pin to gear	1	2
2m	Pin Diameter	1	2
	subtotal:	12	23
3	Documentation		
3a	Part 1 drawing: Front Finger	2	4
3b	Part 2 drawing: Middle Part Finger	2	4
3c	Part 3 drawing: End Part Finger	2	4
3d	Part 4 drawing: Hand Joint	2	4
3e	Part 5 drawing: Pin Size 0.20	1	1
3f	Part 6 drawing: Hand Top	2	6
3g	Part 7 drawing: Hand Bottom	2	6
3h	Part 8 drawing: Pin Size 0.375	1	1
3i	Part 9 drawing Spiral Bevel Gear	1	1
3j	Part 10 drawing: Servo	1	1
3k	Part 11 drawing: Battery	1	1
3l	Part 12 drawing: Screws	1	1
3m	Assembly	1	2
	subtotal:	19	36
4	Proposal Mods		
4a	Project Schedule	1	2
4b	Project Part Inv.	1	2
4c	Crit Des Review*	1	2
	subtotal:	3	6
5	Part Construction		
5a	Make Part 1	1	2
5b	Make Part 2	1	2
5c	Make Part 3	1	2
5d	Make Part 4	1	2
5e	Make Part 5	1	2
5f	Make Part 6	1	2
5g	Make Part 7	1	2
5h	Make Part 8	1	2
5i	Buy Part 9	1	1
5j	Buy Part 10	1	1
5k	Buy Part 11	1	1
5l	Buy Part 12	1	1
5m	Take Part Pictures	1	1
5n	Update Website	1	3
5o	Manufacture Plan*	1	4
	subtotal:	15	28
6	Device Construct		
6a	Assembly	1	3
6e	Take Dev Pictures	1	1
6f	Update Website	1	3
	subtotal:	3	7
7	Tasks		
7a	Ordering Parts	1	6
7b	Creating Pins from Aluminum	1	1
7c	Testing Servo	1	1
7d	Wrie testing & Crimmping	1	3
7e	Place Holder between Servo/Gear	1	6
7f	Arduino Testing	1	2
7g	Testing Whole System	1	4
7h	3D Printing Body	1	3
7i	Create full motion Funtion	1	1
7h	Look for defects and Fix Them	1	3
	subtotal:	10	30
8	495 Deliverables		
8a	Get Report Guide	1	2
8b	Make Rep Outline	1	2
8c	Write Report	1	2
8d	Make Slide Outline	1	2
8e	Create Presentation	1	2
	subtotal:	5	10
	Total Est. Hours=	88	212 =Total Actual Hrs

APPENDIX F – Expertise and Resources

Steel Wire Acquired From:

https://www.tedpella.com/company_html/wire_gauge.htm

Spiral Bevel Gear Acquired From:

http://www.mcmaster.com/#6529k11/=101c6h0

Servo Acquired From:

http://www.hobbyking.com/hobbyking/store/__8303__Hextronik_MG_14_14g_2_6kg_0_11sec_Digital_Aircraft_Servo.html

Arduino

http://store-usa.arduino.cc/products/a000066

Battery Acquired From:

FredMeyer

Screw

http://www.mcmaster.com/#91221a965/=10mlpjg

Benchmarch Prosthetic Hand

http://inmoov.fr/inmoov-finger-prosthetic/

3D Printer Material Abs Plastic

Central Washington University

APPENDIX G – Evaluation sheet (Testing)

Everything has been on schedule, but their was an issue with the prosthetic finger so if was redesigned several times to meet its new specifications. For example, in the prosthetic finger their wasn't enough tension in the wire, so to fix the problem tracks were made towards the top of the finger so rubber bands can be placed to keep the finger flexible and give it the right amount of tension issue. Another issue that occurred was the coding from the Arduino because even though it was written correctly it wasn't functioning properly. Also the servo was working properly because of how the gears chain was made.

