Texas State University
Ingram School of Engineering

2014 Best Product Development Contest Award

Toyota *Process Improvements – Hole plug install*

David Balls
Sergio Espinoza
Justin Garcia
Sage Johnson

TOYOTA
Motor Manufacturing
Texas

1 Lone Star Pass
San Antonio, TX 78264

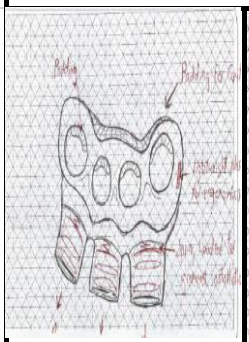
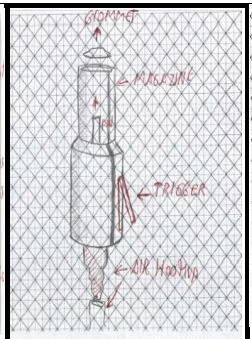
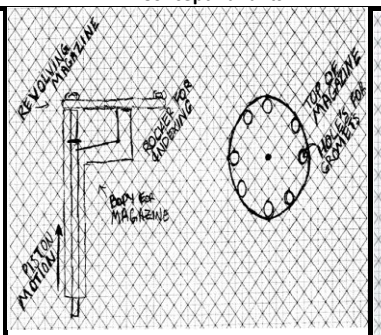
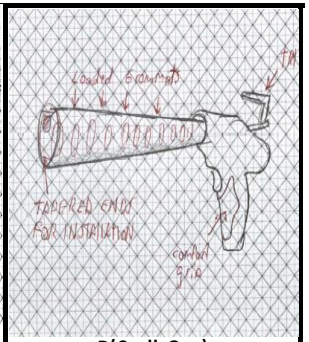
Project Mentor

Julio C. Mata, Paint Specialist

Problem Statement

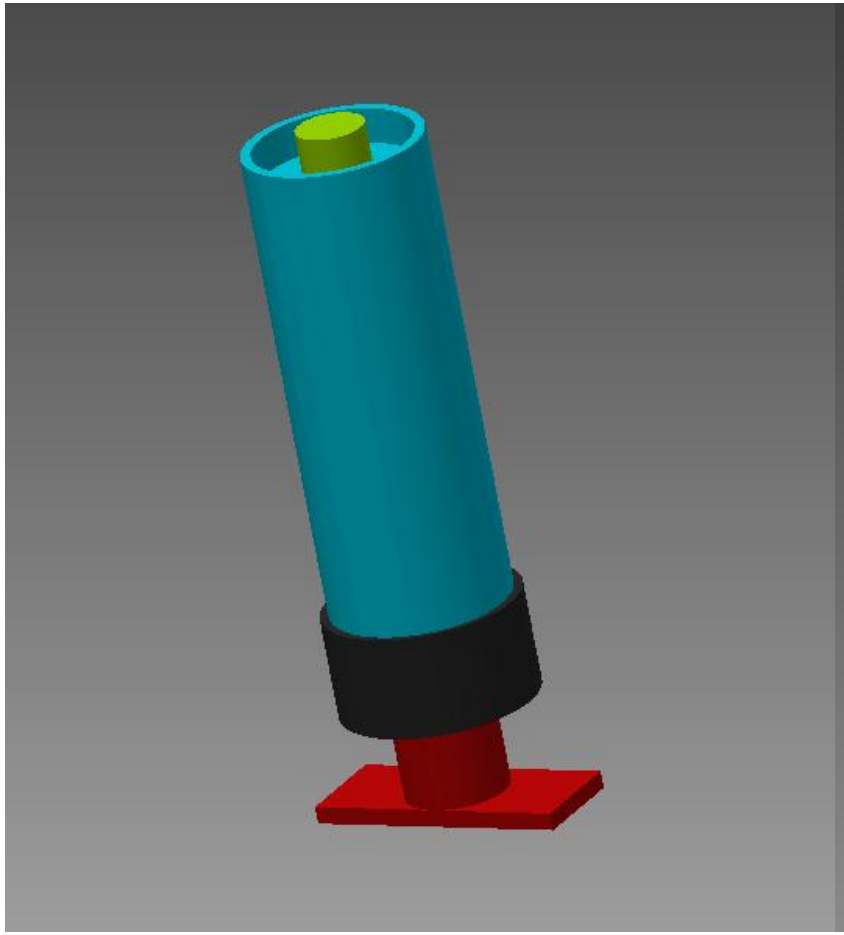
- An ergonomically friendly hand tool is not implemented
- Team members are subjected to fatigue and accidental injury
- Task subjected to human error

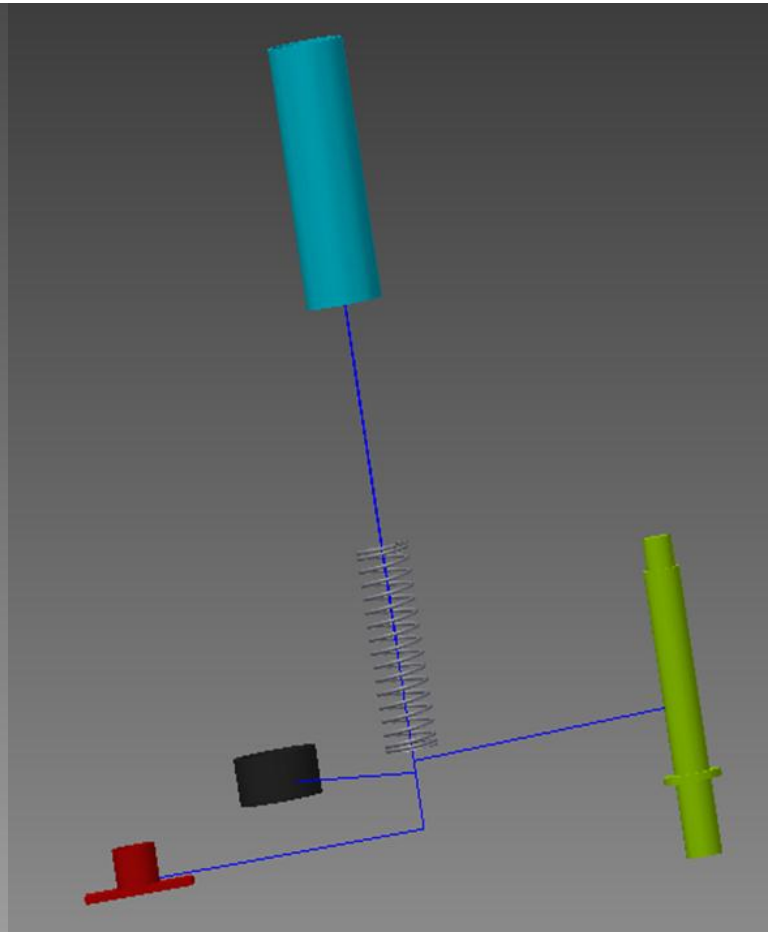
Concept Selection Matrix

		Concept Variants							
									
		A(Multiple Knuckle)		B(Pneumatic Driver)		C(Wheel)		D(Caulk Gun)	
Selection Criteria	**Weight**	**Rating**	**Weighted Scale**	**Rating**	**Weighted Scale**	**Rating**	**Weighted Scale**	**Rating**	**Weighted Scale**
Ergonomic Strain	15%	2	0.3	5	0.75	5	0.75	2	0.3
Ease of Handling	10%	3	0.3	4	0.4	5	0.5	3	0.3
Ease of Reloading	5%	4	0.2	4	0.2	2	0.1	4	0.2
Manufacturing Ease	5%	4	0.2	3	0.15	4	0.2	3	0.15
Weight	10%	4	0.4	4	0.4	5	0.5	4	0.4
Low Maintenance	10%	4	0.4	4	0.4	4	0.4	4	0.4
Reliability	10%	4	0.4	4	0.4	3	0.3	4	0.4
Size	5%	4	0.2	4	0.2	5	0.25	2	0.1
Cylce Time	20%	3	0.6	4	0.8	5	1	4	0.8
Saftey	10%	2	0.2	4	0.4	5	0.5	3	0.3
Total Score		3.2		4.1		4.5			3.35
Rank		5		2		1		4	
Continue?		No		Yes-Final		Yes-Final		No	

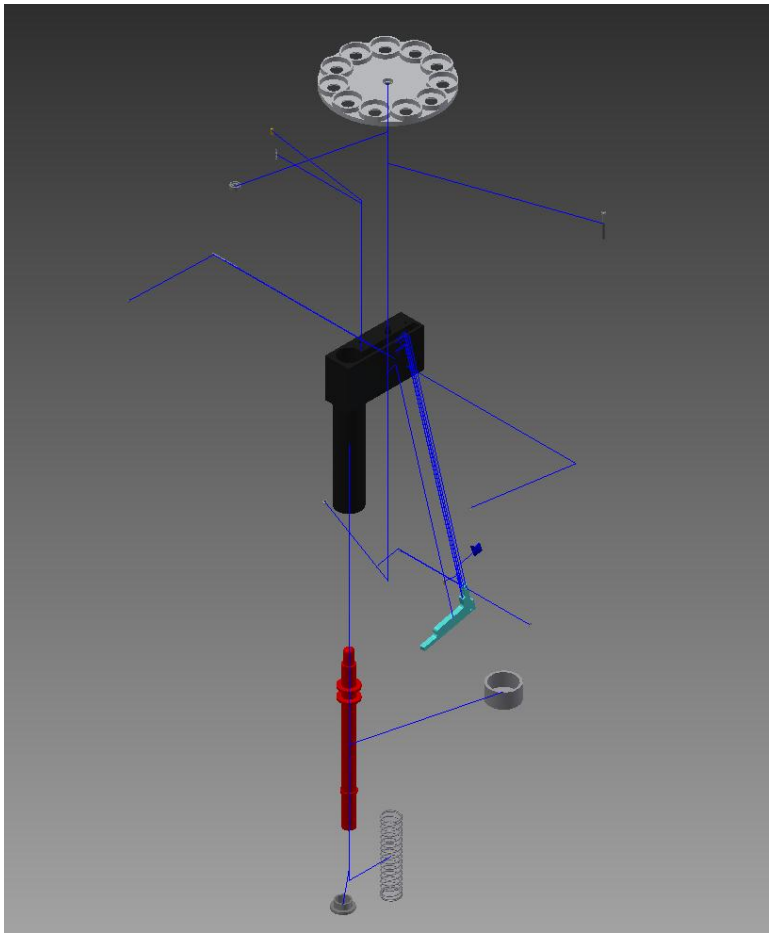
- Multi-Shot & Pneumatically powered Single Shot tied to continue to production

Final Design – Concept 1: Single-Shot





Final Design – Concept 2: Multi-Shot



Prototypes

Single-Shot

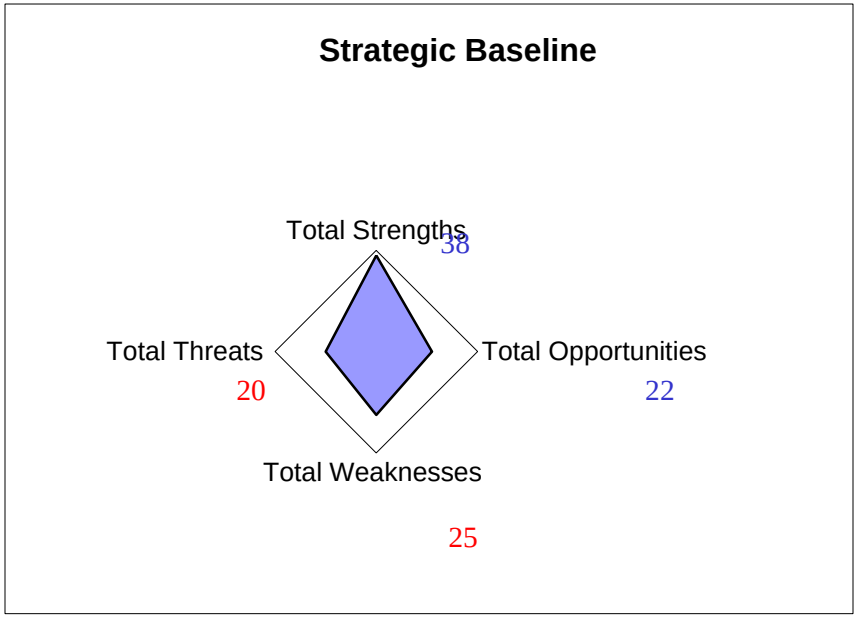
Multi-Shot

Test and Modification

Created a palm handle for added comfort

Business Plan

- Core business:
  - No competition in the industry
  - Implement tool into all of Toyota's manufacturing plants
- SWAT:




