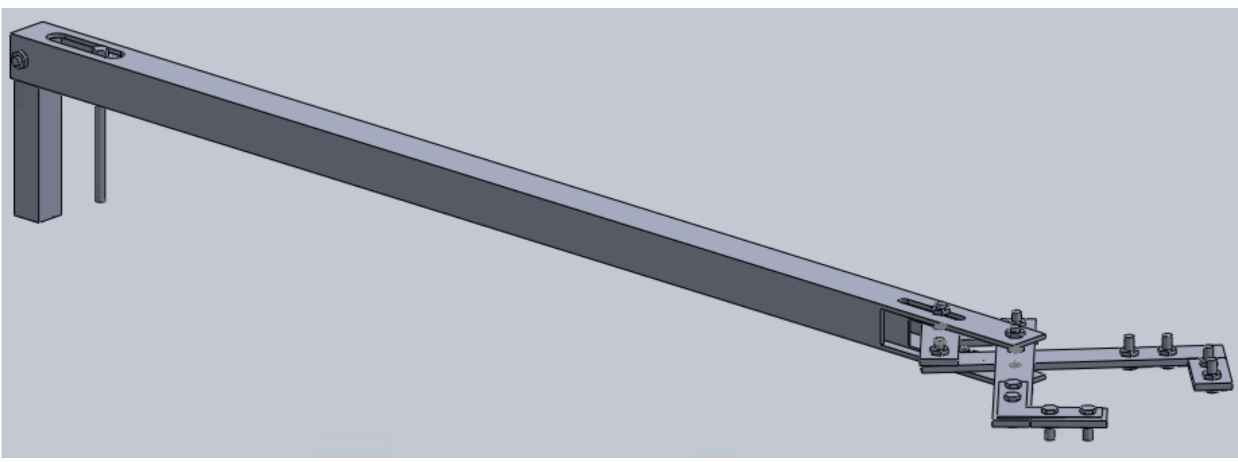
REACH EXTENDER PROJECT



TECH 147 Final Project
Group 7

Design Analyst / Manager **----** *Maxwell Spielman-Sun*

Production Analyst / Manager **----** *Zixi Yang*

Sales Analyst / Manager **----** *Julius Ali*

Grading Criteria for Team Project (60 Points)

Criteria	Points Possible	Points Received		
Julius Ali *Maxwell Spielman-Sun* *Zixi Yang*		______	______	______
1. Portfolio Organization: Completeness, format, clear title page, team members' names, table of contents, detailed meeting log, sequenced and well-organized members' reports etc.	(5)	______	______	______
2. Log of Group's Meetings: Completeness, format, date, attendance, names, details of each meeting etc.	(10)	______	______	______
3. Oral presentation, simulation, and Model/Prototype display: Time, completeness, content, visual aids, clarity, outline, audibility, appearance, preparedness, completion and quality or model etc.	(10)	______	______	______
4. Written report (2-3 pages): Completeness, format, grammar, spelling, content, clarity etc.	(10)	______	______	______
5. Assigned Questions: Completeness, correctness, clarity, analysis, answers etc. (See list of specific questions assigned to each team member)	(10)	______	______	______
6. Documentation of Assigned Tasks: Completeness, format, analysis, clarity, quality etc. (See list of materials to be attached for each team member)	(15)	______	______	______

Total Points Received out of 60 ______ ______ ______

Comments:

____

____

____

Table of Contents

Meeting Minutes

Nov 10th
Attendance: Maxwell Spielman-Sun, Zixi Yang
- First Meeting
- Introductions
- Created a Google Drive to share files
- Traded Contact Information
- Discussed good meeting times

Nov 13th
Attendance: Julius Ali, Maxwell Spielman-Sun
- First meeting with Julius
- Brought Julius up to speed
- Introductions round 2
- Gave Julius access to the Google Drive
- Established a Discord server to facilitate communication
- Decided on the best meeting times

Nov 14th
Attendance: Julius Ali, Maxwell Spielman-Sun, Zixi Yang
- First meeting with the full team
- Project subject chosen
    - Reach Extended -> extension of Max's previous projects
- Roles Assigned
    - Design Analyst/Manager -> Maxwell Spielman-Sun
    - Product Analyst/Manager -> Zixi Yang
    - Sales Analyst/Manager -> Julius Ali

Nov 17th
Attendance: Julius Ali, Maxwell Spielman-Sun, Zixi Yang
- Presented and approved 3D model of the reach extender
- Presented drawings of the the individual models
- Coordinated individual parts

Nov 27th
Attendance: Julius Ali, Maxwell Spielman-Sun, Zixi Yang
- Presented Facility Layout
- Worked on the project
- Coordinated individual parts

<u>Design Analyst / Manager</u>

Maxwell Spielman-Sun

TECH 147 Final Project

Report

Reach Extender Design and Overview

This project is focused on designing a facility that can manufacture a reach extender. The reach extender has a 3 foot long body, with a claw that adds another 8” of reach. The claw mechanism can easily grab most hand-sized objects with good grip strength. The springs attach to smaller pieces of box tubing within the main body of the reach extender. The trigger, attached to the smaller pieces of box tubing, allows the user to utilize the reach extender to grab objects at a distance. It is primarily made of aluminum in order to be lightweight and easy to maneuver. By minimizing material variety, it simplifies and streamlines the supply chain. This eliminates unnecessary waste and helps improve the sustainability of the facility while minimizing environmental impact. The facility utilizes a flexible batch shop format to produce the reach extender. As demand fluctuates, the facility can be repurposed for new designs or different products. This ensures the facility can be used for a long period of time, improving sustainability and minimizing wasted resources. The facility is located in San Jose, and can tap into the abundant supply of green energy in the bay area, like solar. The resulting facility is efficient, green, and sustainable.

Supply Chain

The supply chain starts with the raw metal ores. The assembly is mostly aluminum, with a few pieces of steel. Since the facility is located in San Jose, the nearest source of aluminum ore is in Quebec, Canada. A refinery in Saguenay, Quebec processes the raw ore into aluminum ingots. The assembly specifically uses Aluminum 6061. The aluminum is then shipped to a company called OnlineMetals via train and truck to their facilities in New York. OnlineMetals works with third party manufacturers to work the ingots into bars and box tubing. From there, the aluminum is shipped via train and truck to the facility in San Jose. Steel starts with iron ore, extracted in Michigan. The iron is then refined into steel in Cleveland, Ohio. The assembly utilizes ASTM A228 Steel and 304 stainless steel. MSC Industrial Supply, based in

New York, then works the 304 stainless steel into screws and nuts. Furthermore, OnlineMetals works the ASTM A228 steel into wire for the springs, and some of the 304 stainless steel into flat corner braces. MSC Industrial Supply and OnlineMetals then ship the products to the facility in San Jose. By outsourcing this production, this streamlines the facility design and reduces the necessary machinery, workers, and training.

Facility Design

The facility itself is a batch shop layout. Shipments first arrive through the main garage entrance and are sent to quality assurance - incoming (QA - In) to ensure the materials are up to the facility's standards. If the materials are approved, they are sent to storage. Production is then separated into three different starting materials: box tubing, bars, and wires. The box tubing first heads to the layout section to have the cuts, drills, and milling to be marked out. The box tubing then heads to the circular saws to be cut to length. Then the work travels to the drilling stations for the necessary holes. Finally, the work is sent to the CNC mills. While the other machines are worked by operators, these CNCs will require skilled machinists to work. Once the machinists finish, the work is sent to the sanders to be grinded until safe to handle before heading to the quality assurance - outgoing (QA - Out). The bars follow a similar path. The bars start with the layout, before being cut to length and drilled as necessary. The bars are then sent to the sanders for their appropriate finish before heading to QA - Out. The wires go to the layout section before being cut to length with hand-held wire cutters. The wires are then sent to the spring coilers to be coiled into springs. The first and final loops on the springs are then bent 90 degrees to make them easy to mount. The springs are sanded until safe to handle and then sent to QA - Out. After QA - Out evaluates the parts, operators assemble the reach extender, inspect it one final time, and then ships it out.

In addition to the manufacturing equipment, the facility must accommodate other necessary functions to support the staff. The employees walk through reception into a large open break room. The break room is equipped with lockers for employees to store their personal belongings. There are a series of offices for the managers, accountants, and the security officer. Furthermore, there is a conference room for meetings and presentations as necessary. Finally, there are two restrooms provided for employee usage. There is also a 1 acre parking lot with 100 parking spots outside the facility.

Questions

1. How to incorporate design for manufacture and assembly (DFM/A) in your design tasks. (List and description of ideas and techniques applied will help)

- Minimize variety in raw materials
  - By utilizing the same material in multiple parts, it reduces unnecessary shipping costs, and minimizes supply chain complexity
- Minimize variety in purchased parts
  - When purchasing things like box tubing and bars, the goal was to utilize the same dimensions as much as possible to simplify the manufacturing process and the supply chain
- Utilize pre-built parts
  - Instead of building everything from scratch, we outsource parts of production

2. How much green you incorporated into the product in the design process.

- Similar to the points above, we sought to minimize variety in raw materials and parts. This would reduce unnecessary shipping costs, and allow us to leverage equipment that can manufacturer components on a large scale with minimal waste
- The facility itself can be retrofitted for alternative tasks, when necessary, allowing the company to reuse infrastructure
- The facility can run on green energy sources

3. Complete bill of materials (BOM) and total cost of materials for one assembled product.

- See BOM above
- $80.37 per product

4. The total square footage of the facility.

- See Facility Analysis above
- 20,000 sqft

5. Total number of each of the following items (chairs, machines, people, and isles) in the facility.

- Machines: See Facility Analysis above
- Chairs: Approximately 75
- People: 42 people

6. Takt time in this facility.

Assumption: 7500 products per month (overshooting demand slightly just in case)

7500 products / month * (1 month / 20 work days) = 375 products / day
1 day / 375 products * 8 hours / day * 60 minutes / hour = 1.28 minutes/product

<u>Takt Time = 1.28 minutes / product</u>

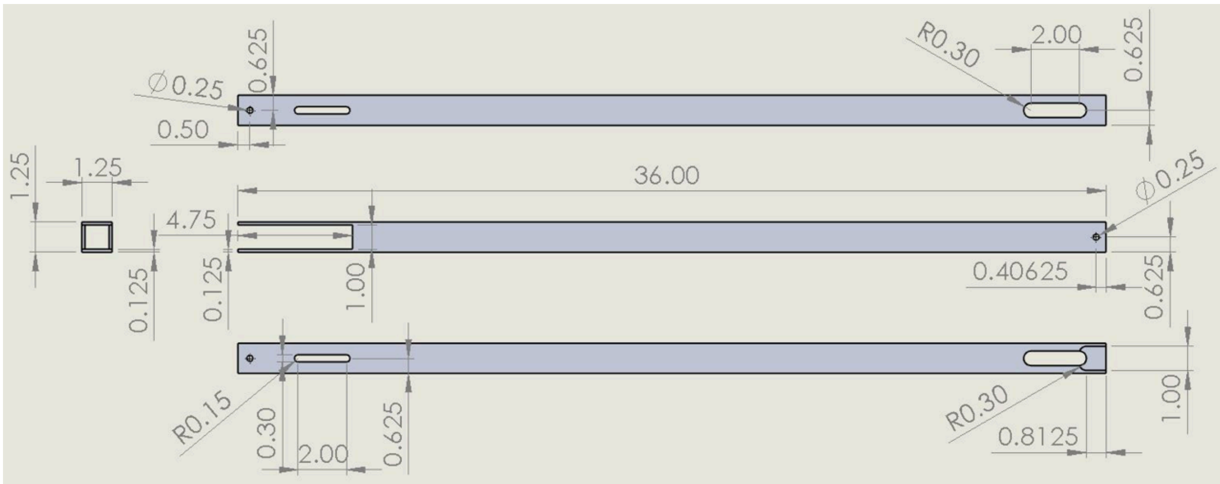
7. The number of toilets and parking spaces to be included.