APPENDIX H – Testing Report

Prosthetic finger will be measure by a caliper, weight by a scale, and tested on a breadboard and electrical software from the electricity lab. When the prosthetic finger was printing several different parts the holes shrank and closed, so they had to be machined. Another issue that occurred was that the shaft for the pin to spin for the spiral bevel gear was press fit. So the side of the prosthetic hand needed to be machined through too great a pin that was press fit on the spiral bevel gear, a slot for the string to wrap around, and enough clearance on the shaft and pin to have it spin properly to contract and recon tract the prosthetic finger.

Project:____Prosthetic Finger______ Initials _____JG_____ Period Covering:__1/13/16—1/15/16___

Description of Task, Time spent, and Results/Disposition:

TASK#_1: Ordering Parts___ HRS: ____6_____ COMMENTS: It should have only taken an hour or less to order the parts, but more research was done to verify that the correct parts were being ordered.

TASK#_2: Creating Pins from Aluminum___ HRS: ____1_____ COMMENTS: Since the material was already in the machine show with the correct diameter the cutting portion and measuring to length made things simpler.

TOTAL TIME:____7_____(Hours during this week)

SUMMARY OF PROGRESS:

So far everything is on schedule and since the aluminum had already had the correct diameter and was in the shop that took off a lot of time for machining it down to size and paying for the cost of the material. This amount of time that was made up helped for the amount of time lost for double checking the material being ordered was the correct one.

ACTIONS TO BE TAKEN: (describe your plans for next week).

Next week parts should arrive, once parts are here they will all be measured and tested to see if everything is the correct material need and meets its requirements.

ON BUDGET ☑ If not, explain.

Yes, so far everything is on budget and is on schedule.

ON SCHEDULE ☑ Attached Gantt chart. All tasks to date should show 100% completion.
IF NOT on schedule, please indicate, in a few sentences, how you plan to get the project back on schedule.

Project: Prosthetic Finger Initials JG Period Covering: 1/18/16—1/25/16

Description of Task, Time spent, and Results/Disposition:

TASK# 7c HRS: 1 COMMENTS: Tested the servo to see if it would turn 360 degrees at 5 volts of electricity. Testing actually took less than 10 minutes which benefitted me in time.

TASK# 7d HRS: 3 COMMENTS: The wire was tested in using different knots to see which knot would be able to hold six pounds of force with out breaking easily, since the wire and the knot are rather small. Testing took longer than it should have, I was aiming for an hour and received two extra hours I didn't account for.

TOTAL TIME: 4 (Hours during this week)

SUMMARY OF PROGRESS:

Everything is back on schedule at first schedule was pushed back because the parts were taking longer to come then expected, but once they arrive I was able to test the servo and attempt to make several different knots with the steel wire. An issue that did arise with the servo was that since there were different tools that already came with the kit it was possible to have the servo rotate 360 degrees, but their needs to be something made to hold the servo and gear together. Also since the wire was so small and gripping it down was an option having create knots was the next best thing.

ACTIONS TO BE TAKEN: (describe your plans for next week).

Next week I will create a place holder so the servo and gear can connect correctly and the Arduino will be coded so it has the correct actions to move the servo to the correct specifications.

ON BUDGET ☑ If not, explain.

Yes, so far everything is on budget and is on schedule.

ON SCHEDULE ☑ Attached Gantt chart. All tasks to date should show 100% completion.
IF NOT on schedule, please indicate, in a few sentences, how you plan to get the project back on schedule.

Project: Prosthetic Finger Initials JG Period Covering: 1/26/16—2/1/16

Description of Task, Time spent, and Results/Disposition:

TASK# 7e HRS: 1 COMMENTS: Servos gear diameter is rather small so a place holder was needed to be made to connect the servo and spiral bevel gear together.

TASK# 7f HRS: 4 COMMENTS: The Arduino was coded so it can have simple functions to move the servo and the system.

TOTAL TIME: 5 (Hours during this week)

SUMMARY OF PROGRESS:

Everything is on schedule, things are running smoothly, all my parts have been gather, but there is one issue from analyzing the 3D prosthetic finger it can be said that their might not be enough tension in the steel wire to keep the finger straight when its in its original straight position.

ACTIONS TO BE TAKEN: (describe your plans for next week).

Next week the purpose will be to create and redesign small parts of the prosthetic finger so rubber bans can be placed in between the joints to keep the finger straight. Also the Arduino, servo, and gear will be tested to see if it is working properly.