Fabrication and Assembly
Autodesk Inventor 2014 for Design
Prototypes made using a uPrint SE Plus 3D printer
Conventional machining
TEXAS STATE UNIVERSITY

Custom Ingot Growth Oven Frame

Eric Leal

Eduardo Murillo

Everett Murphy

Charles Lane

MicroPower

MicroPower Background

- MicroPower Global Inc.
  STAR Park 3055 Hunter Rd.
  San Marcos, TX
- Sponsor- Dr. Ruwan Dedigama, Senior Staff Engineer-Crystal Growth Lead
- Convert heat into electricity using thermoelectric properties
- Grow high quality semiconducting material

MicroPower Chips 2mm²
©MicroPower 2014

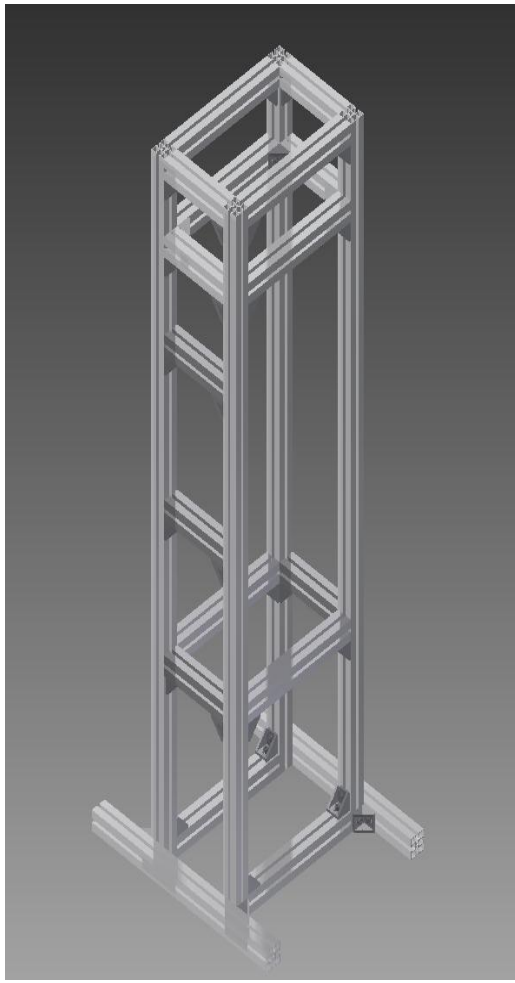
Project Introduction

PROBLEMS

- Design for improvement for an ingot growth oven frame
- Current design obsolete