- See Facility Analysis above
    - 10 toilets
    - 100 parking spaces

Bill of Materials

Part #	Part Name	Material	Qty	Dimensions	Unit Cost	Total Cost
1	Box Tubing (large)	6061 Aluminum	36”	1.25” x 1.25”, 0.125” Wall Thickness	$7.30/ft	$21.90
2	Box Tubing (small)	6061 Aluminum	35.675”	0.875” x 0.875”, 0.0625” Wall Thickness	$3.84/ft	$11.42
3	Aluminum Flat Bar	6061 Aluminum	26”	1.0” x 3/16”	$22.03 /12ft	$3.98
4	Flat Corner Brace	304 Stainless Steel	2	2.75” x 2.75” x 0.75”, 1/16” Thickness	$9.49 /12	$1.58
5	Short Steel Screws	304 Stainless Steel	10	¼” – 20 x 0.75”	$0.25	$2.50
6	Long Steel Screws	304 Stainless Steel	3	¼” – 20 x 1.5”	$0.25	$0.75
7	(Trigger) Steel Bolt	304 Stainless Steel	1	¼” -- 20 x 4”	$0.34	$0.34
8	Nuts	304 Stainless Steel	14	¼” – 20	$0.25	$3.50
9	High Carbon Steel Wire	ASTM A228 Steel	60’	0.055” diameter	$0.60 /in	$36.00
					Estimated Material Cost Total Per Reach Extender	***$80.37***

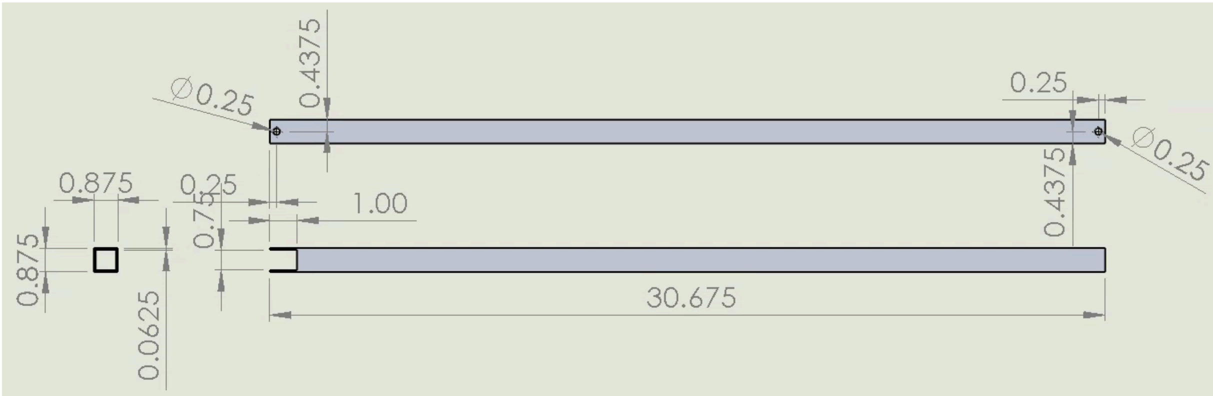
Part Drawings



Part Name: Large Body	***Model Maker***: Maxwell Spielman-Sun
Part Number: #1	***Units***: Inches
Material: Aluminum (6061)	***Number of Parts Required***: 1

Manufacturing Process:

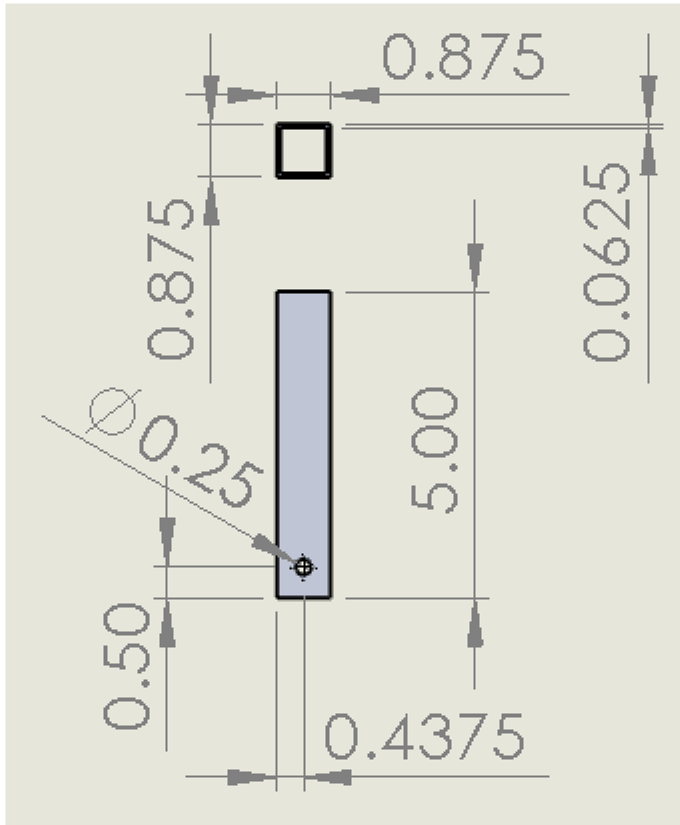
1. Layout the processes
2. Cut the box tubing to length
3. Prick punch to prepare for drilling
4. Drill holes
5. Mill the slots and the cuts
6. Sand and deburr until safe to handle
7. Assemble



Part Name: Small Body	***Model Maker***: Maxwell Spielman-Sun
Part Number: #2	***Units***: Inches
Material: Aluminum (6061)	***Number of Parts Required***: 1

Manufacturing Process:

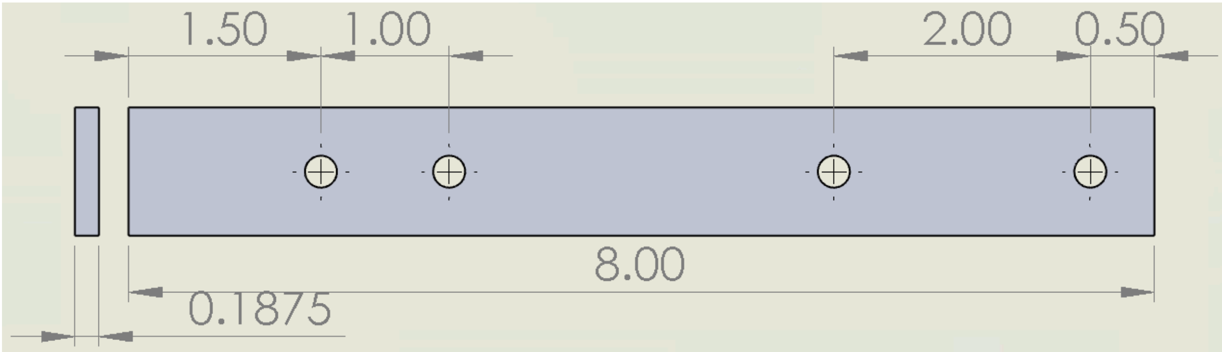
1. Layout the processes
2. Cut the box tubing to length
3. Prick punch to prepare for drilling
4. Drill holes
5. Mill the slots and the cuts
6. Sand and deburr until safe to handle
7. Assemble



Part Name: Handle	***Model Maker***: Maxwell Spielman-Sun
Part Number: #3	***Units***: Inches
Material: Aluminum (6061)	***Number of Parts Required***: 1

Manufacturing Process:

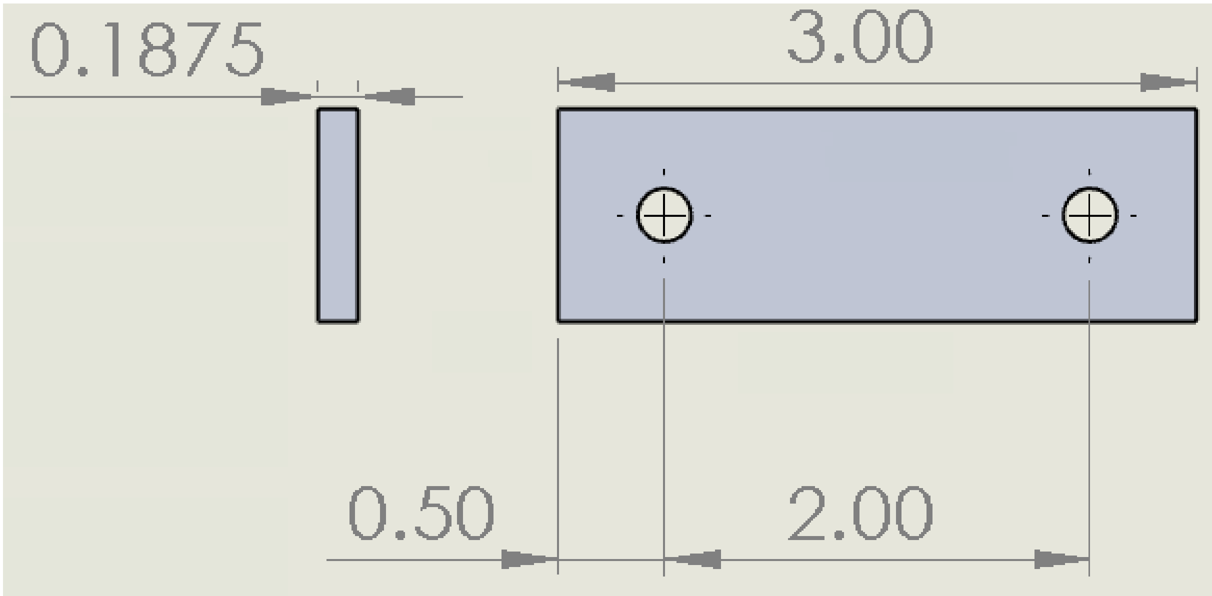
1. Layout the processes
2. Cut the box tubing to length
3. Prick punch to prepare for drilling
4. Drill the holes
5. Sand and deburr until safe to handle
6. Assemble



Part Name: Long Bar	***Model Maker***: Maxwell Spielman-Sun
Part Number: #4	***Units***: Inches
Material: Aluminum (6061)	***Number of Parts Required***: 2

Note: All holes are 0.25” diameter and centered vertically

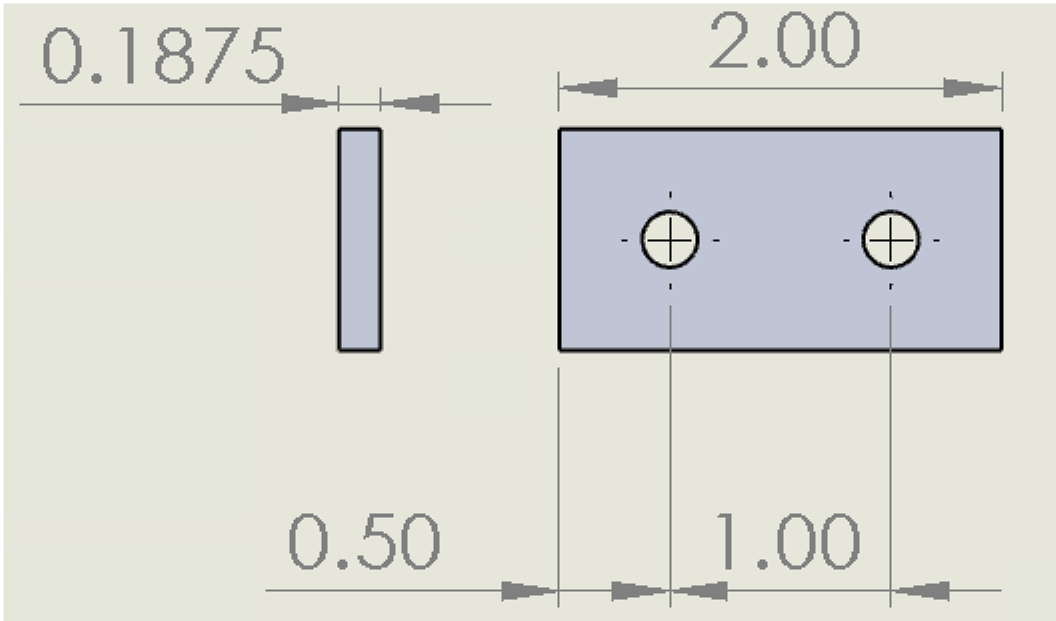
Manufacturing Process:
1. Layout the processes
2. Cut the bar to length
3. Prick punch to prepare for drilling
4. Drill the holes as listed
5. Sand and deburr until safe to handle
6. Assemble



Part Name: Short Bar A	***Model Maker***: Maxwell Spielman-Sun
Part Number: #5	***Units***: Inches
Material: Aluminum (6061)	***Number of Parts Required***: 2
Note: All holes are 0.25” diameter and centered vertically	

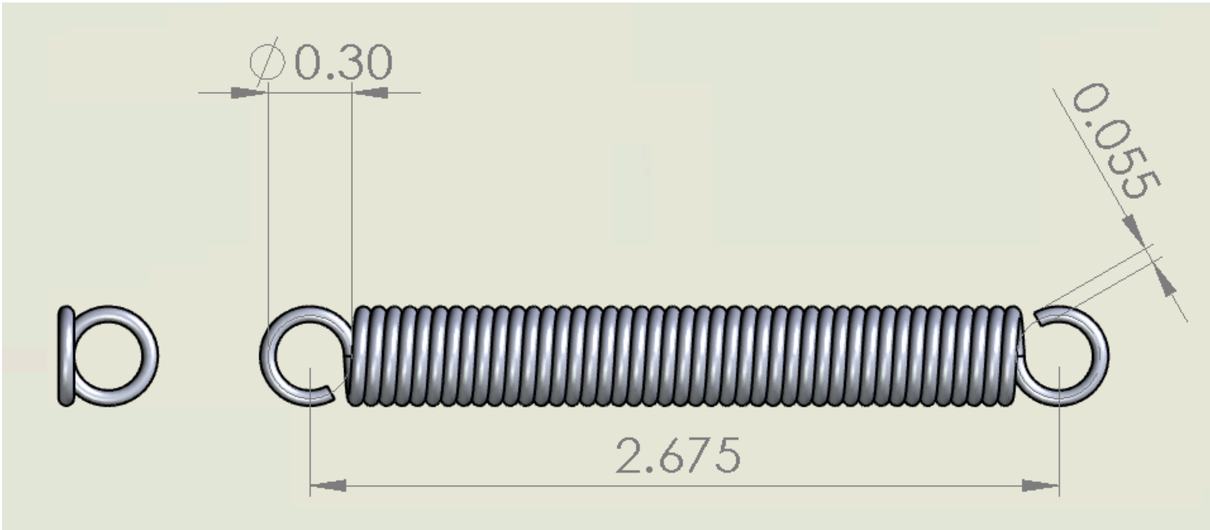
Manufacturing Process:

1. Layout the processes
2. Cut the bar to length
3. Prick punch to prepare for drilling
4. Drill the holes as listed
5. Sand and deburr until safe to handle
6. Assemble



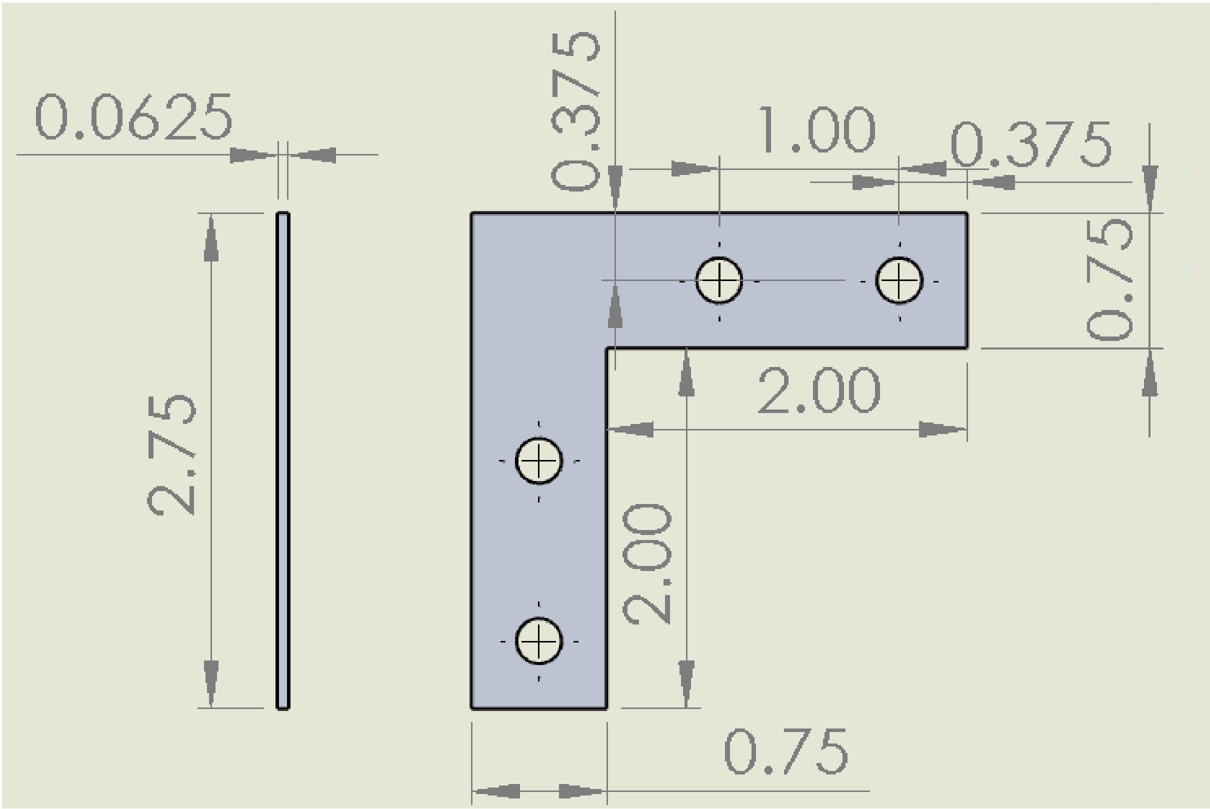
Part Name: Short Bar B	***Model Maker***: Maxwell Spielman-Sun
Part Number: #6	***Units***: Inches
Material: Aluminum (6061)	***Number of Parts Required***: 2
Note: All holes are 0.25" diameter and centered vertically	

Manufacturing Process:
1. Layout the processes
2. Cut the bar to length
3. Prick punch to prepare for drilling
4. Drill the holes as listed
5. Sand and deburr until safe to handle
6. Assemble



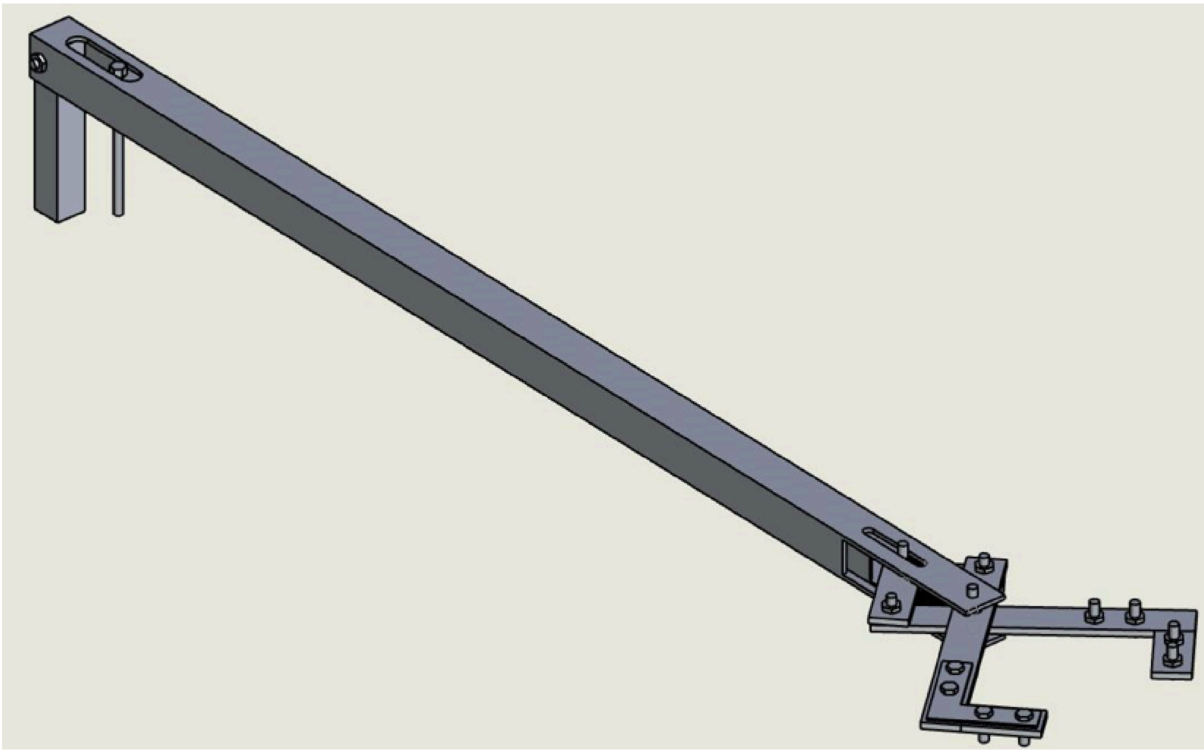
Part Name: Spring	***Model Maker***: Maxwell Spielman-Sun
Part Number: #7	***Units***: Inches
Material: High Carbon Steel Wire (ASTM A228 Steel)	***Number of Parts Required***: 2

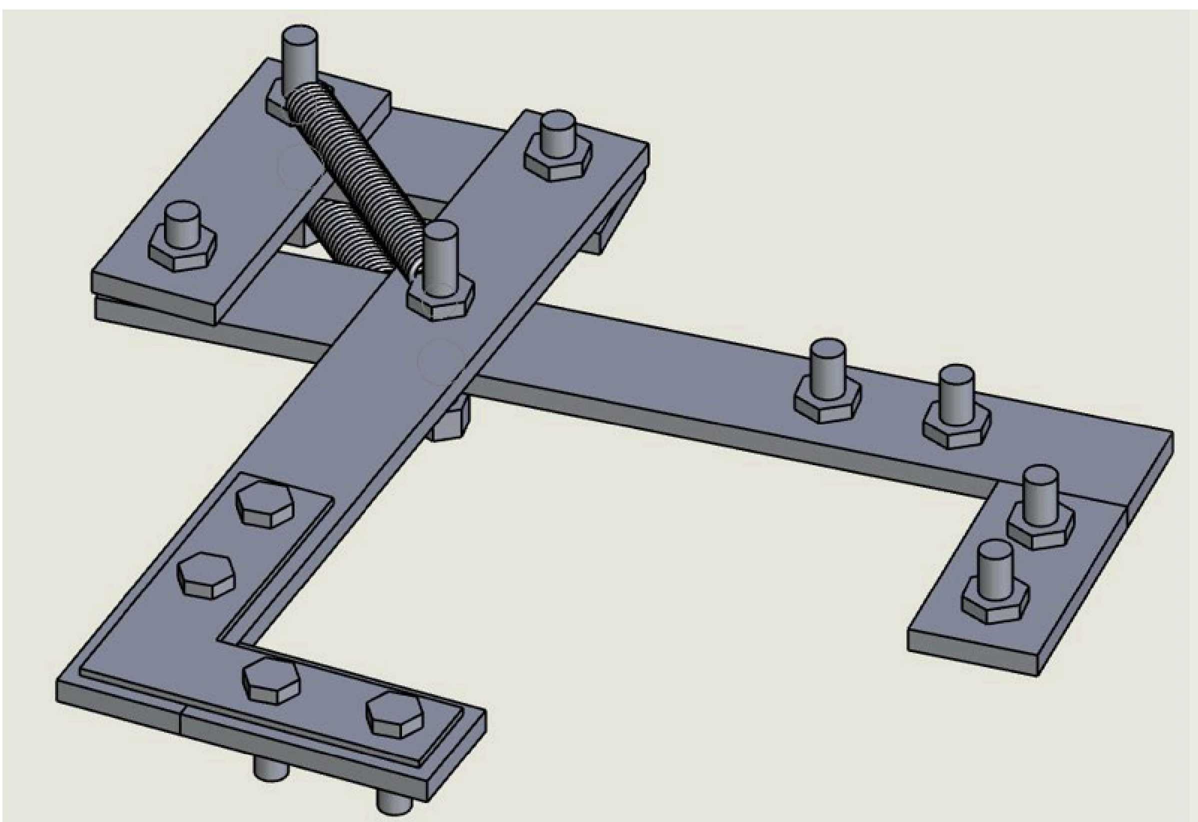
Manufacturing Process:
1. Layout the wire cut
2. Cut the wire to length (30')
3. Sand and deburr the wire cuts until safe to handle
4. Coil the wire to the dimensions specified above
5. Bend the first and last loops 90° as pictured
6. Assemble