ON BUDGET ☑ If not, explain.

Yes, so far everything is on budget and is on schedule.

ON SCHEDULE ☑ Attached Gantt chart. All tasks to date should show 100% completion.
IF NOT on schedule, please indicate, in a few sentences, how you plan to get the project back on schedule.

Project: Prosthetic Finger Initials JG Period Covering: 2/4/16—2/8/16

Description of Task, Time spent, and Results/Disposition:

TASK# 7g HRS: 6 COMMENTS: The prosthetic finger had to be redesigned only on the upper parts of the joints because there wasn't enough tension between the steel wire and the wire to tracks were made so rubber bands can be placed on the inside to stabilize the finger and have it contract and extend as expected.

TASK# 7h HRS: 4 COMMENTS: The Arduino was attached to the servo and gear, so it can be tested to move the spiral bevel gears.

TOTAL TIME: 10 (Hours during this week)

SUMMARY OF PROGRESS:

Everything is on schedule, the 3D prosthetic finger is taken longer to 3D print then expected, but that is not a very big issue. The arudino might need some more coding to have it function better.

ACTIONS TO BE TAKEN: (describe your plans for next week).

Next week the purpose will be to test the Arduino, servo, and gear with the 3D printed finger to see if it is working properly.

ON BUDGET ☑ If not, explain.

Yes, so far everything is on budget and is on schedule.

ON SCHEDULE ☑ Attached Gantt chart. All tasks to date should show 100% completion.
IF NOT on schedule, please indicate, in a few sentences, how you plan to get the project back on schedule.

Project: Prosthetic Finger Initials JG Period Covering: 2/5/16—2/15/16

Description of Task, Time spent, and Results/Disposition:

TASK# 7i HRS: 14 COMMENTS: The prosthetic finger was 3D printed. It took longer to print than expected and the holes came out deformed.

TASK# 7j HRS: 1 COMMENTS: The bushing was tested to see if it fits in the spiral bevel gear and servo to make sure it spins correctly.

TOTAL TIME: 15 (Hours during this week)

SUMMARY OF PROGRESS:

Everything is on schedule, the 3D prosthetic finger is taken longer to 3D print then expected, but that is not a very big issue. The arudino might need some more coding to have it function better.

ACTIONS TO BE TAKEN: (describe your plans for next week).

Next week the purpose will be to fix the deformed holes on the 3D printed finger and tested all the parts together.

ON BUDGET ☑ If not, explain.

Yes, so far everything is on budget and is on schedule.

ON SCHEDULE ☑ Attached Gantt chart. All tasks to date should show 100% completion.
IF NOT on schedule, please indicate, in a few sentences, how you plan to get the project back on schedule.

Project: Prosthetic Finger Initials JG Period Covering: 2/5/16—2/15/16

Description of Task, Time spent, and Results/Disposition:

TASK# 7i HRS: 2 COMMENTS: The prosthetic finger holes came out deformed, but where fixed.

TASK# 7j HRS: 1 COMMENTS: The servo was tested to make sure it spins correctly, but it couldn't fully turn all the way. Their will be new code placed in the servo to make it spin properly.

TOTAL TIME: 3 (Hours during this week)

SUMMARY OF PROGRESS:

Everything is on schedule, the servo and arudino need more coding to have it function properly.

ACTIONS TO BE TAKEN: (describe your plans for next week).

Next week the purpose will be to fix the coding and tested all the parts together.

ON BUDGET ☑ If not, explain.

Yes, so far everything is on budget and is on schedule.

ON SCHEDULE ☑ Attached Gantt chart. All tasks to date should show 100% completion.
IF NOT on schedule, please indicate, in a few sentences, how you plan to get the project back on schedule.

Project: Prosthetic Finger Initials JG Period Covering: 2/25/16—2/29/16

Description of Task, Time spent, and Results/Disposition:

TASK# 7i HRS: 2 COMMENTS: The prosthetic fingers tracks were closed, so they were filled and scraped to open up the track to the correct size needed.