OPPORTUNITIES

- Create mobility
- Computer user friendly



Customer Needs

Constraints

-The oven frame keeps the ingot stable

-The oven frame dimension is adjustable

-The structure of the oven allows easy access to reach ingot

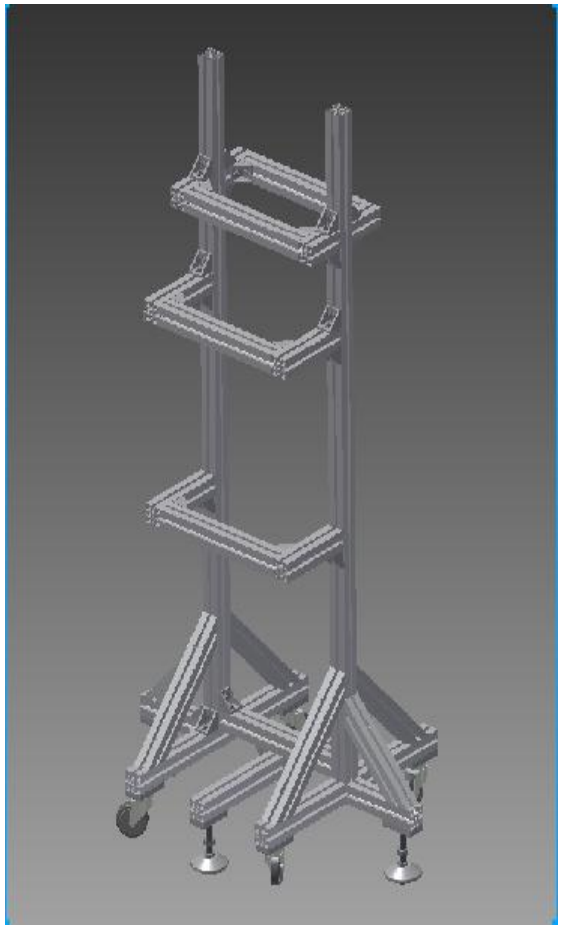
-The oven frame is mobile

Criteria

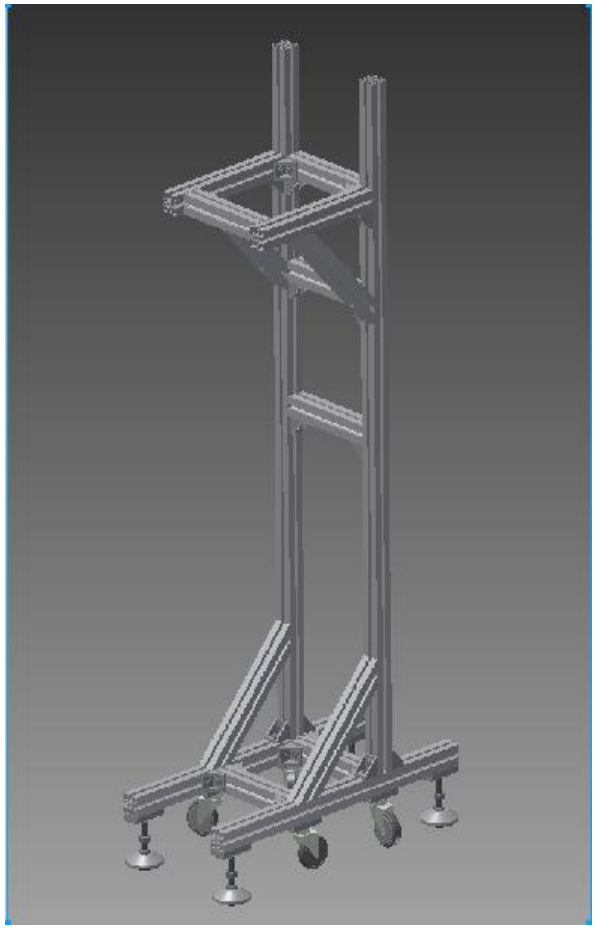
-The cost of material is minimized

-The frame is not taller than 6 feet

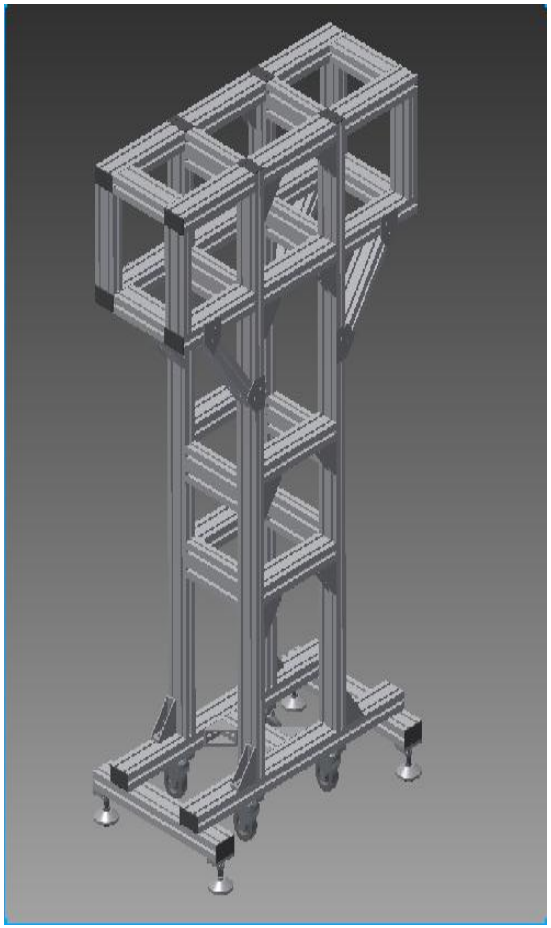
Concept Generation



Single oven with unique storage potential

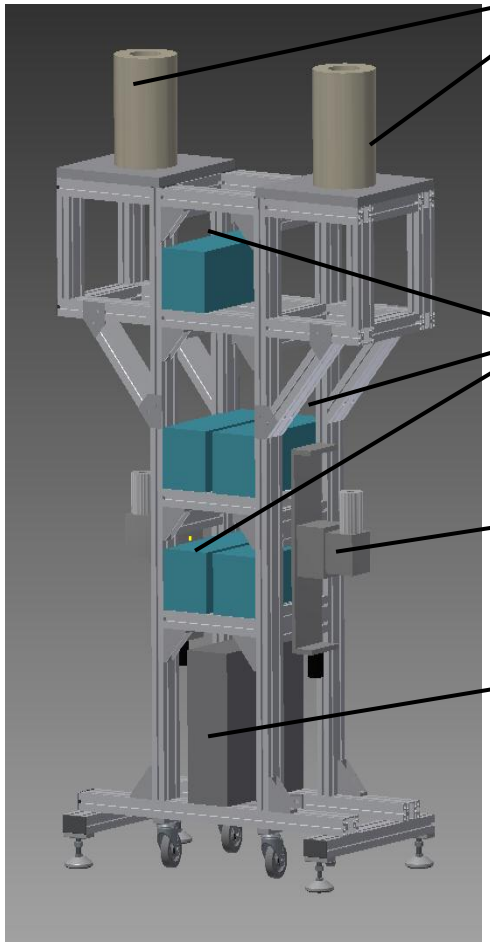


Single oven keeping material to a minimum

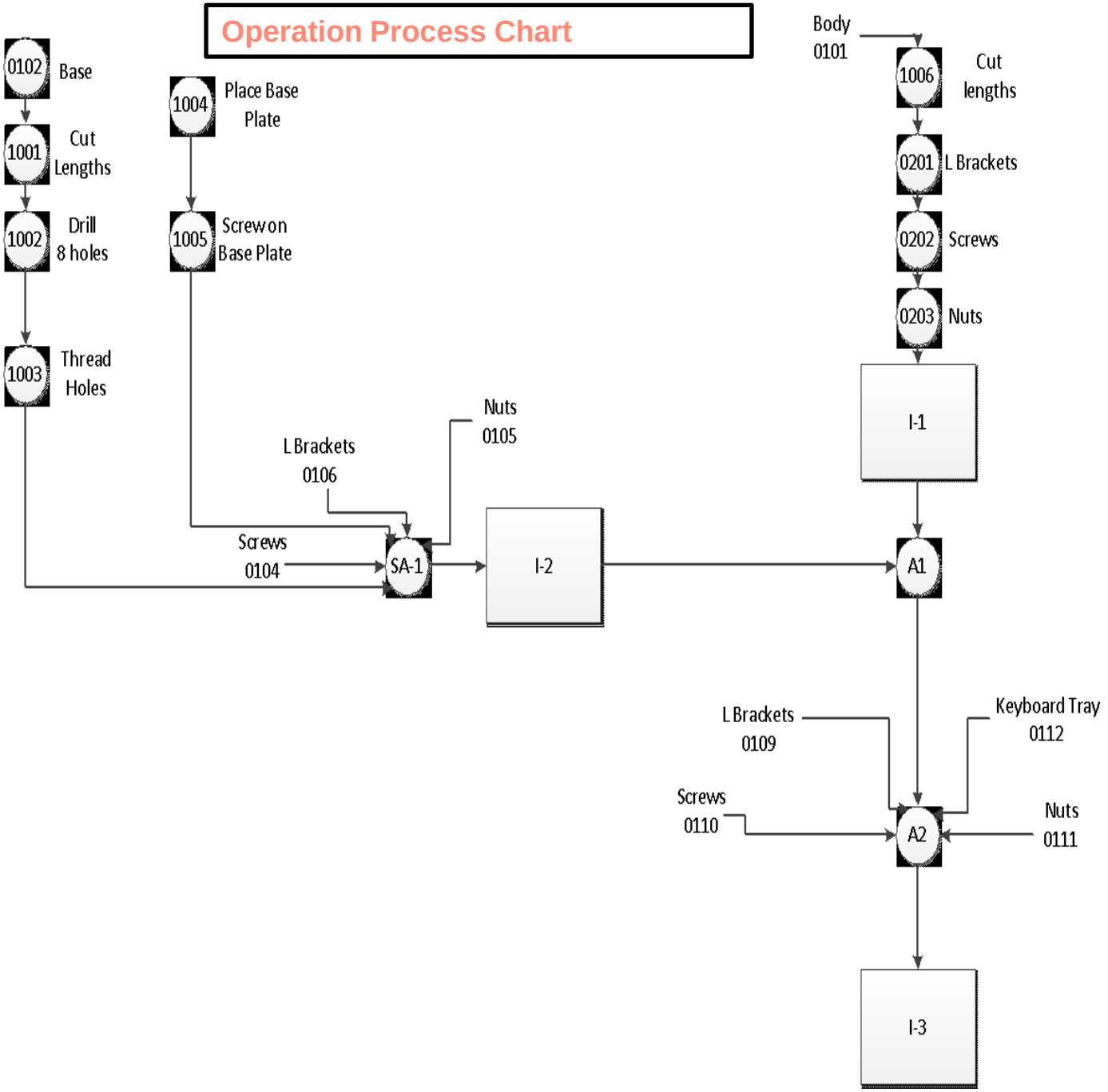


Dual ovens with one frame

Final Design



Operation Process Chart



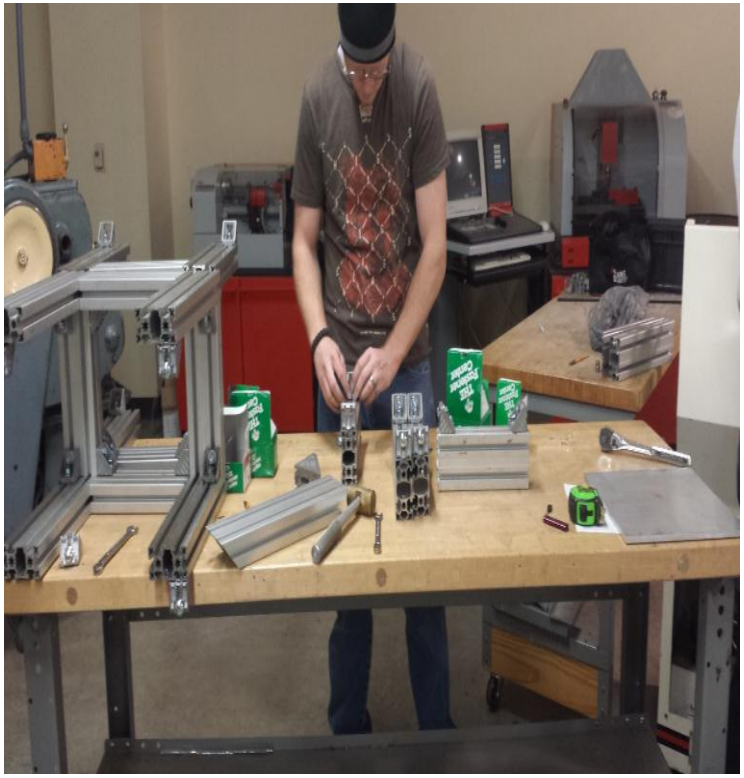
Manufacturing Processes

Drill press to create holes in the gusset plates

Water jet to cut gusset plates

Wet saw to cut extruded t-slots into desired length

Assembly Processes

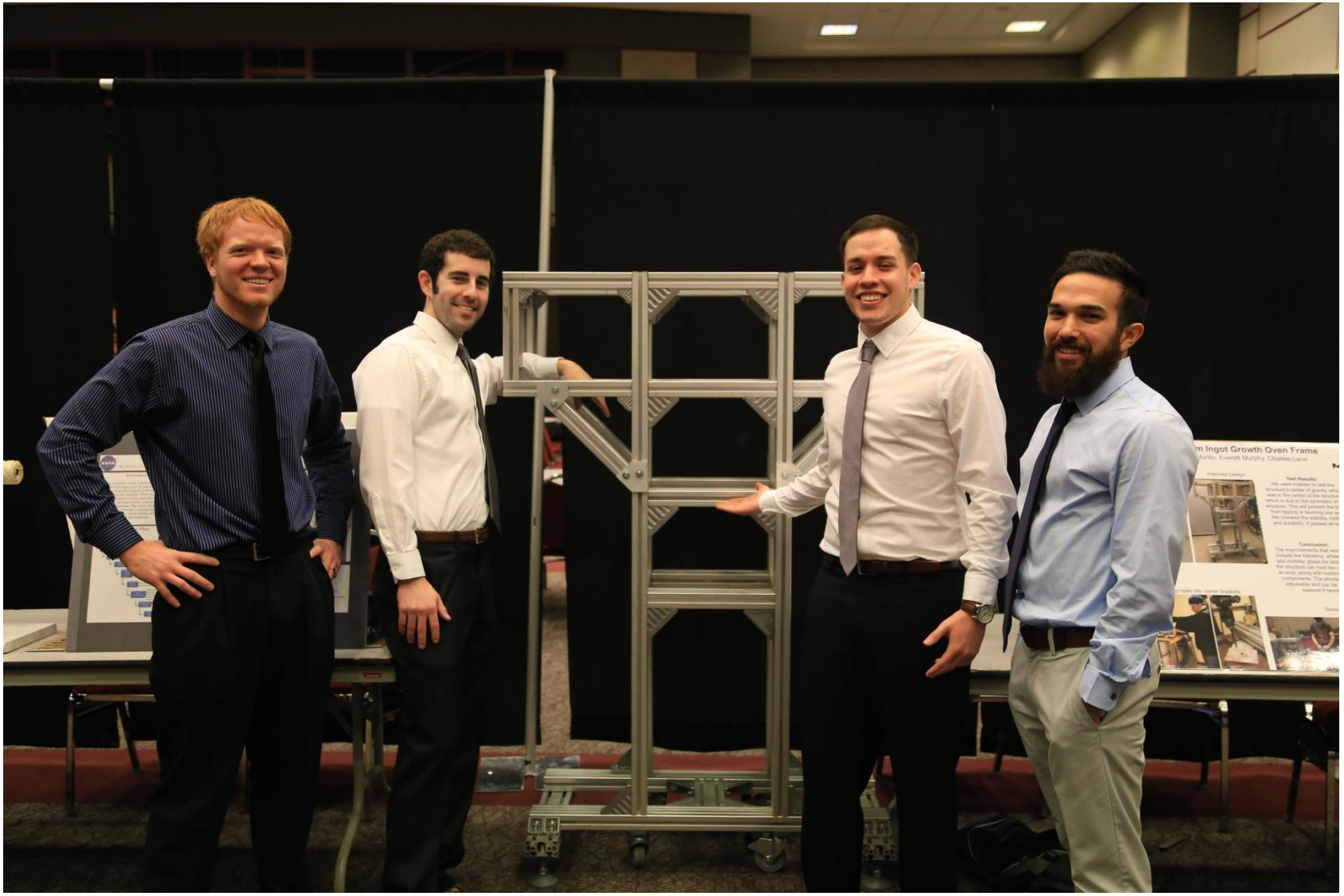


Final product

The improved design (right picture) has many upgrades compared to the original design (left picture).

Improvements include:

1. Wheels for mobility
2. Glides for stability
3. The ability to hold two processes at once
4. Ability to hold all components
5. Better adjustability


m Ingot Growth Oven Frame

The “BenchWarmer”
By Tekease – CycleChair LLC

Courtney Araiza
Ryan Hamilton
Casey Hodges
Ben Ijah

Background Information

Our Sponsor:

- Christopher Stanford
  - Located in San Marcos, Texas
  - Owner of Trekease and ChairCycle LLC.
  - Sponsor of the “BenchWarmer”

Trekease

Background Information

Our Product:

- The “BenchWarmer”
  - This product is a developmental workout/ rehabilitation device for people with disabilities or confined to a wheelchair.
  - This product is based around having the freedom to workout and not be in a fixed location.
  - This product uses a bar spliced by a resistive spring to stimulate exercise and give a full free range of motion.
  - This product is easily attachable and remove able from the chair.

Our Competitor:

- The “Love Handles”
  - This product is a workout device for people with disabilities and for rehabilitation.
  - This product permanently attaches to the chair.
  - This product uses a set of resistive plates to stimulate exersise.

TOP NEEDS

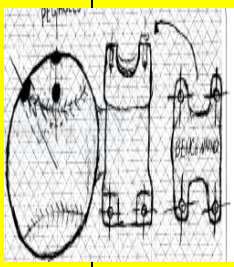
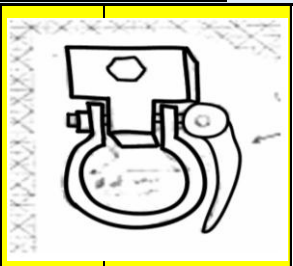
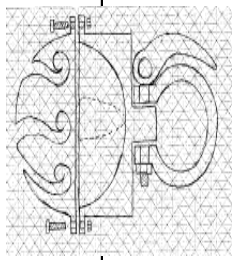
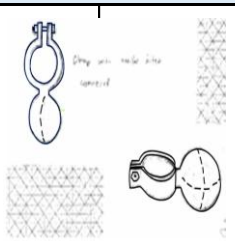
#	Needs		Impact
1	The product	must be affordable.	1
2	The product	must attach to the wheelchair.	5
3	The product	must be safe.	5
4	The product	must be easy to use.	3
5	The product	must be lightweight.	3
6	The product	must have free range of motion.	5
7	The product	must be strong.	3
8	The product	must stimulate physical exercise.	5
9	The product	must be easy to assemble.	1
10	The product	must be aesthetically pleasing.	1
11	The product	must allow full operation of wheelchair.	5

TOP METRICS

Matrix #	Needs #	Metric	Impact	Units
1	1, 5, 7	Final Selling Price	5	US $
2	2, 3, 4, 6, 7, 9, 10	Versitility of Use	3	list
3	3, 6	OSHA Stardards	5	Binary
4	2, 3, 4, 5, 6, 8, 9, 10	Functionablity of Product	3	subj
5	1, 2, 4, 5, 7, 8, 9, 10	Weight of Product	5	kg
6	1, 5, 7, 9	Durability of equipment	3	Mpa
7	4, 6, 8	Total Calories Burnned	5	cal
8	2, 3, 4, 5, 6, 8, 9, 10	Overall Useability	3	list