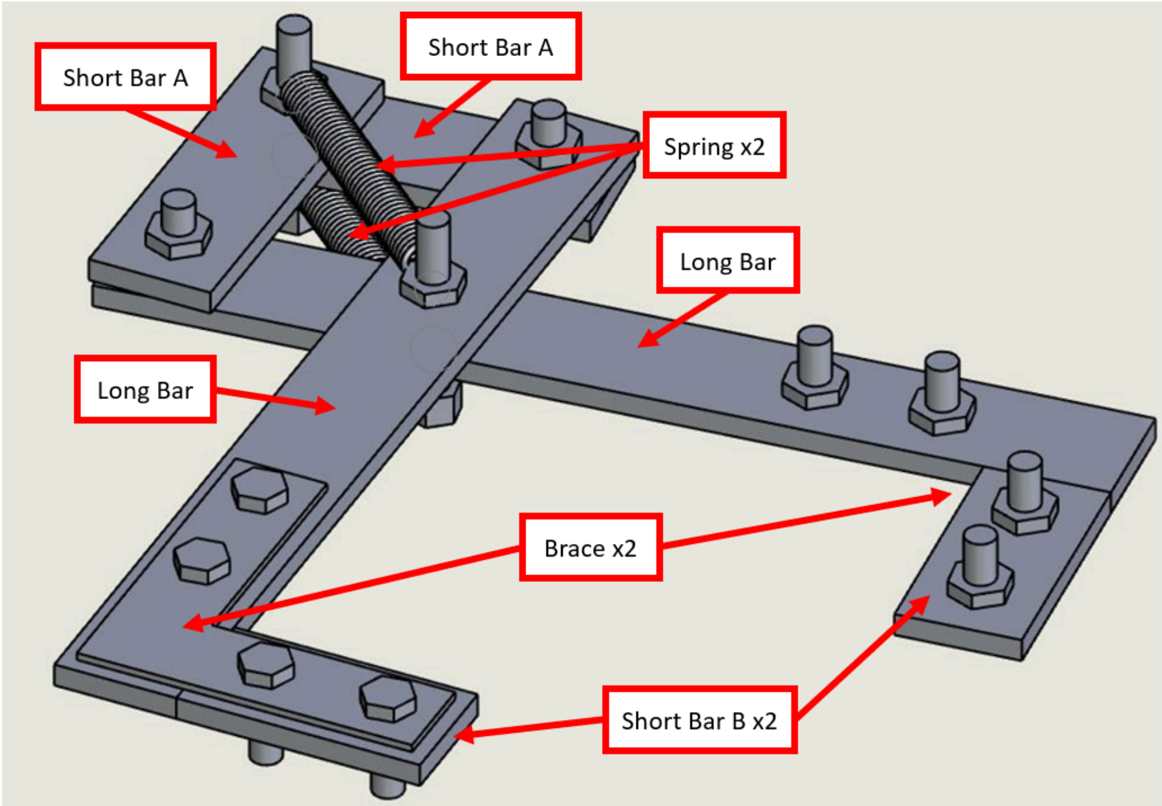


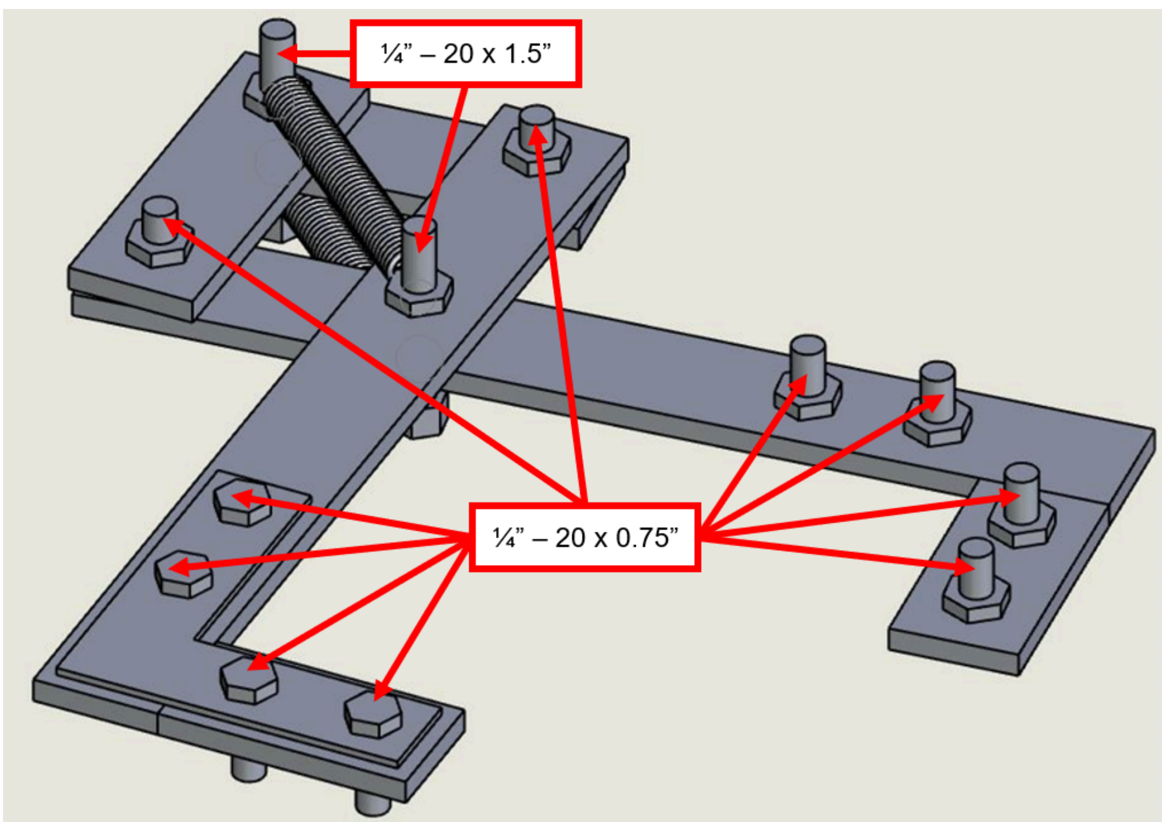
Part Name: Flat Corner Brace (Purchased)	***Model Maker***: Maxwell Spielman-Sun
Part Number: #8	***Units***: Inches
Material: Stainless Steel (304)	***Number of Parts Required***: 2
Note: All holes are 0.25” diameter and centered appropriately	

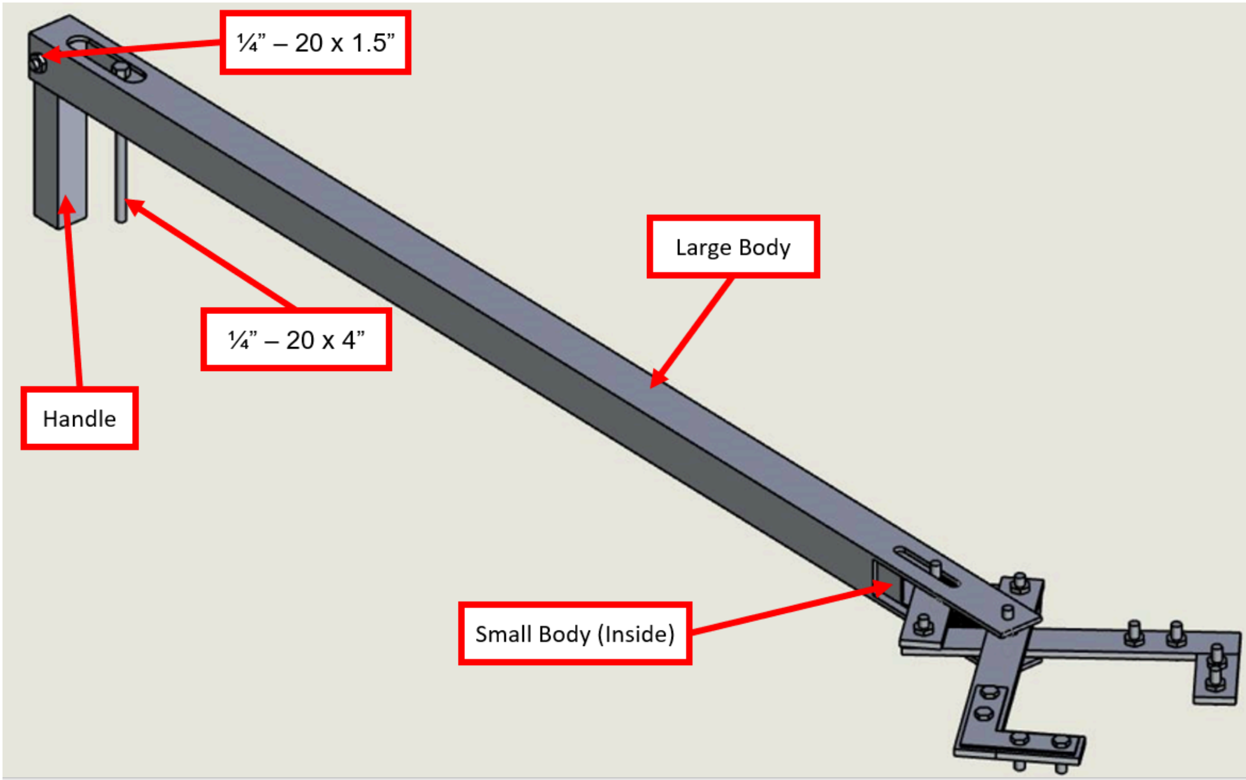
Assembly Drawings



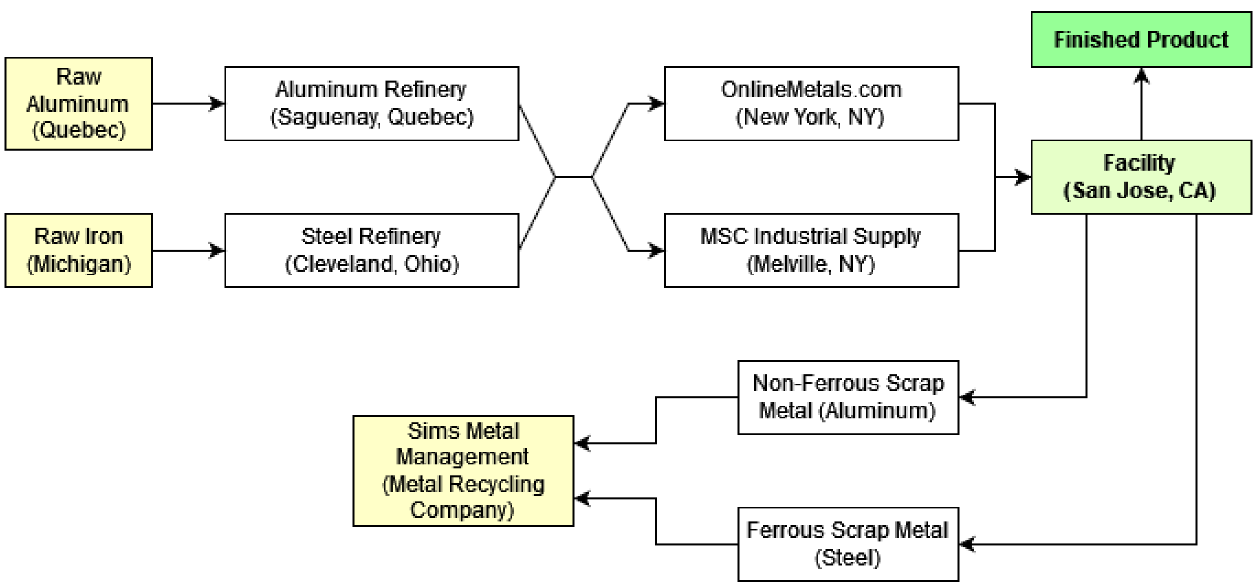



Short Bar A
Short Bar A
Spring x2
Long Bar
Long Bar
Brace x2
Short Bar B x2

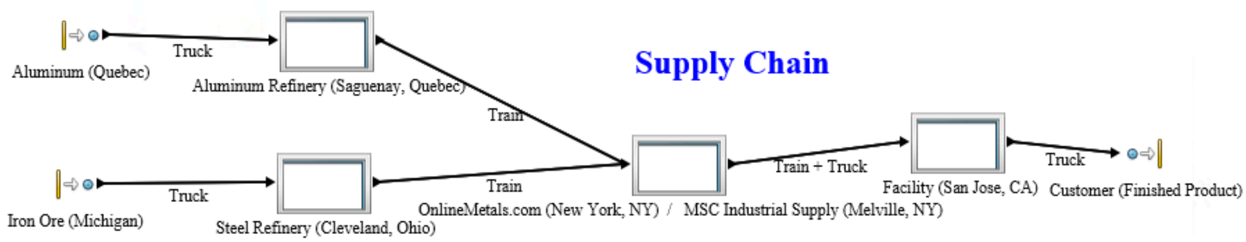

¼" – 20 x 1.5"
¼" – 20 x 0.75"