TASK# 7j HRS: 2 COMMENTS: The servo was tested to make sure it spins correctly, but it couldn't fully turn all the way. Their will be new code placed in the servo to make it spin properly.

TOTAL TIME: 4 (Hours during this week)

SUMMARY OF PROGRESS:

Everything is on schedule, the servo and Arduino need more coding to have it function properly. The track needs to have a small anchor on the outside of the fingers wall to properly hold the wire in place.

ACTIONS TO BE TAKEN: (describe your plans for next week).

Next week the purpose will be to fix the coding and finger and test all the parts together.

ON BUDGET ☑ If not, explain.

Yes, so far everything is on budget and is on schedule.

ON SCHEDULE ☑ Attached Gantt chart. All tasks to date should show 100% completion.
IF NOT on schedule, please indicate, in a few sentences, how you plan to get the project back on schedule.

Project: Prosthetic Finger Initials JG Period Covering: 2/29/16—3/07/16

Description of Task, Time spent, and Results/Disposition:

TASK# 7i HRS: 4 COMMENTS: The prosthetic fingers hole to tie the knot of the steel wire was small so a drill was used to make the hole larger. Also, the servo and spiral bevel gear that was attached was off center to the other spiral bevel gear so a base was created to evenly balance the servo with the spiral bevel gear.

TASK# 7j HRS: 3 COMMENTS: The servo was tested to make sure it spins correctly with its new code, but it couldn't fully turn all the way because there was something stuck in the gears so it was taken apart and fixed.

TOTAL TIME: 7 (Hours during this week)

SUMMARY OF PROGRESS:

Everything is on schedule and the prosthetic finger is working properly.

ACTIONS TO BE TAKEN: (describe your plans for next week).

Next week the purpose will be to present the project.

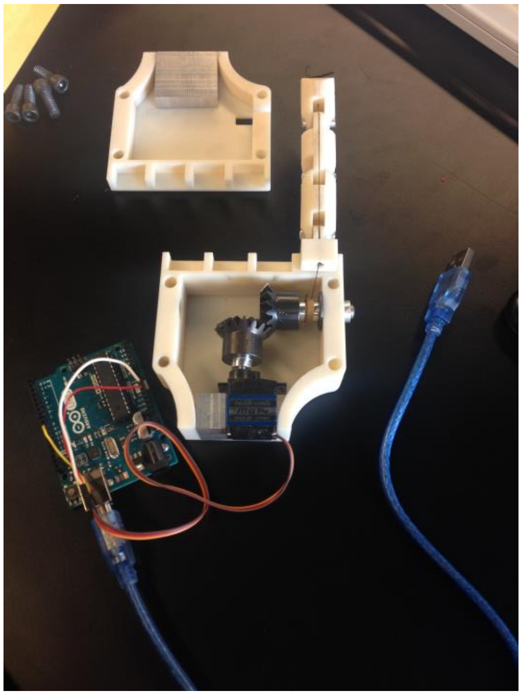
ON BUDGET ☑ If not, explain.

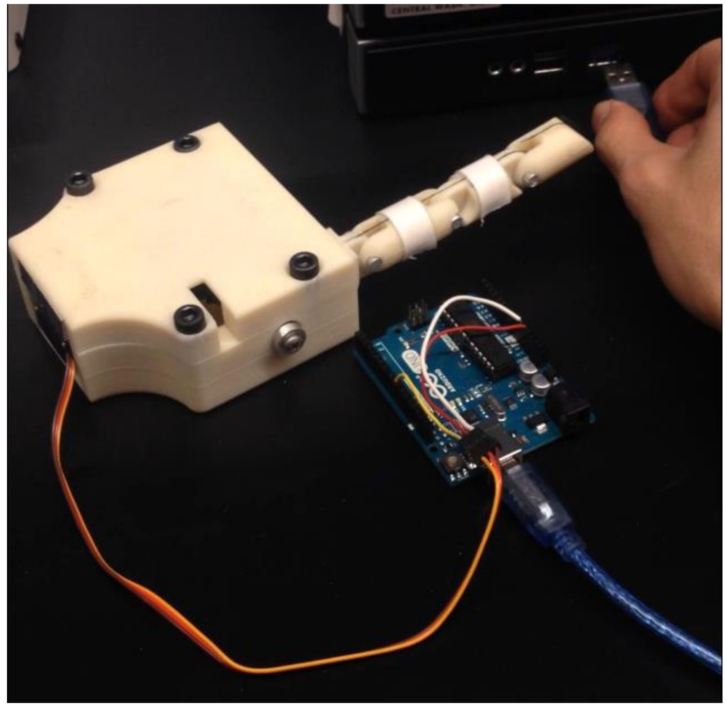
Yes, so far everything is on budget and is on schedule.