Concept Scoring

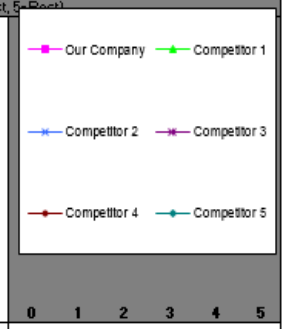
Concepts Scoring

									
		Baseball Mount/ Bracket		Basic Model		Ball Joint Model		Basic Ball Model	
Selection Criteria	Weight	Rating	weighted Score	Rating	weighted Score	Rating	weighted Score	Rating	weighted Score
Safe	20%	5	1	4	0.8	4	0.8	3	0.6
Full operation of weelchair	10%	5	0.5	5	0.5	5	0.5	5	0.5
Stimulate physical exercise	20%	3	0.6	3	0.6	3	0.6	3	0.6
Attach to wheelchair	5%	5	0.25	5	0.25	3	0.15	4	0.2
Strong	5%	4	0.2	3	0.15	3	0.15	3	0.15
Free range of motion	5%	3	0.15	3	0.15	4	0.2	3	0.15
Affordable	10%	4	0.4	5	0.5	1	0.1	4	0.4
Easy to use	5%	4	0.2	5	0.25	4	0.2	3	0.15
Lightweight	10%	3	0.3	5	0.5	3	0.3	4	0.4
Easy to assemble	5%	3	0.15	5	0.25	3	0.15	3	0.15
Aesthetically pleasing	5%	5	0.25	2	0.1	5	0.25	2	0.1
	Total Score	4		4.05		3.4		3.4	
	Rank	2		1		3		4	
	Continue?	Yes		Yes		No		No	

House of Quality

Weight/ Importance	Demanded Quality (a.k.a. "Customer Requirements" or "Whats")	price	versatility	OSHA standards	[illegible]ability	weight	durability	calories burned	useability
1.0	affordable	Θ	▲	▲	O	▲	O	▲	▲
5.0	attachable to chair	▲	Θ	O	Θ	O	▲	▲	Θ
5.0	safety	▲	O	Θ	Θ	▲	▲	▲	O
3.0	easy to use	▲	Θ	▲	Θ	O	▲	O	Θ
3.0	light	O	▲	▲	O	Θ	O	▲	O
5.0	free range of motion	▲	Θ	O	Θ	▲	▲	O	Θ
3.0	strong	O	O	▲	▲	Θ	Θ	▲	▲
5.0	stimulate exercise	▲	▲	▲	O	O	▲	Θ	Θ
1.0	easy to assemble	▲	Θ	▲	O	O	O	▲	Θ
5.0	full operation of chair	▲	O	▲	Θ	Θ	O	▲	Θ

Competitive Analysis
(0=Worst, 5=Best)



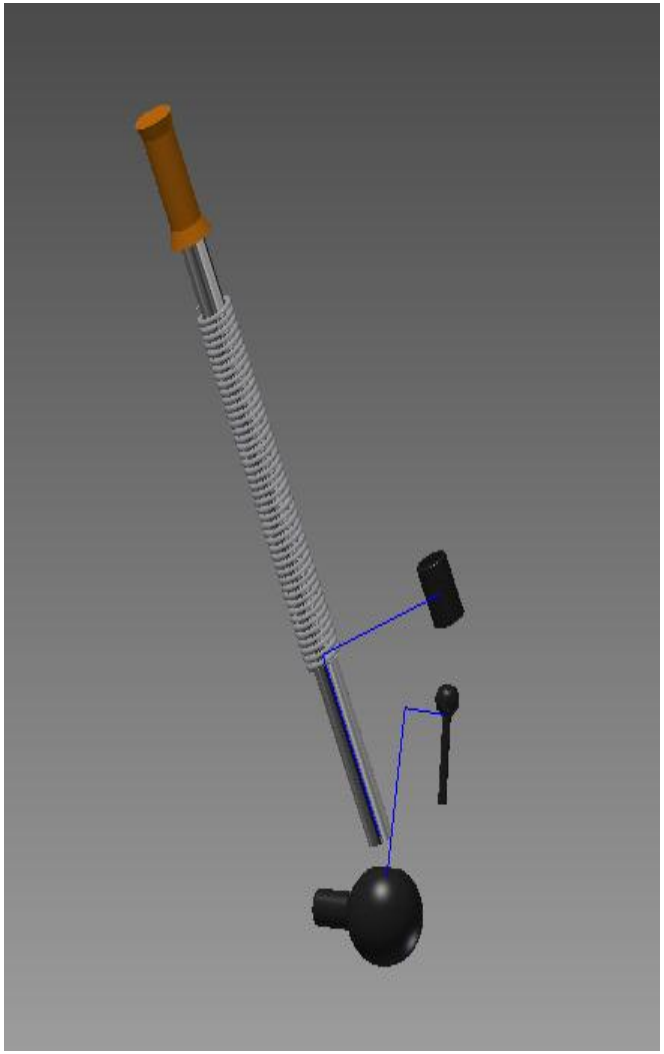
Our Company	Competitor 1	Competitor 2	Competitor 3	Competitor 4	Competitor 5
5	0	1			
4	2	0			
5	3	2			
4	5	3			
5	3	0			
5	1	0			
3	3	5			
5	2	5			
5	3	1			
5	4	0			

Target or Limit Value	10	10	10	10	10	10	10	10
Difficulty (0-Easy to Accomplish, 10-Extremely Difficult)	2	6	5	5	3	7	6	3
Max Relationship Value in Column	9	9	9	9	9	9	9	9
Weight / Importance	155.6	483.3	266.7	666.7	422.2	222.2	255.6	677.8
Relative Weight	4.9	15.3	8.5	21.2	13.4	7.1	8.1	21.5

BenchWarmer Final Design

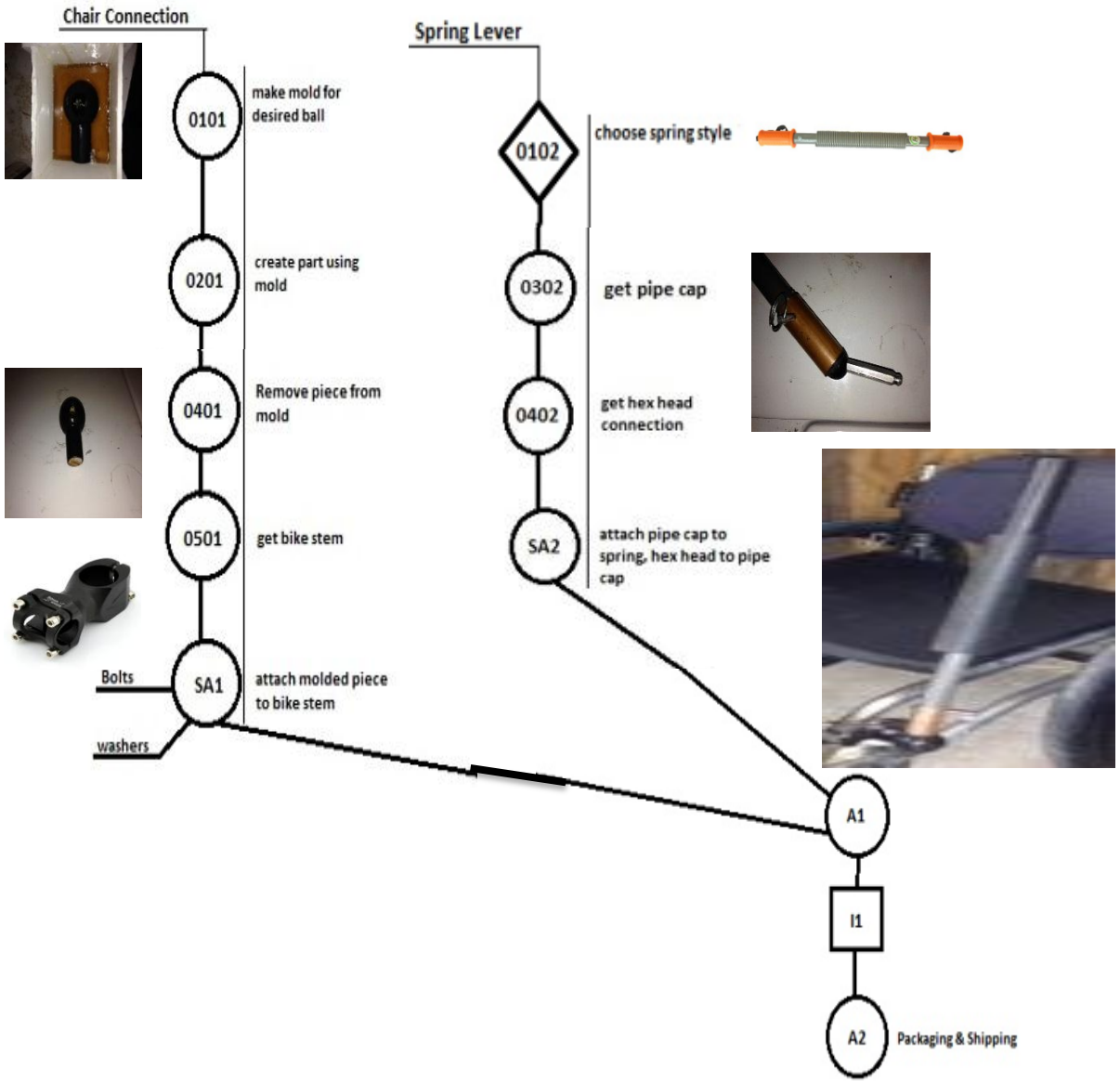
BenchWarmer Final Design Exploded Drawing

- Versatile model (optional sport themed design)
- Cast from high strength materials
- Simple assembly
- Outsourced for high quality parts
- Aesthetically pleasing
- Approved for prototyping



Bill of Material	
Quantity	Description
2	Spring Bar
2	Bicycle stem
2	Bar mount
2	Ball/ Base Mount
2	Hitch Pin
2	Safety Foam

Operation Process Chart



Side By Side Comparison

The Benchwarmer:

- Has full range of motion.
- Has resistance up to 30 kg.
- Non-intrusive and able to be broken down.
- Will not scratch chair.
- Optional bases for multiple aesthetics.
- Durable
- Price: $395

Love Handles:

- Only has motion in the +/- X direction.
- Has resistance up to 8 lbs.
- Bulky and permanently attached and unable to break down.
- Will scratch paint on chair.
- Bulky and unattractive.
- Fragile
- Price: $235