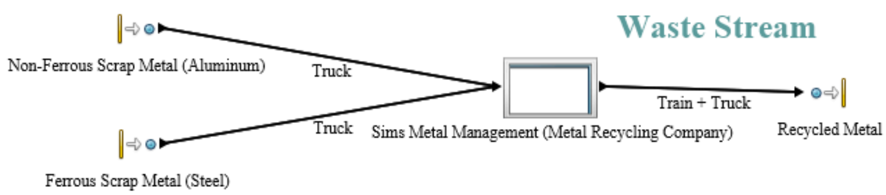


Supply Chain

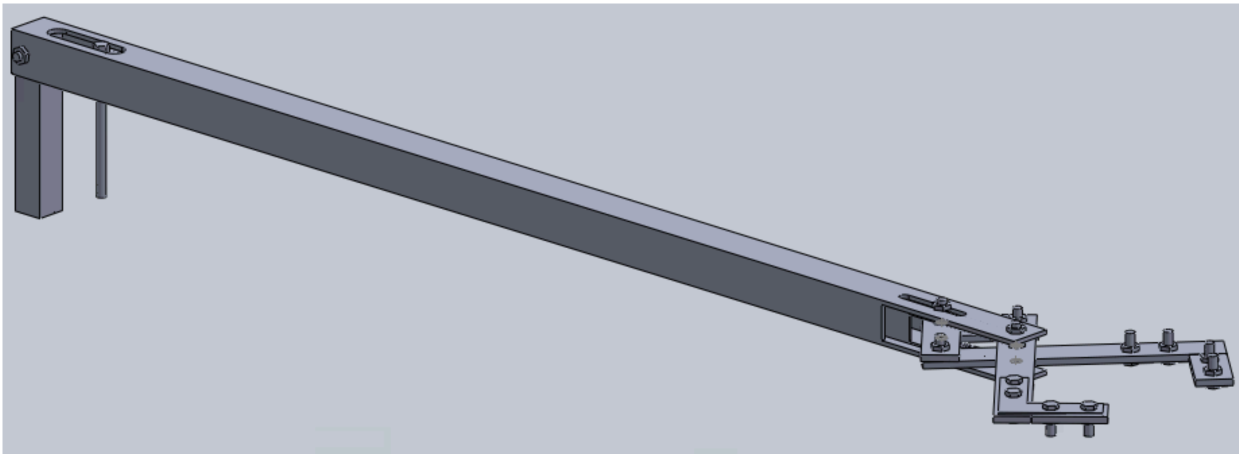


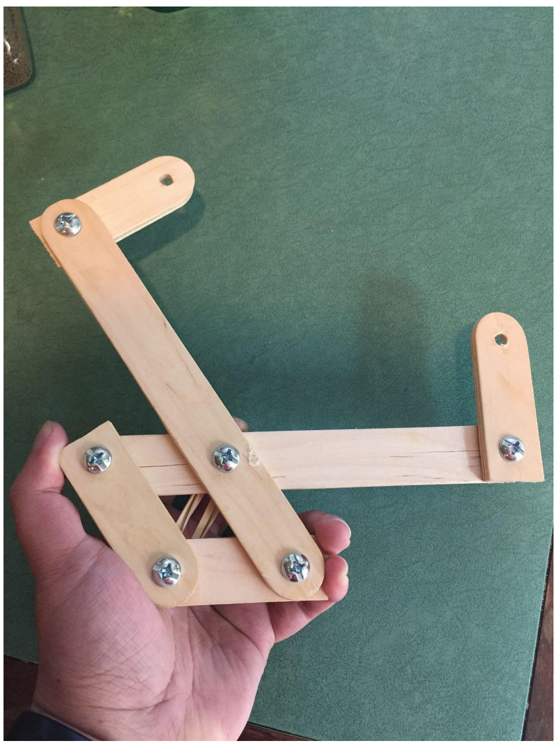
Supply Chain Simulation

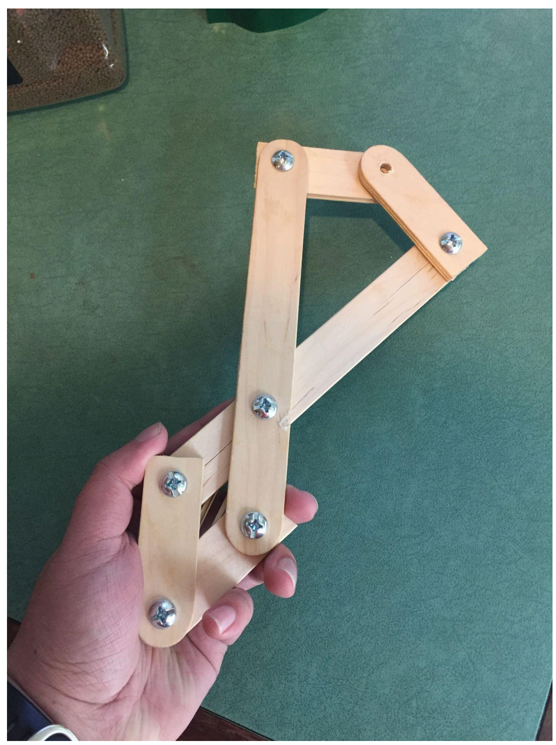




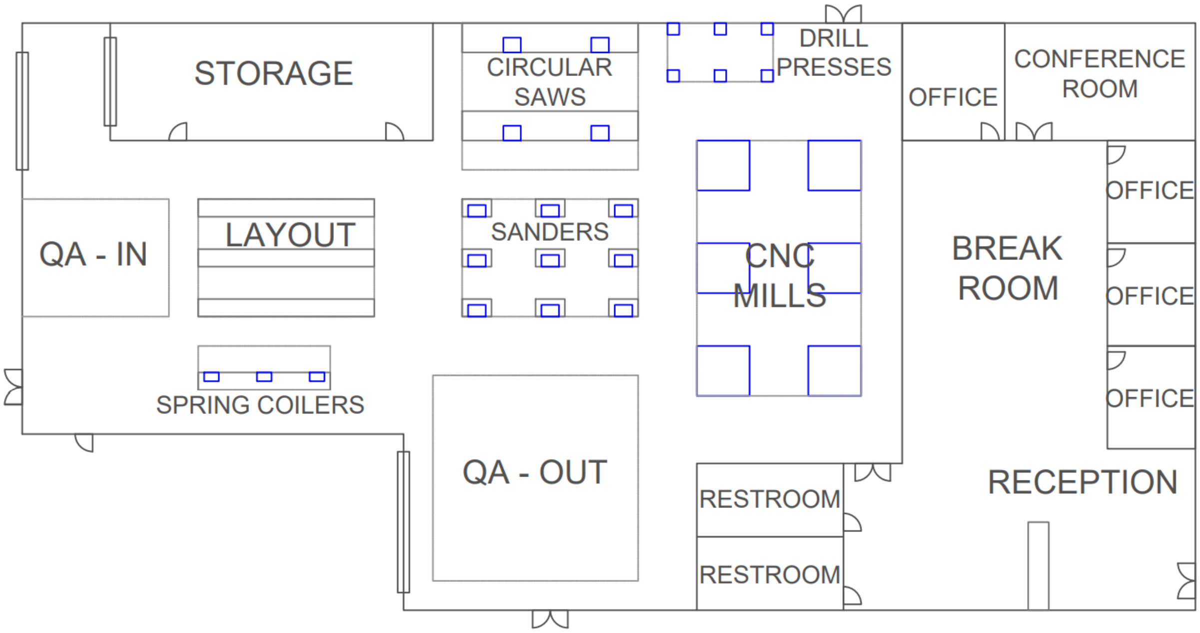
Full assembly model







Facility Layout



Note: The 200’ x 100’ facility is drawn to scale

Product Analysis

Product	Material	Shape / Form	Supplier	Cost	Processes
Large Body	6061 Aluminum	Box Tubing	OnlineMetals	$21.90	Layout, Cut, Punch, Drill Mill, Sand, Assembly
Small Body	6061 Aluminum	Box Tubing	OnlineMetals	$9.82	Layout, Cut, Punch, Drill Mill, Sand, Assembly
Handle	6061 Aluminum	Box Tubing	OnlineMetals	$1.60	Layout, Cut, Punch, Drill Sand, Assembly
Long Bar	6061 Aluminum	Bar	OnlineMetals	$1.22	Layout, Cut, Punch, Drill Sand, Assembly
Short Bar A	6061 Aluminum	Bar	OnlineMetals	$0.46	Layout, Cut, Punch, Drill Sand, Assembly
Short Bar B	6061 Aluminum	Bar	OnlineMetals	$0.31	Layout, Cut, Punch, Drill Sand, Assembly
Spring	ASTM A228 Steel	Wire	OnlineMetals	$18.00	Layout, Cut, Sand, Coil Bend, Assembly
Flat Brace	304 Stainless Steel	Flat Brace	OnlineMetals	$1.58	
Screw	304 Stainless Steel	Screw	MSC Industrial Supply	$0.25	
Nut	304 Stainless Steel	Nut	MSC Industrial Supply	$0.05	

Facility Analysis

Building Name	Units	Size of Space (ft)	Equipment	Condition
Drafting Station	6	30 x 20	Drafting Table/Tools	Good
Cutting Station	4	30 x 25	Circular Saw	Good
Drilling Station	6	18 x 10	Drill Press	Good
Sanding Station	9	30 x 20	Belt Sander	Good
Coiling Station	3	22.5 x 7.5	Spring Coiler	Good
CNC Mill Station	6	43.5 x 28	CNC Mills	Okay
QA Stations (Assembly)	8	25 x 20 / 35 x 35	Workbench, tools	Okay
Storage	1	55 x 20	Shelves	Good
Office	4	20 x 17.5 / 17.5 x 15	Computer, Desk, Chair	Okay
Reception	1	-	Computer, Desk, Chair	Good
Conference Room	1	32.5 x 17.5	Table, chairs, projector	Good
Restrooms	2	25 x 12.5	Toilets (5 per restroom)	Okay
Break Room	1	45 x 30	Lockers, tables, TVs	
Full Facility	1	200 x 100		Good
Parking Lot	1	~1 acre	100 spots	Okay

Production Analyst / Manager

Zixi Yang

TECH 147 Final Project

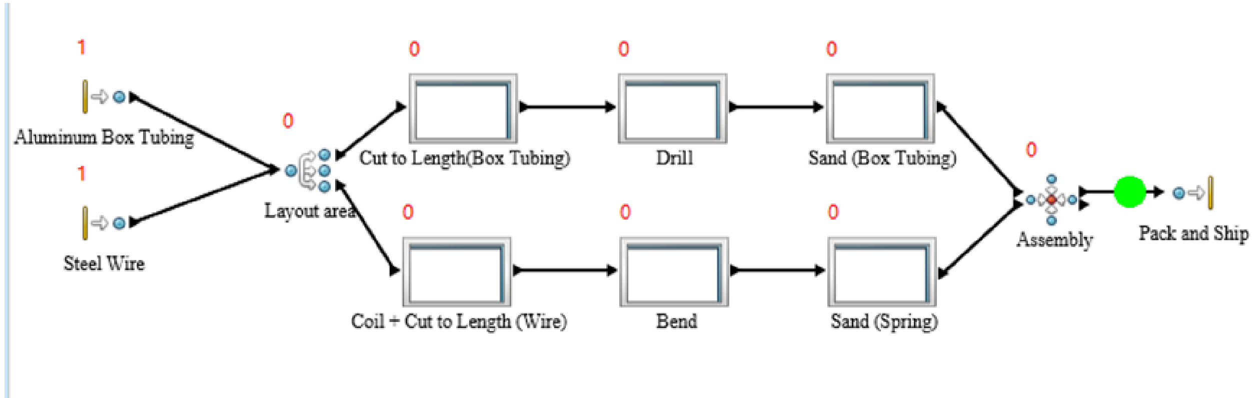
Report

Introduction

As the production analyst and manager, my responsibility is to produce all the process plans that support production of the product. Select, and analyze the equipment and tools needed to produce the product. Furthermore, I also need to show the individual resource utilization for operators and equipment times by making a pie or bar chart during each respective parts' processing. And last, I need to provide all related green analysis of the production area.

Simulation

Based on the equipment's name, processes and needed transportations provided by my teammate Maxwell. I made a process simulation by using SIMPROCESS. The process starts with the operators bringing the raw materials to the layout area, marking, and preparing the pieces to be worked. After the work is marked and planned out, operators will assign their duties between the wire spring and the limbs of the aluminum box tube, and the wire will be sent to the spring coiler. The operator will operate the coiler to roll the wire into a spring. The coilers also have built-in wire cutting capabilities that allow them to cut the spring to a certain length when curled. The operator can then use simple pliers to bend the first and last coils into rings for installation. operators who process aluminum box tubes will take their work to the cutting station. Using circular saws, they cut the box tubes into lengths, depending on whether they are making short or long limbs. After cutting them to a certain length, the operator takes the work to the drilling station and uses the drill to make the necessary holes in the design. After completing a specific part (spring or limb), the operator will stop before the grinding station to make it easy/safe for the operator to handle the part and possibly improve assembly efficiency. After the parts have been polished and cleaned, they will be assembled at the assembly station. The completed components will be well packaged and shipped out.



Screenshot of the whole process simulation using SIMPROCESS

Process Planning

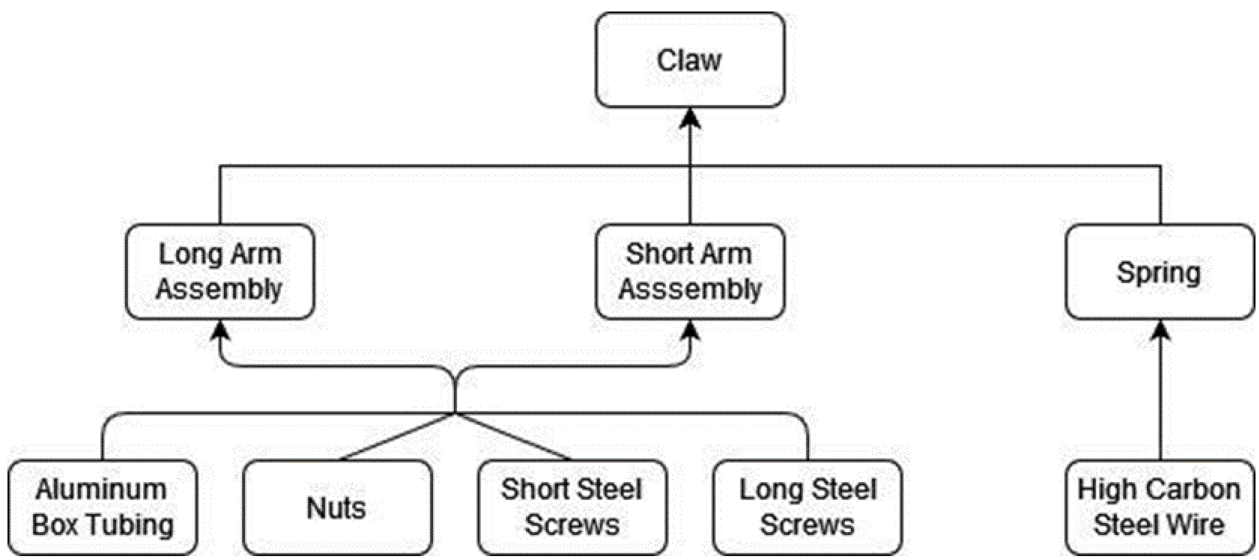
According to the data provided by Maxwell, I have made a tasks sheet for the fabrication phase of all items. The sheet contains a number of tasks, Description of Tasks, using time, machines, and tooling methods. As a result, the total number of hours needed to process all the parts would be 60 minutes. And based on the data and the time needed for processing all the parts, I made a pie chart of resource utilization for operator and equipment time during the respective parts' processing.