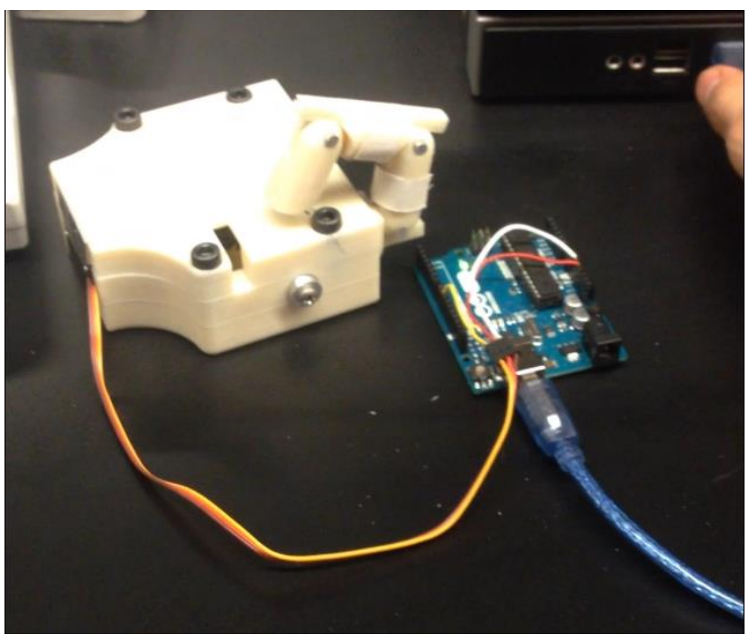
ON SCHEDULE ☑ Attached Gantt chart. All tasks to date should show 100% completion.
IF NOT on schedule, please indicate, in a few sentences, how you plan to get the project back on schedule.

APPENDIX I – Testing Data

The prosthetic finger became a success over the time.







APPENDIX J – Resume

Jose Garcia

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EDUCATION

Bachelor of Science in Mechanical Engineering Technology Anticipated June 2017
Specializing: Manufacturing
Central Washington University, Ellensburg, WA
Dean's List – 6 quarters Fall 2012 - Spring 2013
GPA: 3.31

Leadership/Activities

Member TRIO SSS Program 2012 – Present
Member McNair Program 2014 – Present
Member Douglas Honors Program 2014 – Present
Member American Society of Mechanical Engineers (ASME) 2012 – Present
Member Experience Leadership Project (ELP) Fall 2012

- Completed several projects to build my leadership abilities via team building exercises
- Leadership Training

Member The National Society of Collegiate Scholars (NSCS) 2014 – Present

- VP, Public Relations

Senator, Christian Club Fall 2013 – Present

- Go to monthly meetings and discuss ideas on how to improve the church

Volunteer, Asia University America Program (AUAP) 2012 – Present

- Teach Japanese students English skills and real life situations

PROFESSIONAL SKILLS

Language: Fluent in Spanish (Speaking)
Computer Skills: PowerPoint, Word, Proficient in Macintosh, Window Systems, AutoCAD, Rhino, and SolidWorks

EXPERIENCE

Reserve Officers' Training Corps (ROTC) Cadet, CWU, Ellensburg, WA Sept. 2012 – Sept. 2013

- Led 56 fellow cadets both directly and by example
- Solved complex problems in a time sensitive, stressful situation

Habitat for Humanity, Pasco, WA Sept. 2012

- Helped create houses for low income families

Mover and Shaker, CWU, Ellensburg, WA Sept. 2012

- Directed students to their residence hall room assignment