Product Development

Make/Buy Decision

Manufactured

- Hex-Ball Spring Bar Connector



- Holding Ball Attachment



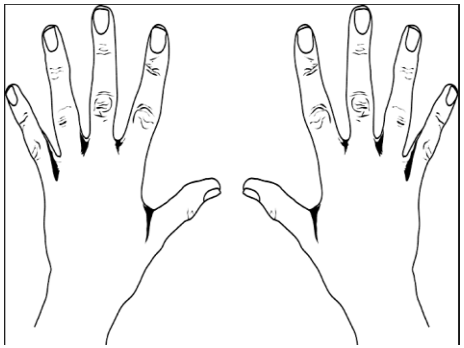

Final Product

Financial Plan

SWOT

Multicultural, globalization, ethics

Any gender, and body size, Left/right hand



Serving veteran community by helping for rehabilitation

ANSI standards used

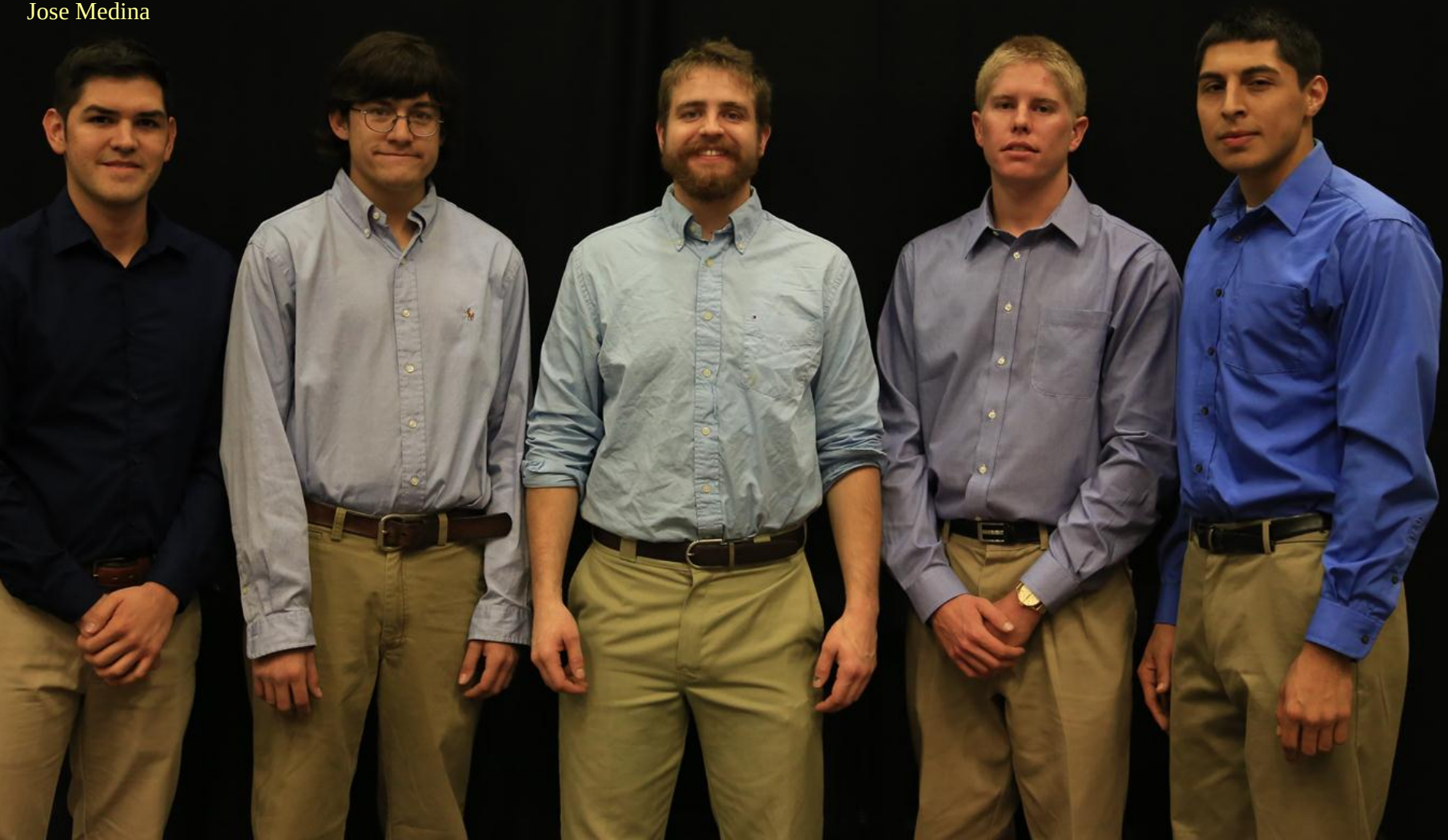
ANSI

American National Standards Institute


Side By Side Comparison
The Benchwarmer:
Has full range of motion.
Has resistance up to 30 kg.
Non-intrusive and able to be broken down.
Will not scratch chair.
Optional bases for multiple aesthetics.
able
$395
Love Handles:
Only has motion in the +/- X direction.
Has resistance up to 8 lbs.
Bulky and permanently attached and unable to break down.
Will scratch paint on chair.
Bulky and unattractive.
Fragile
Price: $235
MEMBER THE TEXAS STATE UNIVERSITY SYSTEM
TEXAS STATE UNIVERSITY

Centrifugal Power Transmission

Abdel-Muti Zabalawi
Steven Barrantes
Abel Ardis
Shelby Huff
Jose Medina



About Our Sponsor

Mohammed Khodabakhsk

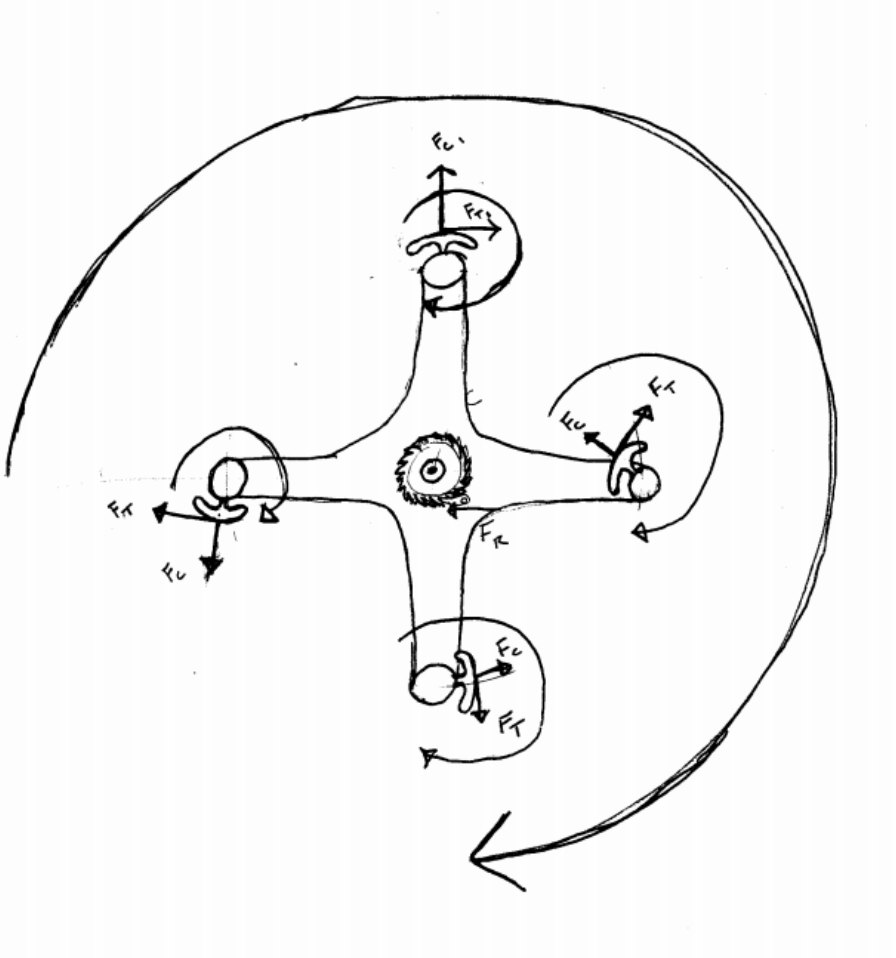
New Beginnings, based in California

Project:

To optimize a power transmitting device utilizing centrifugal force created by spinning cams (weights).

Concept Background

- Resultant forces causes a moment about the center axis.



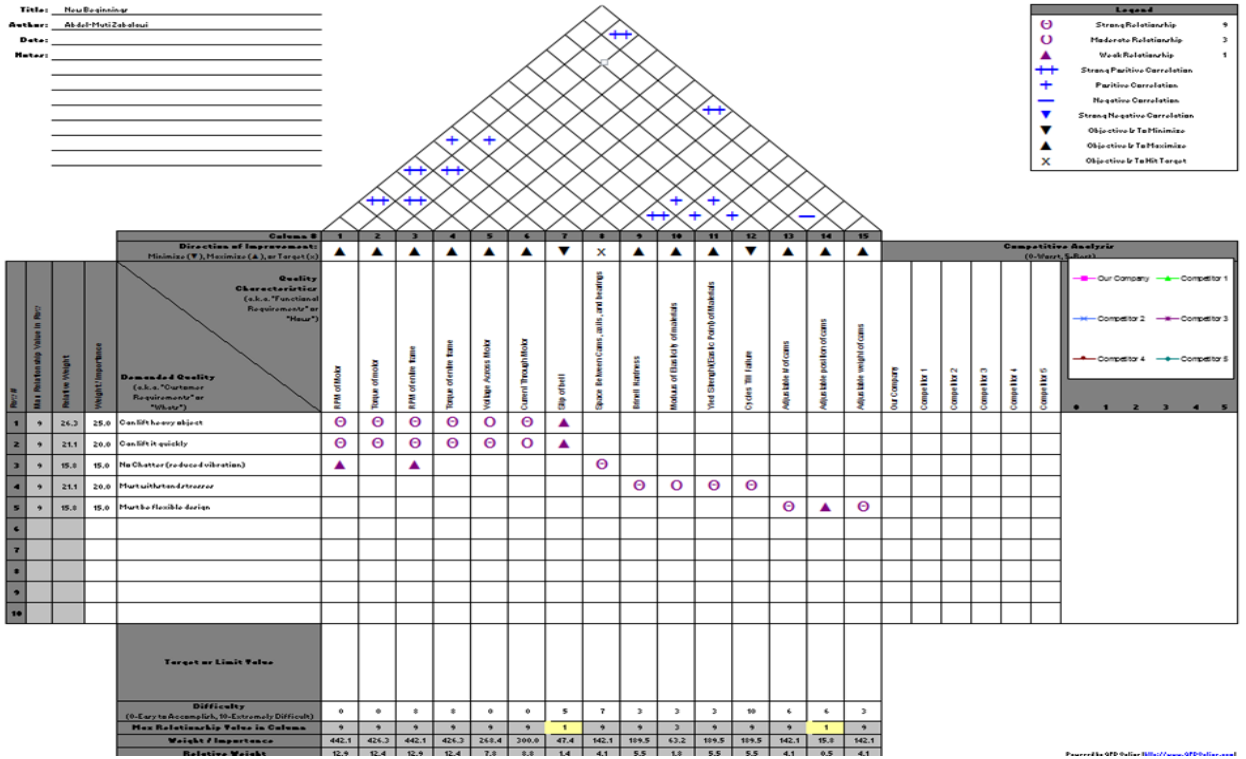
Identifying Customer Needs

Need Statements

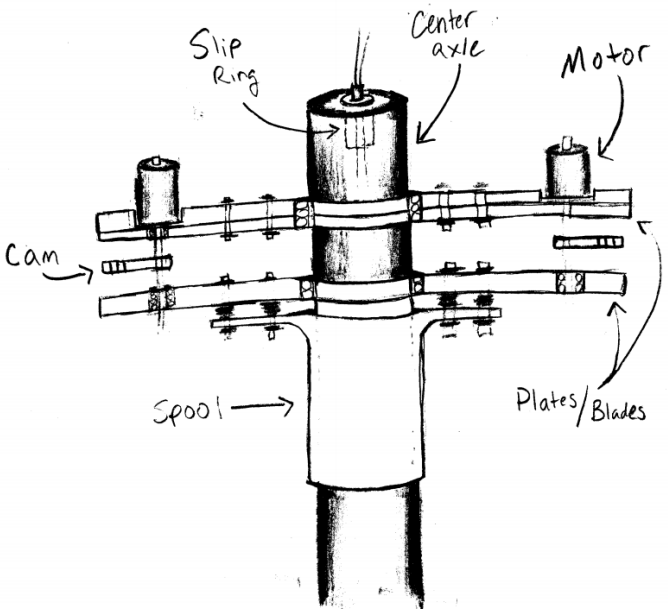
The system must transmit power efficiently.	5
The system must lift heavy objects safely.	5
The design must be able to sustain the cyclical stresses associated with the rotation of the weighted cams.	5
The mechanism must be flexible for testing.	4
The system must rotate.	4