Task #	Description of Task	Time (min)	Machine	Tooling
1	Cut the aluminum box tubing to length	5	Circular Saw	Clamp

2	File cuts until safe to handle	3	Belt Sander	File
3	Layout the holes in the box tubing for the drill press	5	-	Drafting
4	Drill the holes in the box tubing	10	Drill Press	-
5	Clean up drilled holes	5	-	File
6	Cut spring/wire to length	5	-	Pliers
7	Utilize the spring coiler to produce a metal spring	10	Spring Coiler	Pliers
8	Twist the end turns in the spring to make loops	2	-	Pliers
9	Assemble the claw	10	-	-
10	Clean up/file rough edges	5	Belt Sander	File
Estimated total time working		***60***		

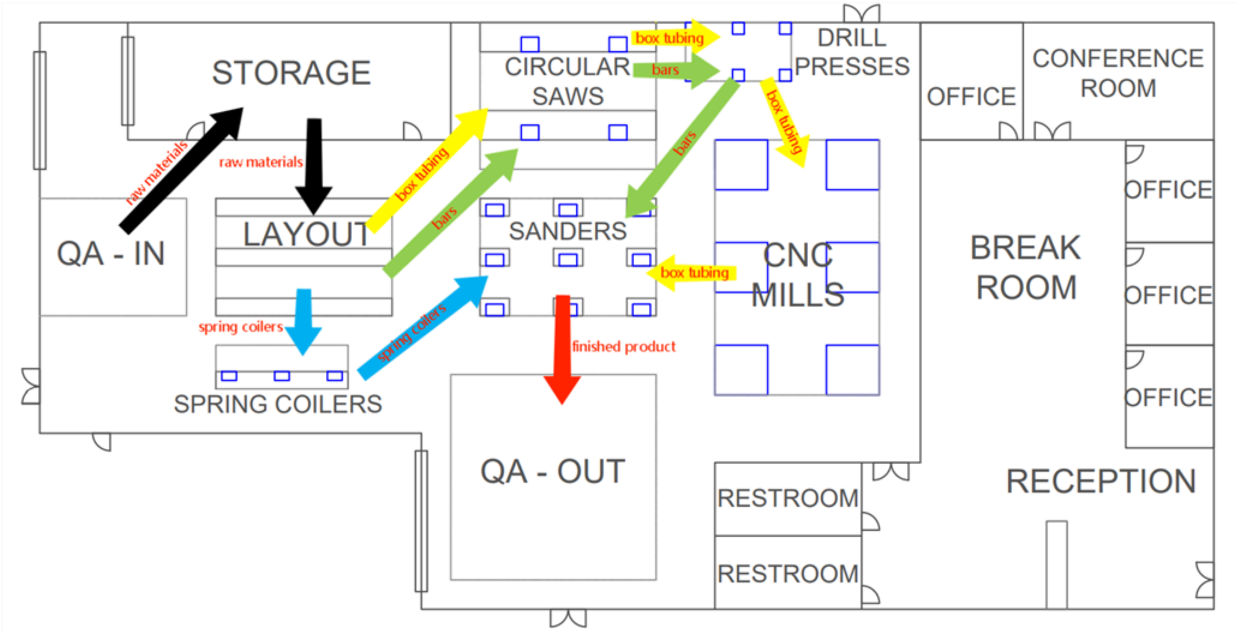
Assembly Chart

According to the bill of materials created by the Design Analyst, I made the Assembly chart for our product. According to the chart, the aluminum box tubing, nuts, short steel screws, and the long steel screws will be assembled into two different parts, which are long arm assembly and short arm assembly. Besides, the spring as the third part of our part will be produced using high carbon steel wire. The final three parts will be assembled, and our product is well-produced.



Facility Layout (All parts processing flow path)

According to the facility layout designed by the design analyst, and the process flow path provided by myself, I configured the facility layout to show the process flow paths of all the individual parts with different colors. The black arrow represents the raw materials, yellow arrow represents the box tubing, green arrow represents the bars, blue arrow represents the wires, and the finished product is represented by the red arrow.



Equipment Analysis

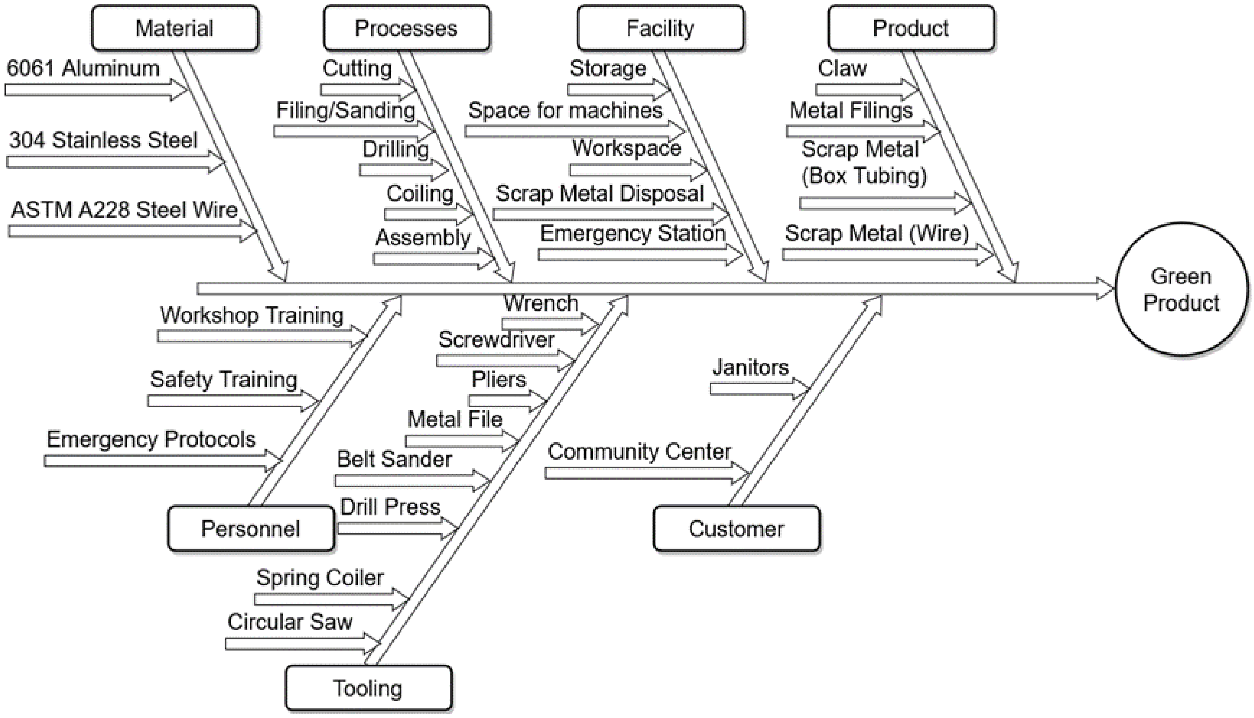
Through our group discussion and analysis of thinking about equipment needs, and data obtained through online searches, I made an Equipment Analysis sheet including machine name, model, units, dimensions, sizes, costs, suppliers, condition, and accessories. The total cost of equipment and tooling in the facility will be $140 + $400 + $500 + $115 = $1,155.

Machine	Make/ Model	Units Avail	Dimensions	Size	Cost	Supplier	Condition	Accessories
Circular Saw	DCS565	2	36” x 28”	6.5” Blade	$140.00	DeWalt	Good	Clamps, Scale

Drill Press	15 in. Drill Press w/ LED	4	24” x 24”	15” Drill, 20”x14” table	$400.00	RIGID	Good	Clamps
Spring Coiler	W-13A	1	18” x 28”	200’ wire per minute	$500.00	Torrington Wire Machinery	Good	Clamps
Belt Sander	WEN Belt Disc Sander	2	24” x 40”	4”x36” belt	$115.00	WEN	Good	Scale

Green Production Systems Analysis

According to the previous project, and the product detail information provided by my teammate, I designed an Ishikawa diagram with seven aspects including material, processes, facility, product, personnel, tooling, and customer. I also made the average percentage of green based on the Ishikawa diagram. The overall environmental impact of the facility will depend primarily on energy. Ideally, if the facility were to operate mainly at noon, most of the energy utilities would come from solar power plants. However, the facility does not have built-in energy generation. As a result, the facility received the following scores:



Ishikawa diagram

Average percentage of green	
Environment Impact Score	7
Green Policies Score	8
Reputation Survey Score	9

<u>The organizational chart of the personnel who work in this facility</u>

After our analysis of the whole process planning and discussing the number of workers needed, I made the organizational chart of the personnel who work in the facility, the personnel chart contains with design manager, production manager, sales manager, one security guard, one accountant, one receptionist, three supervisors, six machinists, twenty operators, and seven quality control inspectors.

7 Safety Rules for operators

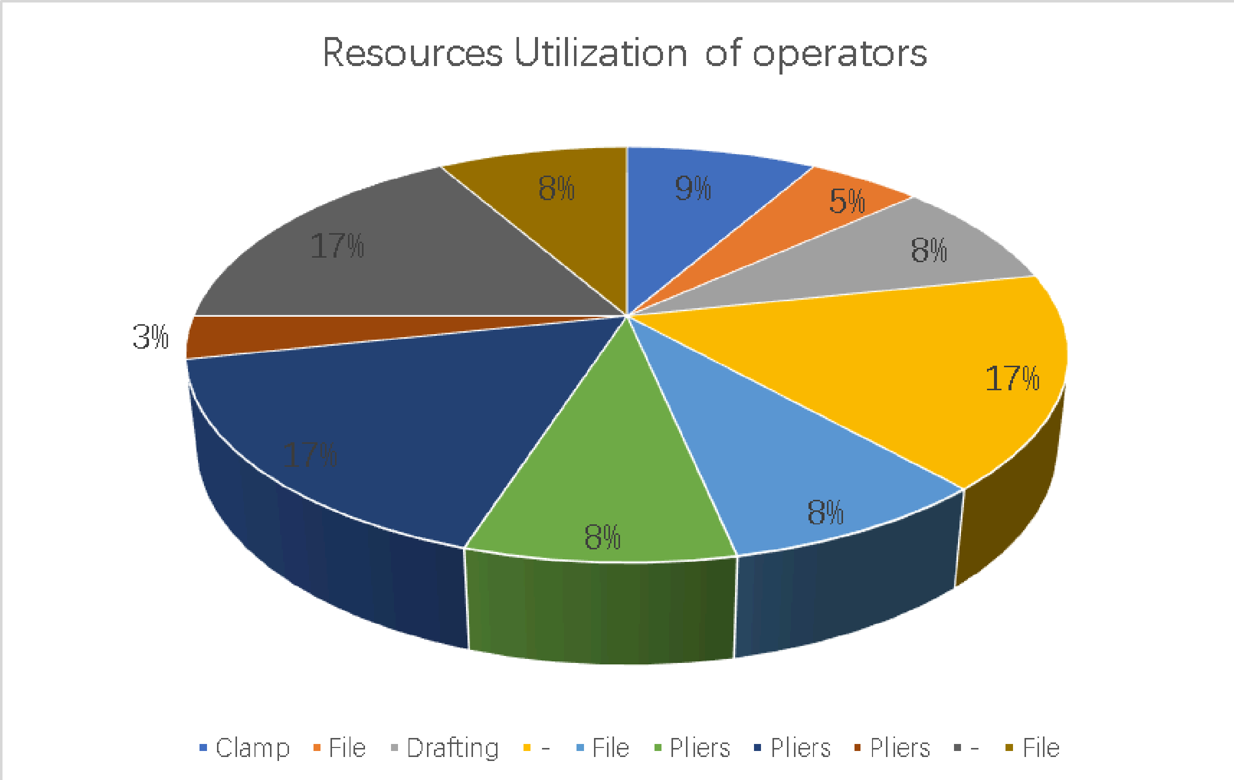
1. Keep the work area clean.
2. Use tools suitable for the job.
3. Always wear a helmet during work tasks.
4. Do not work on live equipment.
5. Make sure that the material is properly labeled and stored.
6. In case of danger, communicate the danger to other personnel.
7. Stop working when you need to deal with danger.

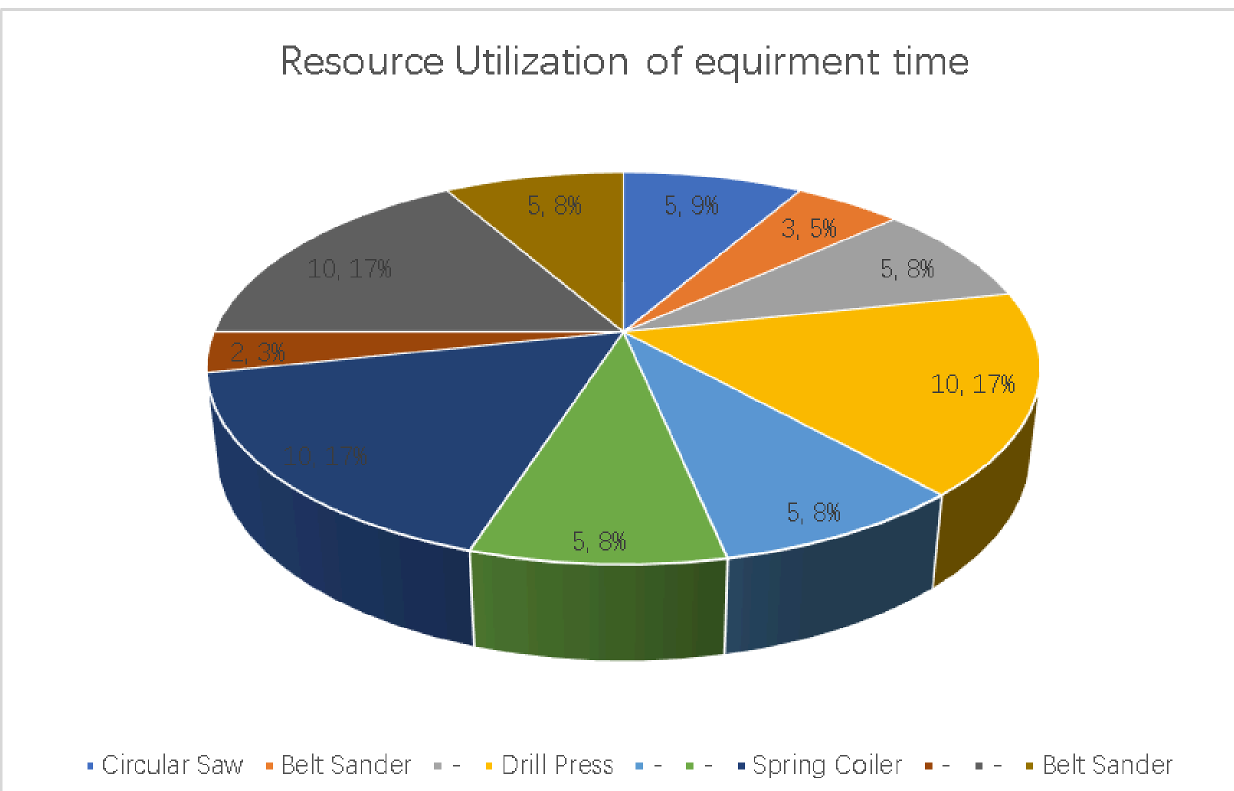
Assigned Questions

1. Total number of hours needed to process all the parts.

The total number of hours needed to process all the parts is 1 hour.

2. Resource utilization for operator(s) and equipment time during the respective part's processing.


Resources Utilization of operators
9%
5%
8%
17%
8%
8%
17%
3%
17%
8%
Clamp
File
Drafting
-
File
Pliers
Pliers
Pliers
-
File


Resource Utilization of equirment time
5, 9%
3, 5%
5, 8%
10, 17%
5, 8%
5, 8%
10, 17%
2, 3%
10, 17%
5, 8%
Circular Saw
Belt Sander
-
Drill Press
-
-
Spring Coiler
-
-
Belt Sander

3. The amount of time it takes to assemble one complete product.

It will take 10 minutes to assemble one complete product.

4. Average percentage of green from Ishikawa diagram.

Material	70%
Processes	70%
Facility	80%
Product	90%
Personnel	80%
Tooling	80%
Customer	70%

5. Percentage or proportion of green composition in each system.

Average percentage of green	
Environment Impact Score	7
Green Policies Score	8
Reputation Survey Score	9

6. How much a typical operator would make during the 3-month period if average hourly pay is $35.00.

35 $/hour * 8 hours * 5 days * 4 weeks * 3 months = $16,800

7. Total cost of equipment and tooling in the facility.

The total cost of equipment and tooling in the facility will be $1,155

8. Total number of personnel who work in this facility

The total number of personnel who work in this facility will be 42 people.

<u>Sales Analyst / Manager</u>

Julius Ali

TECH 147 Final Project

Report

Forecasting

In this project, I am responsible for the sales manager of our company. Our company makes an extended reach product that will help people to get an assisted life. As a sales manager, I made the forecast for the next three months which are the fourth, fifth, and sixth month. The fourth month forecast is 6700, the fifth month is 6542.5, and the sixth month is 6454.3. I used 0.3 for the smoothing constant.

(4th Month)

Actual = (5000 + 6000 + 7000) / 3

= 18000 / 3

= 6000

Forecast = Old Forecast + α (Actual - Old Forecast)

= 7000 + 0.3 (6000 - 7000)

= 6700

(5th Month)

Actual = (5000 + 6000 + 7000 + 6700) / 4

= 24700 / 4

= 6175

Forecast = Old Forecast + α (Actual - Old Forecast)

= 6700 + 0.3 (6175 - 6700)

= 6542.5

(6th Month)

Actual = (5000 + 6000 + 7000 + 6700 + 6542.5) / 5

= 31242.5 / 5

= 6248.5

Forecast = Old Forecast + α (Actual - Old Forecast)

= 6542.5 + 0.3 (6248.5 – 6542.5)

= 6454.3

Scheduling

For scheduling, I used MPS, MRP, and daily production schedule. The MPS is a 12 week period which then I put week 1-4 for the fourth month forecast, week 5-8 for the fifth month forecast, and week 9-12 for the sixth month forecast. I divided the forecasted result by 4 and got the forecasted result for each week. For the large body, small body, and handle consists of only 1 part per product which gives me 1675 while for the rest there are two parts per product. Because there are two parts per product, I multiply the forecasted amount per week by 2 to keep up with the required component of each product. I like to start a new period with the same number of available products so I adjust the MPS so that it will be the same on the first, fifth, and ninth period of the week. The MPS and the MRP for the large body and small body are identical because it is almost an identical component so I schedule the production similarly. For the MRP I took the third week of the fourth month for each part. I used a five days period for the MRP. The forecast for the MRP is the forecasted unit of that week divided by 5. At the period number 5 of the MRP, it always matches with the number of available units of the week period of the MPS. For the daily production schedule, the needed production time for each product in order to keep up with the monthly requirement is 1.43 minutes per item. The total part that will be done each day is roughly 335 items. Someday it will be more, someday it will be less depending on the MRP. The production hours per day is 8 hours.

	MPS Time-Phased Record											
Item: Large Body #1	Period in Weeks											
	1	2	3	4	5	6	7	8	9	10	11	12
Forecast	1675	1675	1675	1675	1636	1636	1636	1636	1614	1614	1614	1614
Available	75	80	40	50	30	45	60	50	37	48	56	50
MPS	1700	1680	1635	1685	1616	1651	1651	1626	1601	1625	1622	1608
On Hand	50	75	80	40	50	30	45	60	50	37	48	56

	MPS Time-Phased Record											
Item: Small Body #2	Period in Weeks											
	1	2	3	4	5	6	7	8	9	10	11	12
Forecast	1675	1675	1675	1675	1636	1636	1636	1636	1614	1614	1614	1614
Available	75	80	40	50	30	45	60	50	37	48	56	50
MPS	1700	1680	1635	1685	1616	1651	1651	1626	1601	1625	1622	1608
On Hand	50	75	80	40	50	30	45	60	50	37	48	56

	MPS Time-Phased Record											
Item: Handle #3	Period in Weeks											
	1	2	3	4	5	6	7	8	9	10	11	12
Forecast	1675	1675	1675	1675	1636	1636	1636	1636	1614	1614	1614	1614
Available	150	160	80	100	60	90	120	100	74	96	112	100
MPS	1725	1685	1595	1695	1596	1666	1666	1616	1588	1636	1630	1602
On Hand	100	150	160	80	100	60	90	120	100	74	96	112

	MPS Time-Phased Record											
Item: Long Bar #4	Period in Weeks											
	1	2	3	4	5	6	7	8	9	10	11	12
Forecast	3350	3350	3350	3350	3272	3272	3272	3272	3228	3228	3228	3228
Available	35	40	37	25	40	36	43	25	55	47	50	25
MPS	3360	3355	3347	3338	3287	3268	3279	3254	3258	3220	3231	3203
On Hand	25	35	40	37	25	40	36	43	25	55	47	50

	MPS Time-Phased Record											
Item: Short Bar A #5	Period in Weeks											
	1	2	3	4	5	6	7	8	9	10	11	12
Forecast	3350	3350	3350	3350	3272	3272	3272	3272	3228	3228	3228	3228
Available	50	47	55	40	38	35	57	40	35	46	52	40
MPS	3360	3347	3358	3335	3270	3269	3294	3255	3223	3239	3234	3216
On Hand	40	50	47	55	40	38	35	57	40	35	46	52

	MPS Time-Phased Record											
Item: Short Bar B #6	Period in Weeks											
	1	2	3	4	5	6	7	8	9	10	11	12
Forecast	3350	3350	3350	3350	3272	3272	3272	3272	3228	3228	3228	3228
Available	35	42	43	33	25	27	50	35	31	39	40	25
MPS	3360	3357	3351	3340	3264	3274	3295	3257	3224	3236	3229	3213
On Hand	25	35	42	43	33	25	27	50	35	31	39	40

	MPS Time-Phased Record											
Item: Spring #7	Period in Weeks											
	1	2	3	4	5	6	7	8	9	10	11	12
Forecast	3350	3350	3350	3350	3272	3272	3272	3272	3228	3228	3228	3228
Available	50	66	60	37	42	48	40	37	63	65	54	37
MPS	3363	3366	3344	3327	3277	3278	3264	3269	3254	3230	3217	3211
On Hand	37	50	66	60	37	42	48	40	37	63	65	54

	MPS Time-Phased Record											
Item: Flat Corner Brace #8	Period in Weeks											
	1	2	3	4	5	6	7	8	9	10	11	12
Forecast	3350	3350	3350	3350	3272	3272	3272	3272	3228	3228	3228	3228
Available	45	53	67	40	31	58	43	40	55	60	47	55
MPS	3360	3358	3364	3323	3263	3299	3257	3269	3243	3233	3215	3236
On Hand	35	45	53	67	40	31	58	43	40	55	60	47

3rd Week of the 4th Month		MRP Record				
Item: Large Body #1		Period Number				
		1	2	3	4	5
Gross Requirements (Forecast)		335	335	335	335	335
Projected Available Balance	80	80	90	70	80	40
Master Production Schedule		335	345	325	335	295

3rd Week of the 4th Month		MRP Record				
Item: Small Body #2		Period Number				
		1	2	3	4	5
Gross Requirements (Forecast)		335	335	335	335	335
Projected Available Balance	80	80	90	70	80	40
Master Production Schedule		335	345	325	335	295

3rd Week of the 4th Month		MRP Record				
Item: Handle #3		Period Number				
		1	2	3	4	5
Gross Requirements (Forecast)		335	335	335	335	335
Projected Available Balance	160	170	150	150	170	80
Master Production Schedule		345	325	325	345	255

3rd Week of the 4th Month		MRP Record				
Item: Long Bar #4		Period Number				
		1	2	3	4	5
Gross Requirements (Forecast)		670	670	670	670	670
Projected Available Balance	40	45	40	35	40	37
Master Production Schedule		675	670	665	670	667

3rd Week of the 4th Month		MRP Record				
Item: Short Bar A #5		Period Number				
		1	2	3	4	5
Gross Requirements (Forecast)		670	670	670	670	670
Projected Available Balance	47	37	42	57	52	55
Master Production Schedule		660	665	680	675	678

3rd Week of the 4th Month		MRP Record				
Item: Short Bar B #6		Period Number				
		1	2	3	4	5
Gross Requirements (Forecast)		670	670	670	670	670
Projected Available Balance	42	37	44	47	40	43
Master Production Schedule		665	672	675	668	671

3rd Week of the 4th Month		MRP Record				
Item: Spring #7		Period Number				
		1	2	3	4	5
Gross Requirements (Forecast)		670	670	670	670	670
Projected Available Balance	66	66	71	61	66	60
Master Production Schedule		670	675	665	670	664

3rd Week of the 4th Month		MRP Record				
Item: Flat Corner Brace #8		Period Number				
		1	2	3	4	5
Gross Requirements (Forecast)		670	670	670	670	670
Projected Available Balance	53	61	71	71	74	67
Master Production Schedule		665	675	675	678	671

Daily Production Schedule

Part No.	Part Name	Unit	Station # or Machine Name	Timer Per Part in Minutes	Total Time in Minutes
1	Large Body	325	Circular Saw, Drill Press, CNC Mill, Belt Sander	0.16	52
2	Small Body	325	Circular Saw, Drill Press, CNC Mill, Belt Sander	0.16	52
3	Handle	325	Circular Saw, Drill Press, Belt Sander	0.12	39
4	Long Bar	665	Circular Saw, Drill Press, Belt Sander	0.1	66.5
5	Short Bar A	680	Circular Saw, Drill Press, Belt Sander	0.1	68
6	Short Bar B	675	Circular Saw, Drill Press, Belt Sander	0.1	67.5
7	Spring	665	Circular Saw, Spring Coiler, Belt Sander	0.1	66.5
8	Flat Corner Brace	675	Circular Saw, Drill Press, Belt Sander	0.1	67.5
		Total		0.94	479

Product Cost Estimation

The product cost estimation for each product including the overhead cost and labor is $415.24 per product. In the production costs, I calculated everything per 1.43 minutes which is the time to make 1 unit of the product. The labor costs in total each 1.43 minutes is $317.24. The tools and machine costs, I calculated it by determining the depreciation each 1.43 minutes of production time. All the machines are new except the CNC mill. Since used machines depreciate less compared to new machines, I calculated 10% depreciation for the CNC mill but for the rest I used 25% depreciation. For the energy costs, I calculated the electricity and gas every 1.43 minutes. However, for the transportation costs I assumed that each product will cost about $15 from raw materials to the end product. The reason I calculated everything for every

1.43 minutes is because I want to get an accurate estimation of how much the production costs for each product.