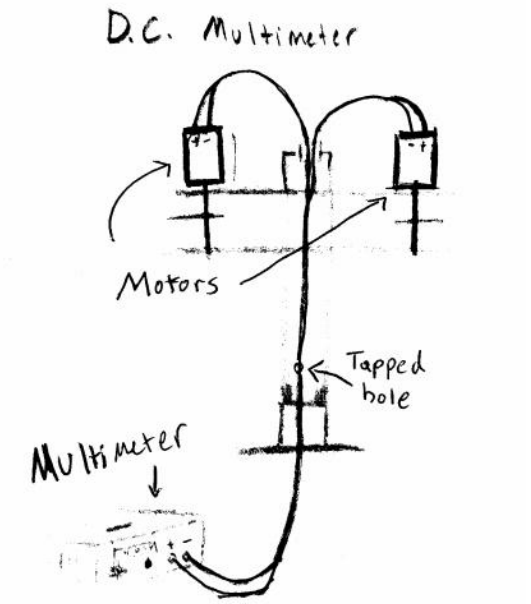
Want Statements

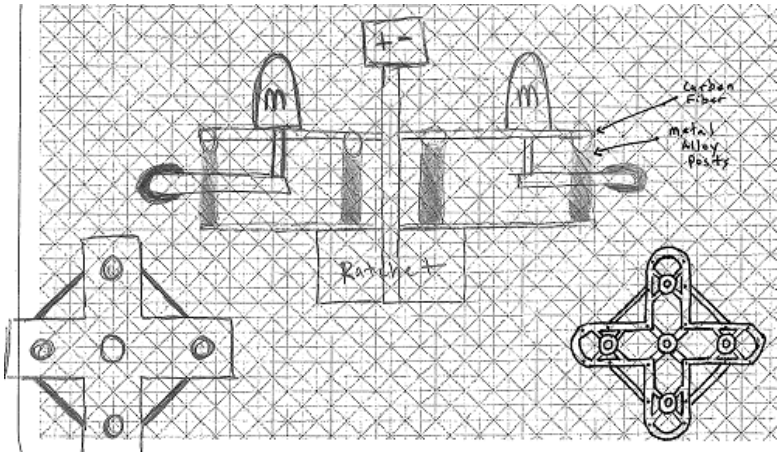
The design should be made of mostly stock and premade components to reduce cost.	4
The apparatus can be easily accessed for maintenance.	4
The mechanism is lightweight.	3
The mechanism varies in number of cams.	3
The design has a long product life.	2

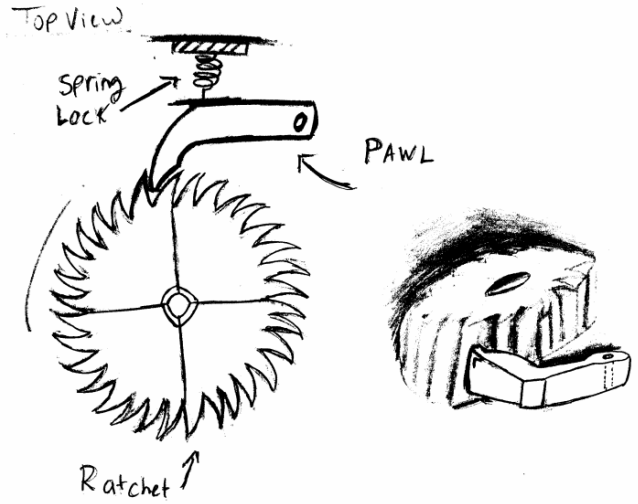


Concept Generation





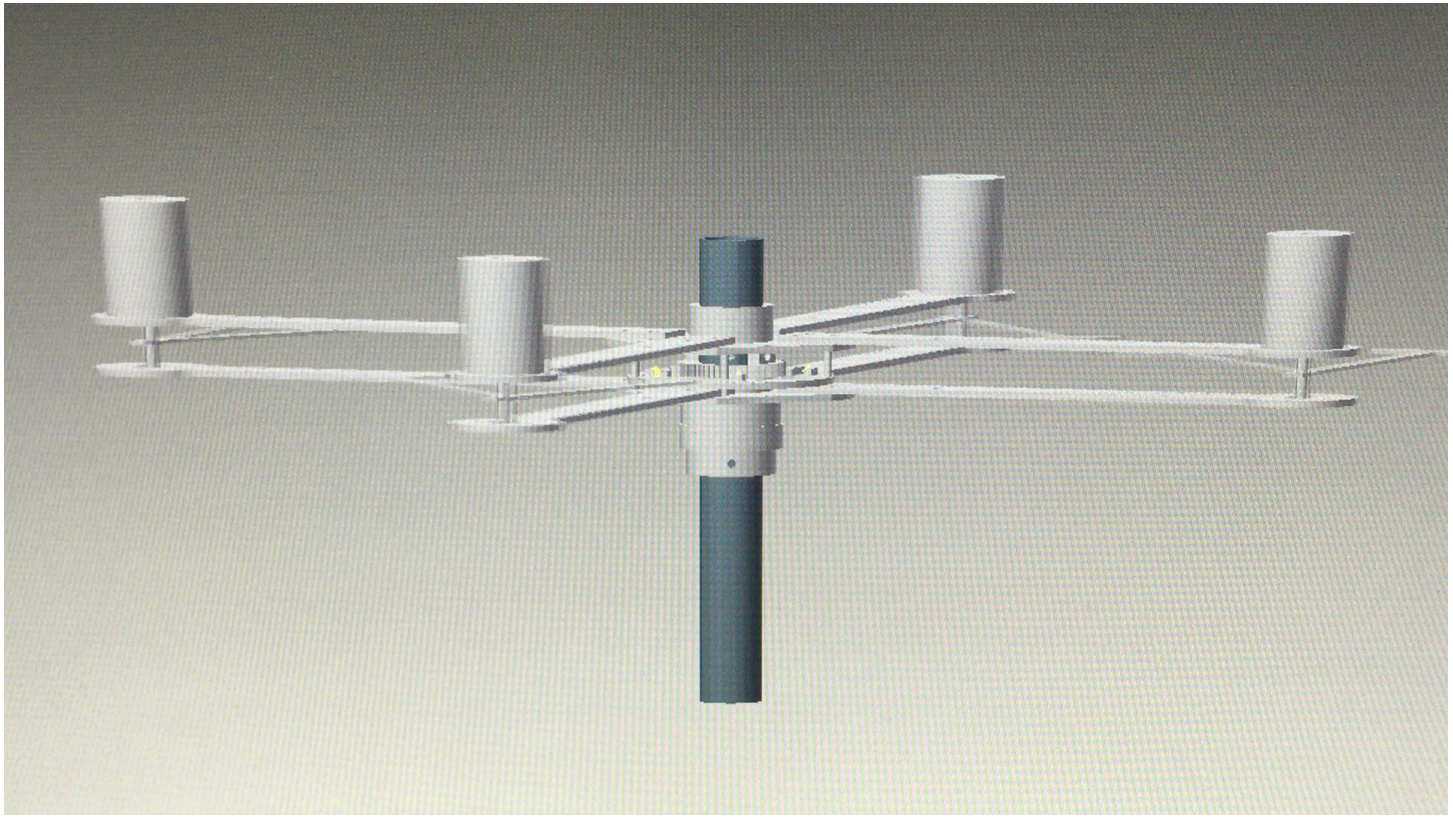




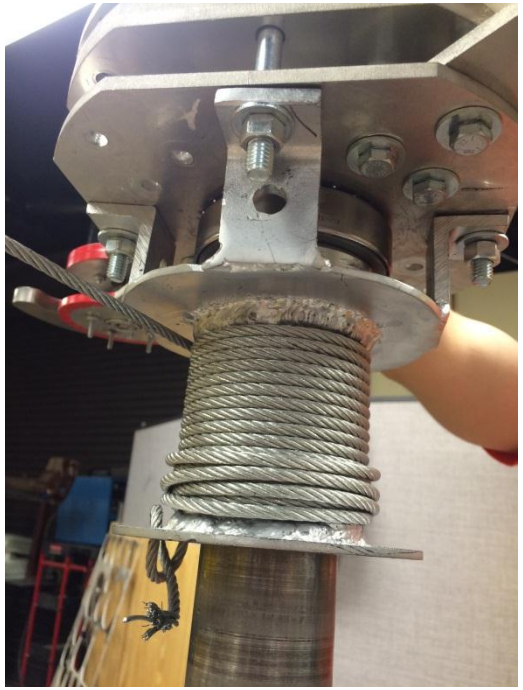
F.M.E.A.

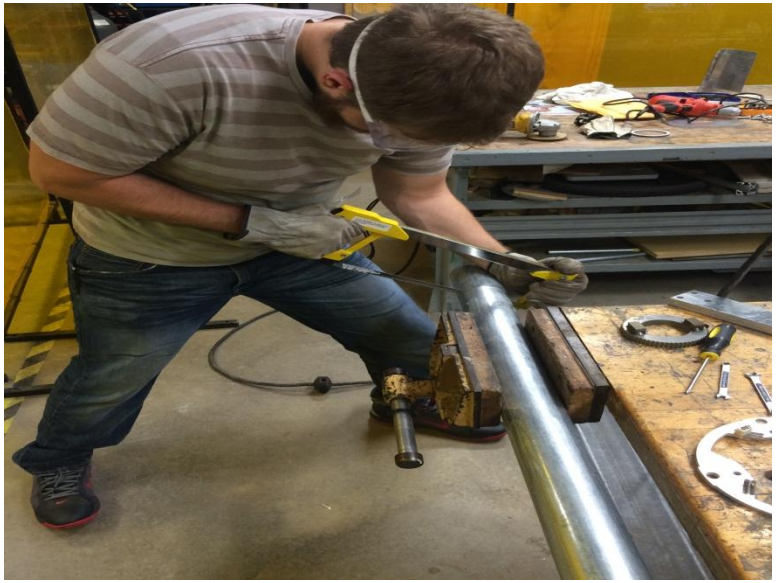
Potential Failure Mode	Potential Failure Effects	SEV	Potential Causes	OCC	Current Controls	DET	RPN	Actions Recommended
Frame fails	Cannot Lift Objects	5	Fails due to dynamic stresses	2	Visual examination	5	50	Finite element anlaysis
Structure does not produce torque	Cannot Lift objects	5	high stresses in ratchet/key	2	Design with propper tolerances and measure	4	40	Aquire stronger reliible ratchet
Device has chatter	Not Efficient	2	Not Lubricated Properly	4	Apply Lubricant	3	24	continous inspection of bolts and lube
Motors Break	Cannot Lift Objects	4	Load is too great for Motor	2	Reduce Weights	3	24	Finite element anlaysis
Frame fails	Cannot Lift Objects	5	Crack in Frame	1	Visual examination	4	20	
Structure does not produce torque	Cannot Lift objects	5	RPM too low or weight too heavy	3	Add Weight/ get new motor/ change voltage	1	15	Use correct motor weight combo
Cams have insufficient rpm	Cannot Lift objects	5	weight not balanced	3	Design Properly/ Reduce load	1	15	Use Proper belt and number of belts
Wires tangled	Does Not Rotate	5	Poor design/ assembly	3		1	15	
Device has chatter	Not Safe	3	Weights too heavy	4	Use tight tolerances	1	12	Design properly
Structure does not produce torque	Cannot Lift objects	5	Poor imbalanced design	1	Apply Lubricant	1	5	Make sure Lubricate is applied
Cams have insufficient rpm	Cannot Lift objects	5	Cams don't fit bearings or housing	1	Design with propper tolerances and measure	1	5	
Device has chatter	Not Efficient	2	Too Many components	1	Make lean lighter design	2	4	
Device has chatter	Not Efficient	2	All axels don't fit housings properly	1	Design with propper tolerances and measure	1	2	
Device has chatter	Not Efficient	2	Screws and bolts fit poorly	1	Design with propper tolerances and use standard sizes	1	2	
In what ways does the Key Input go wrong?	What is the impact on the Key Output Variables (Customer Requirements)	How Severe is the effect to the	What causes the Key Input to go wrong?	How often	What are the existing controls and procedures (inspection and test) that prevent eith the cause	How well		What are the actions for reducing the occurrance of the

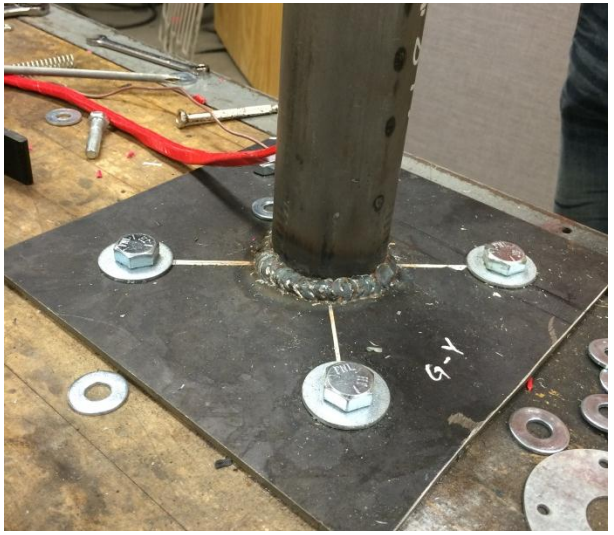
Proposed Design



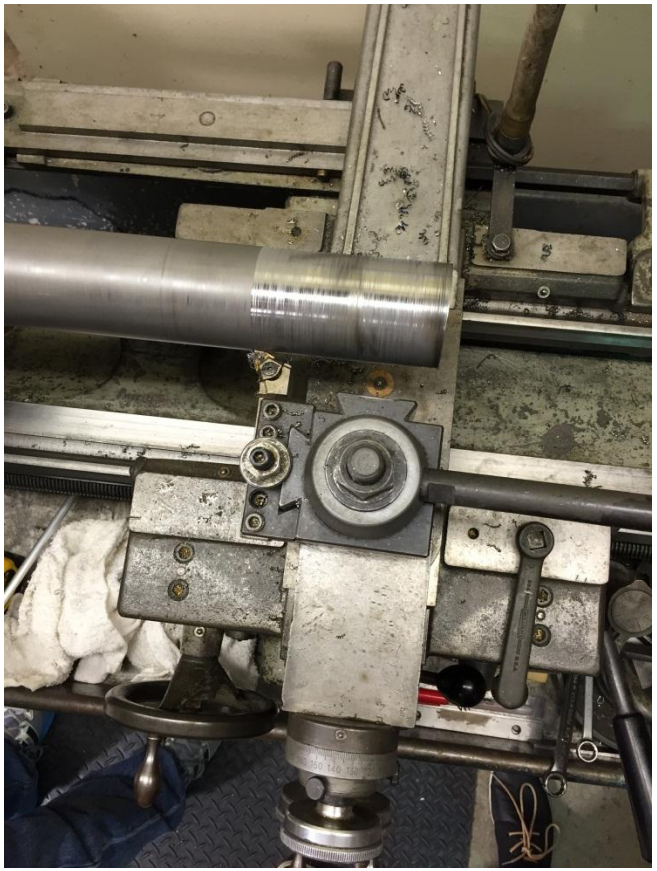
Fabrication





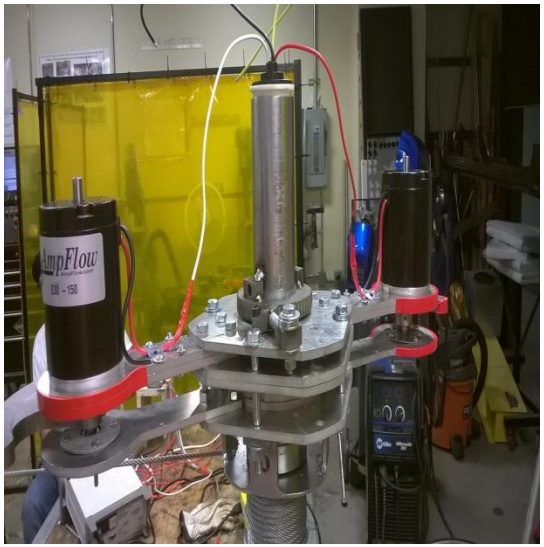


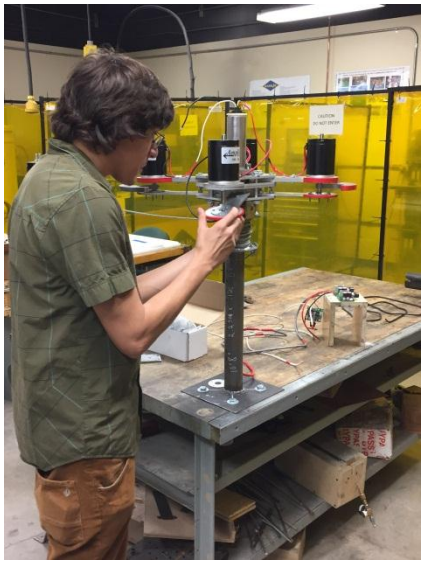
Milling of Center Axel Shaft



Third and Final Model

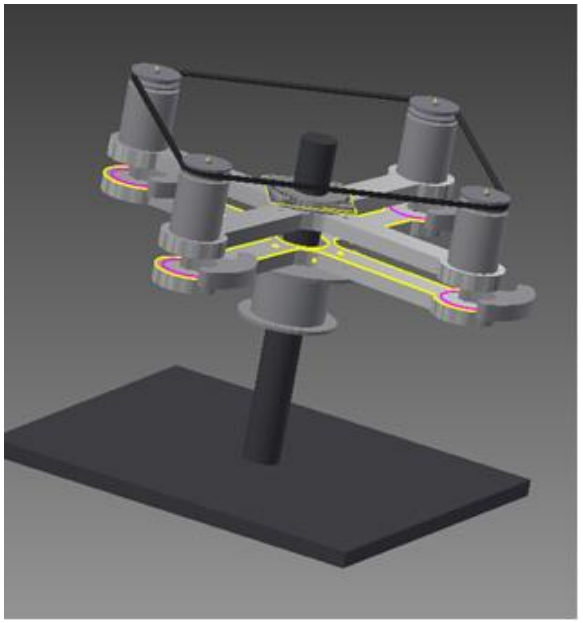
- Design sports shorter arms to provide better stability thus reducing vibration produced.
- Slip ring used to safely power motors.
- Cam design is significantly different, reducing weight and length.

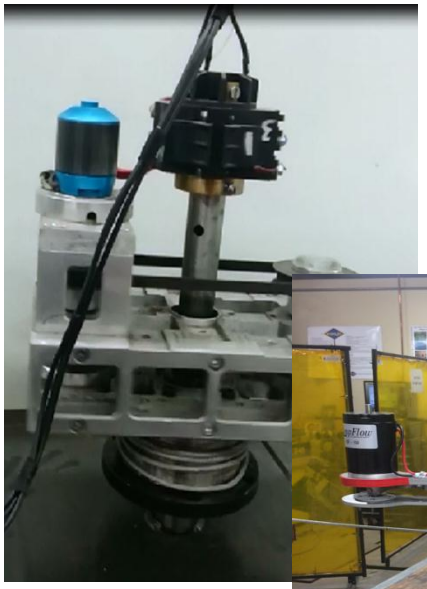


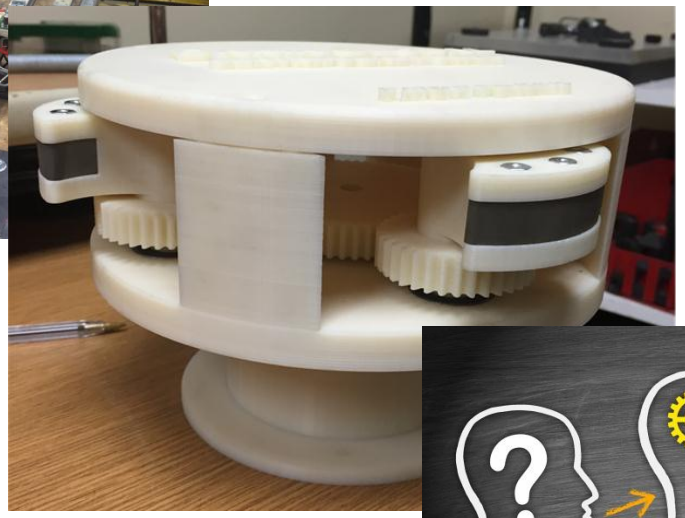


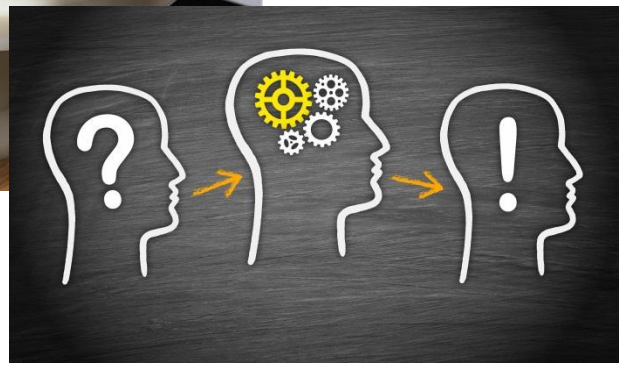
Conclusions and Future Work Outlook

- Part changes
- Optimization: Weight, arms, cams, motors
- Designing commercial products: Windmill (low speed wind)





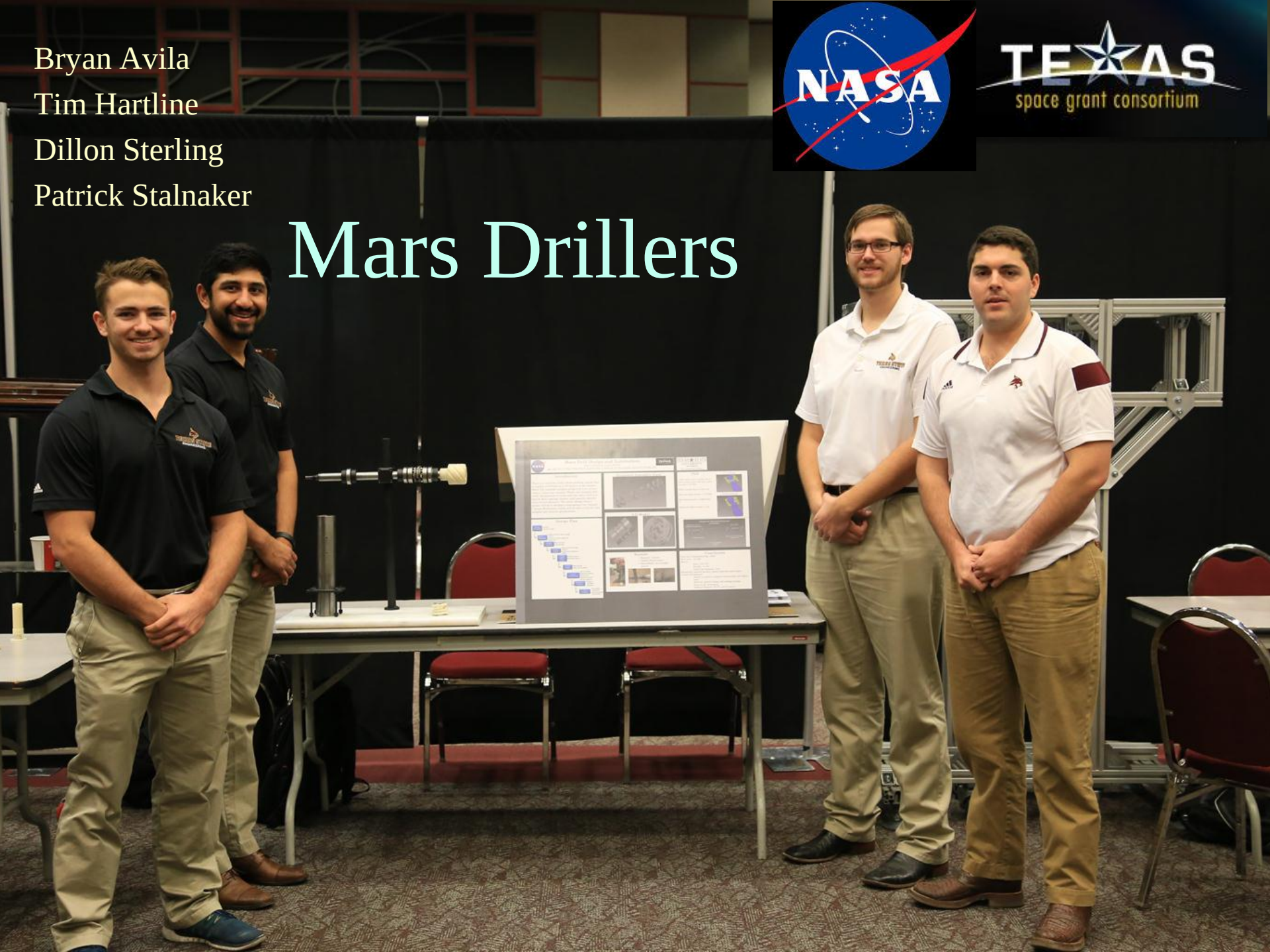





TEXAS
STATE
UNIVERSITY
Ring
Cam
Spool

Bryan Avila
Tim Hartline
Dillon Sterling
Patrick Stalnaker

Mars Drillers



Purpose of Project

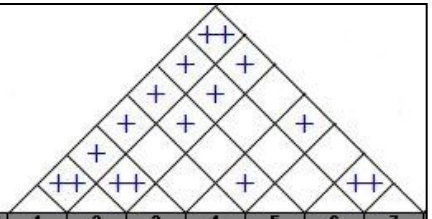
- To look for signs of water and life on Mars.
- Develop alternate designs from past and present drilling systems.
- The atmosphere is 95% CO2
- Surface is similar to permafrost