Product Cost Estimation Sheet

Quantity Needed		Unit Cost	Cost Computation & Justification	Cost ($)
1. Materials (from BOM)				
1a)	36”	$7.30/ft	Box Tubing (Large)	$21.90
1b)	35.675”	$3.84/ft	Box Tubing (Small)	$11.42
1c)	26”	$22.03/12ft	Aluminum Flat Bar	$3.98
1d)	2	$9.49/12	Flat Corner Brace	$1.58
1e)	10	$0.25	Short Steel Screws	$2.50
1f)	3	$0.25	Long Steel Screws	$0.75
1g)	1	$0.34	(Trigger) Steel Bolt	$0.34
1h)	14	$0.25	Nuts	$3.50
1i)	60”	$0.60/in	High Carbon Steel Wire	$36.00
2. Labor: Total time in hours from Process Charts times wages/hour				
2a)	1.43min	$221.85	Production Process for	$317.24
3. Tools and Machines (Including Rental & Depreciation Costs)				
3a)	4.	$0.00043/1.43min	Depreciation Circular Saw (25%)	$0.0017
3b)	6	$0.00124/1.43min	Depreciation Drill Press (25%)	$0.0075
3c)	3	$0.0016/1.43min	Depreciation Spring Coiler (25%)	$0.0047
3d)	9	$0.00036/1.43min	Depreciation Belt Sander (25%)	$0.0032
3e)	6	$0.074/1.43min	Depreciation CNC Mill (10%)	$0.446
4. Energy (Including Gas, Electricity etc.)				
4a)	1.43min	$0.4/min	Electricity and Gas	$0.57
5. Overhead and Other Costs (Including Profit Margin)				
5a).	1	$15.00	Transportation	$15.00
TOTAL COST				**$415.24**

Personnel Analysis

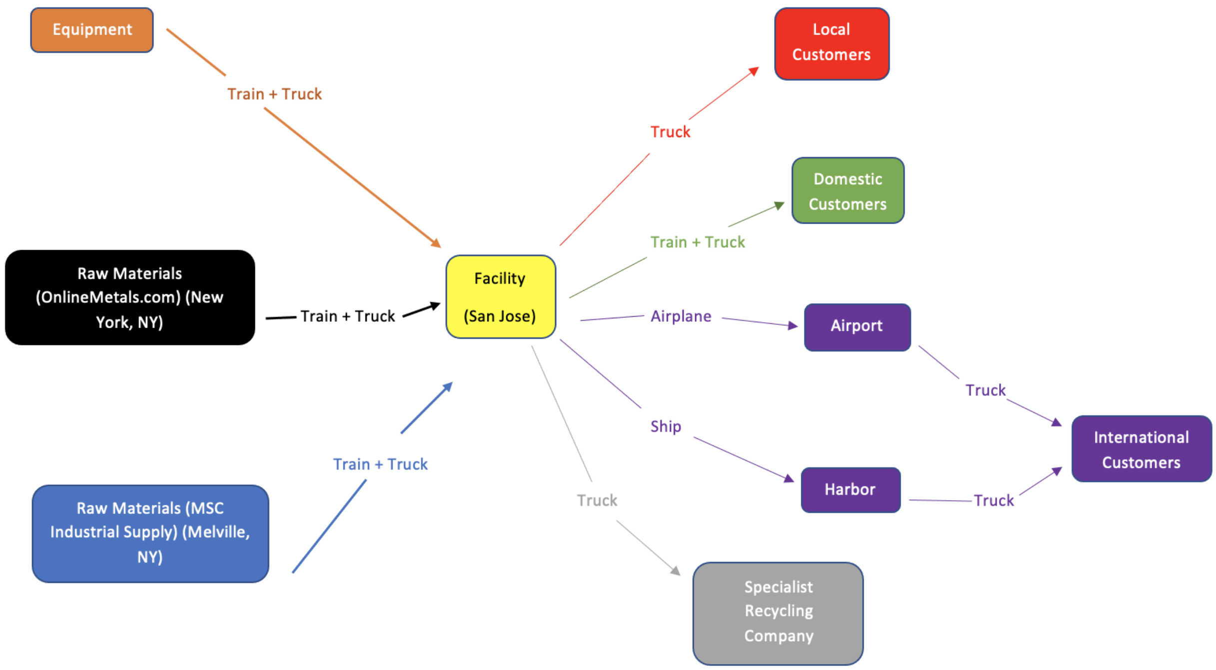
There are 42 employees in total in our company. The most number employed is the operator which occupied 20 of the 42. The annual salary for all the employees is $25,557,000. I included myself along with my fellow group mates in the personnel analysis. Each of us gets a

$70,000 salary annually. Most of the personnel in our company have bachelor's degree education while only the security and receptionist have a high school diploma.

Personnel	Number employed	Average years of employm ent	Average age	Sex	Salary	Education	Ethnicity	Marrital status	Number of MHS
Design manager	1	5	48	Male	$70,000	Bachelor's Degree	White	Single	2
Production manager	1	4	46	Male	$70,000	Bachelor's Degree	Asian	Single	2
Sales manager	1	3	45	Male	$70,000	Bachelor's Degree	Asian	Single	2
Security	1	4	42	Male	$45,000	High School	Latino	Married	0
Accountant	1	6	44	Female	$50,000	Bachelor's Degree	White	Married	0
Receptionist	1	2	39	Female	$50,000	High School	White	Single	0
Supervisor	3	5	46	Male	$60,000	Bachelor's Degree	Asian	Married	2
Machinist	6	4	45	Male	$90,000	Bachelor's Degree	White	Single	5
Operator	20	2	43	Male	$50,000	Bachelor's Degree	Asian	Married	1
Quality control	7	5	37	Male	$53,500	Bachelor's Degree	White	Married	1
Total	42	4	43.5		$608,500				15

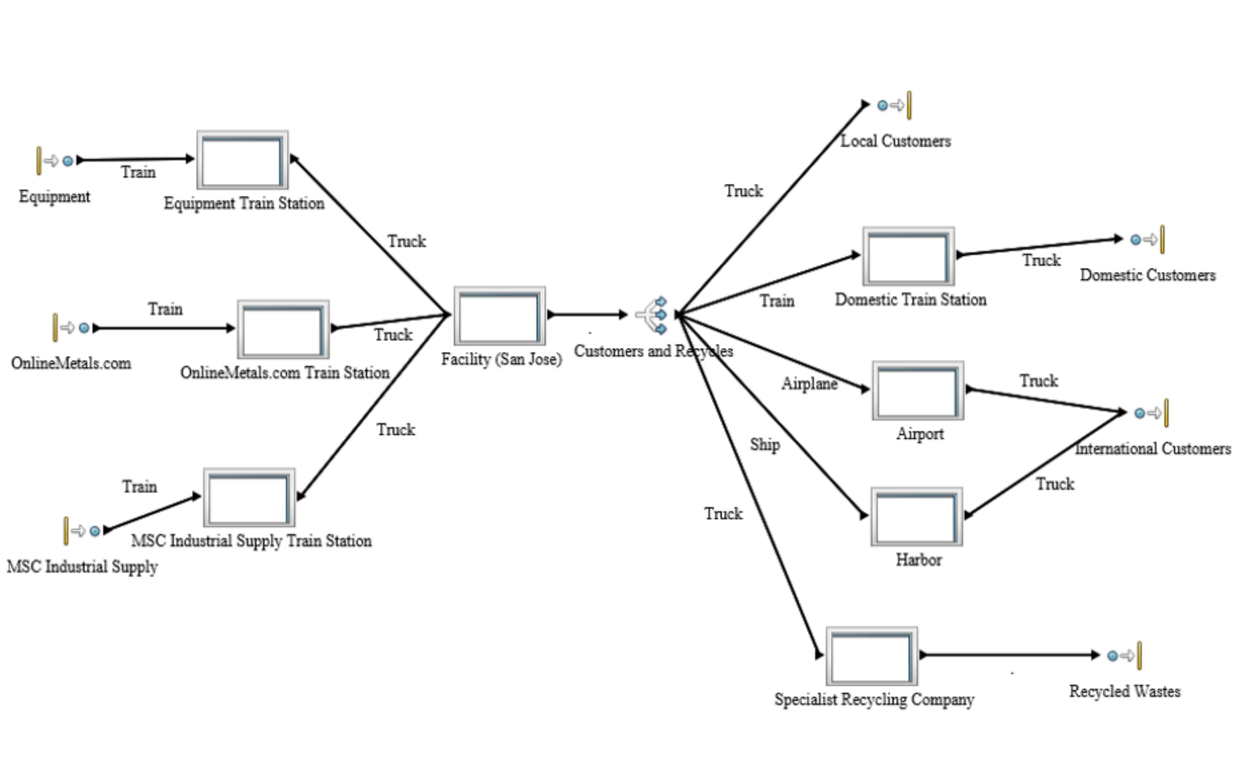
Logistics

In this section I took care of the transportation in the company from the raw material to the end product to the customers. Most of the transportation uses trucks and trains. Only international transportation to international customers needs a ship and airplane. I gave two options for international customers depending on the time requirement that they need. If they need the transportation quicker then they will pay more for the transportation using an airplane which will be quicker. If quick transportation is not a requirement then they can opt for a cheaper transportation price which is through the sea but it will take longer to arrive.


Equipment
Train + Truck
Raw Materials (OnlineMetals.com) (New York, NY)
Train + Truck
Raw Materials (MSC Industrial Supply) (Melville, NY)
Train + Truck
Facility
(San Jose)
Truck
Local Customers
Train + Truck
Domestic Customers
Airplane
Airport
Truck
Ship
Harbor
Truck
International Customers
Truck
Specialist Recycling Company

Simulation

As for the simulation, I used simprocess to simulate the process that was made in the logistics graphs. Simprocess also tells me about the efficiency of the logistics graph.



Waste Stream Analysis

Since our materials are all made out of metals which are steel and aluminum, most of our waste comes from the excess metal from the manufacturing process which will be sent to a specialist metal recycling company. There are some other wastes that come with it, thich are cardboard from the excess of end product packaging, plastic which also comes from the excess of end product packaging, and paper which comes from the office. Cardboard will be shredded, composted, and re-used as soil conditioner. Plastic and paper will be sent to specialist recycling companies.

Waste Stream Analysis

Waste from manufacturing process → Aluminum → Sent to specialist metal recycling company

Waste from manufacturing process → Steel → Sent to specialist metal recycling company

Excess packaging for product shipment → Cardboard → Shredded, composted, re-used as soil conditioner

Excess packaging for product shipment → Plastic → Sent to specialist recycling companies

Waste from office and reception → Paper → Sent to specialist recycling companies

Assigned Questions

1. Price that each assembled product must retail for so that the company could pay off the project's cost in 5 years.

The base price for each product with all the cost is $415.24. The total machine costs $365,500. The annual labor cost is $25,557,000. In five years, the labor costs will be $127,785,000. The total labor costs and machine costs is $128,150,500. If we sell 6500 units in a month then retail price will be $745.24.

2. Retail price of each product if the company applies 50% overhead costs to the base price.

Since the cost of labor and the materials is $399.18. If we apply 50% overhead costs from the base price, then the price will be $598.77. If we want the retail price to cover the costs for the next five years, then the retail price will be $598.77 + $330 which is $928.77.

3. Total number of products that must be produced each week if the company must meet its production schedule.

Each week the company has to produce 335 units of product.

4. Total number of working hours (including support personnel) for the entire 3-month production.

The working hours per day is 8 hours for all personnel. The working days are 5 days which gives us 40 hours a week. Multiply 40 hours by 4 will give us the number of working hours in 1 month. There are 42 personnel in total. The 3 months production working hours will be 42 X 40 X 4 X3 which is 20,160 hours in three months.

5. Cost involved in paying all the machinists, operators, and assemblers during the period if hourly pay is $35.

Operators = 20
Machinists = 6
Quality Control = 7

Total employees = 33

Costs involved = 33 X 40 X 4 X 35 = $184,800 per month

6. Total cost of the entire three-month project: labor, materials, energy, rent, tooling, and facilities (assume that monthly rent is $10.00 per square foot).

Labor = $25,557,000 X 3 = $6,389,250
Materials = 6500 X 3 X $81.97 = $1,598,415
Energy = 0.57 X 6500 X 3 = $11,115
Rent = $10 X 20000 X 3 = $600,000
Tooling = 0.4631 X 6500 X 3 = $9040.45

Total costs = $8,607,820.45

7. Five (5) potential retailers of your product.
Amazon, supermarkets, cleaning supplies stores, assisted living store, Ebay.