Customer Constraints

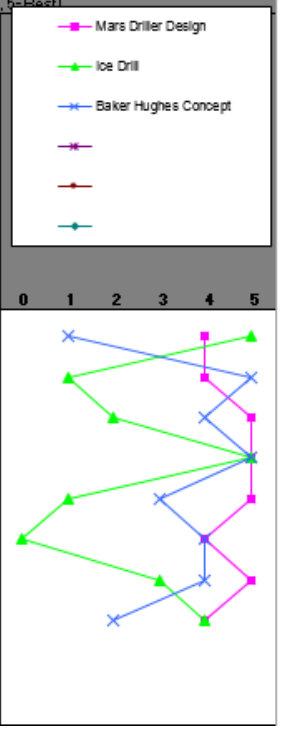
- ❖ Produce and cut core samples that are 10 cm x 2 cm.
- ❖ Hold the core samples for future extraction.
- ❖ Be as compact as possible.

Metrics/ House of Quality

Legend		
⊙	Strong Relationship	9
O	Moderate Relationship	3
▲	Weak Relationship	1
++	Strong Positive Correlation	
+	Positive Correlation	
—	Negative Correlation	
▼	Strong Negative Correlation	
▼	Objective Is To Minimize	
▲	Objective Is To Maximize	
X	Objective Is To Hit Target	

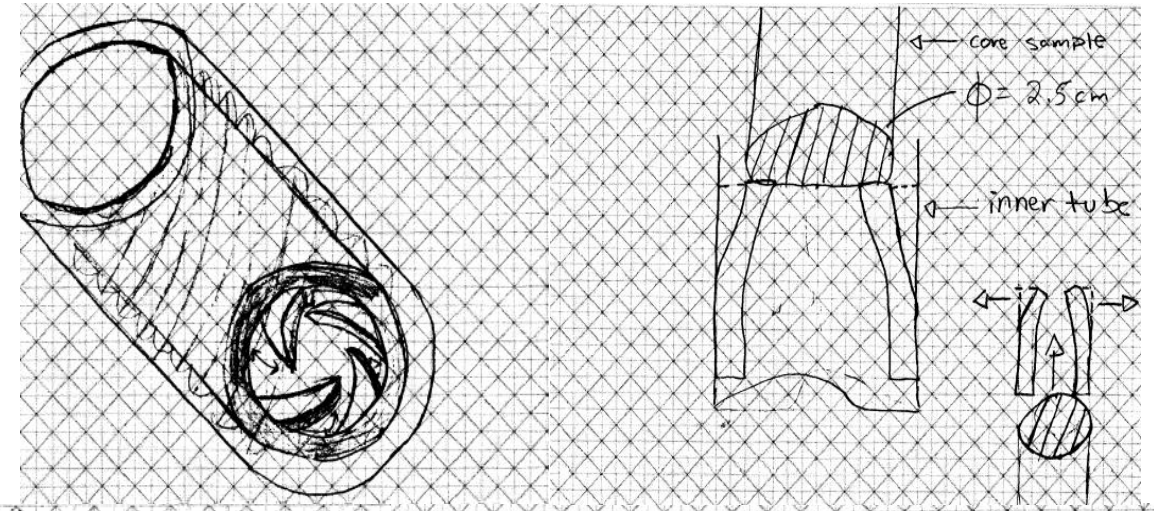


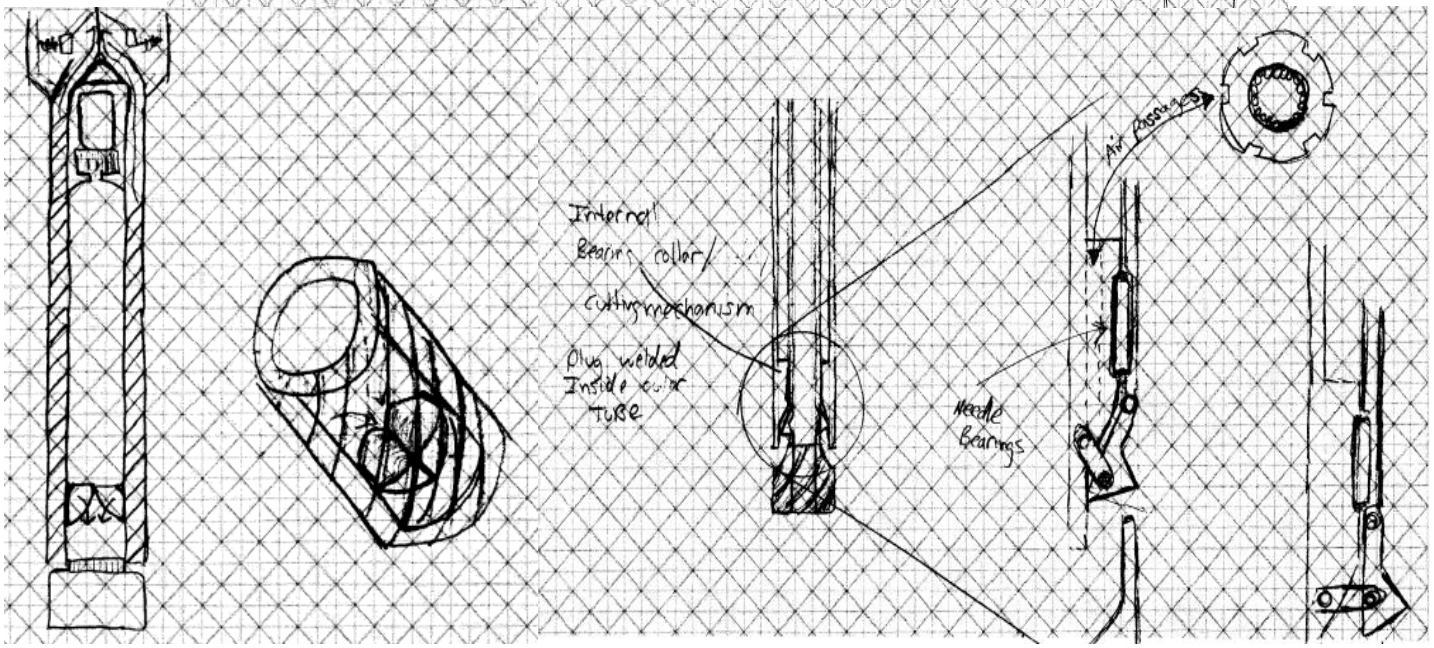
Column #				1	2	3	4	5	6	7	Competitive Analysis (0=Worst, 5=Best)						
Direction of Improvement: Minimize (▼), Maximize (▲), or Target (x)				X	X	X	▼	▼	▲	X							
Row #	Max Relationship Value in Row	Relative Weight	Weight / Importance	Demanded Quality (a.k.a. "Customer Requirements" or "Whats") \ Quality Characteristics (a.k.a. "Functional Requirements" or "Hows")	volume (material)	watts	volts	volume(space occupied)	kg	meters	number of samples	Mars Driller Design	Ice Drill	Baker Hughes Concept			
1	9	13.6	9.0	Extract loose cuttings and core samples	⊙			▲		O	⊙	4	5	1			
2	9	15.2	10.0	Power Consumption	O	⊙	⊙				O	4	1	5			
3	9	7.6	5.0	Power Source		⊙	⊙					5	2	4			
4	9	10.6	7.0	Produce 10cm x 2.5cm core sample	⊙			O		▲	⊙	5	5	5			
5	9	7.6	5.0	Compact design				⊙	⊙			5	1	3			
6	9	15.2	10.0	Weight				O	⊙			4	0	4			
7	9	15.2	10.0	Drill depth	O					⊙	O	5	3	4			
8	9	15.2	10.0	Move Core sample						⊙	O	4	4	2			
9																	
10																	
				Target or Limit Value	50 cm per day	5 w-hrs per sol	operates on 28 volts	n/a	<45kg	Can obtain 20m	3- 10cmx2.5cm per drill cycle						
				Difficulty (0=Easy to Accomplish, 10=Extremely	1	9	2	1	7	2	10							
				Max Relationship Value in Column	9	9	9	9	9	9	9							
				Weight / Importance	309.1	204.5	204.5	159.1	204.5	324.2	354.5							
				Relative Weight	17.6	11.6	11.6	9.0	11.6	18.4	20.1							



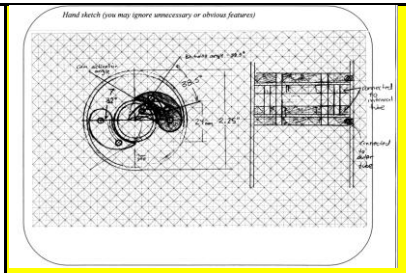
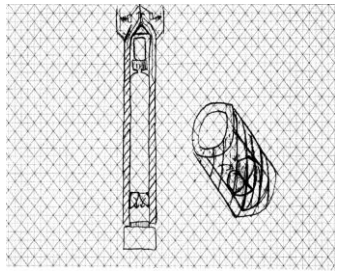
Customer constraints

Concept Ideas





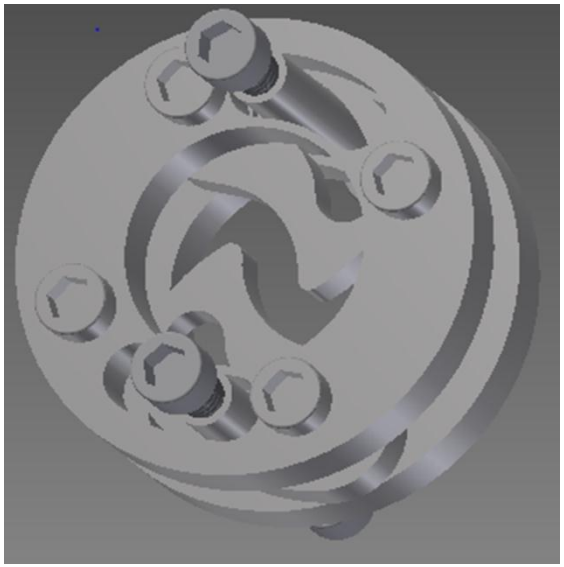
Concept Selection

Core Sample Cutting System				
	Cam		Flap Door	
Selection Criteria	**Rating**	**Weight Score**	**Rating**	**Weighted Scor**
The cutting system weighs less than or equal to 45 kg.	2	0.16	4	0.32
The cutting system consumes less than 50 W-hr per sol.	3	0.45	4	0.6
The cutting system can extract sample cores and cuttings.	4	1.2	2	0.6
The cutting system is manufacturable	3	0.54	3	0.54
The cutting is able to operate after failure	4	1.08	1	0.27
The cutting system is low cost.	2	0.04	5	0.1
Total Score:		3.47		2.43
Rank:		1		2
Continue?		y		y

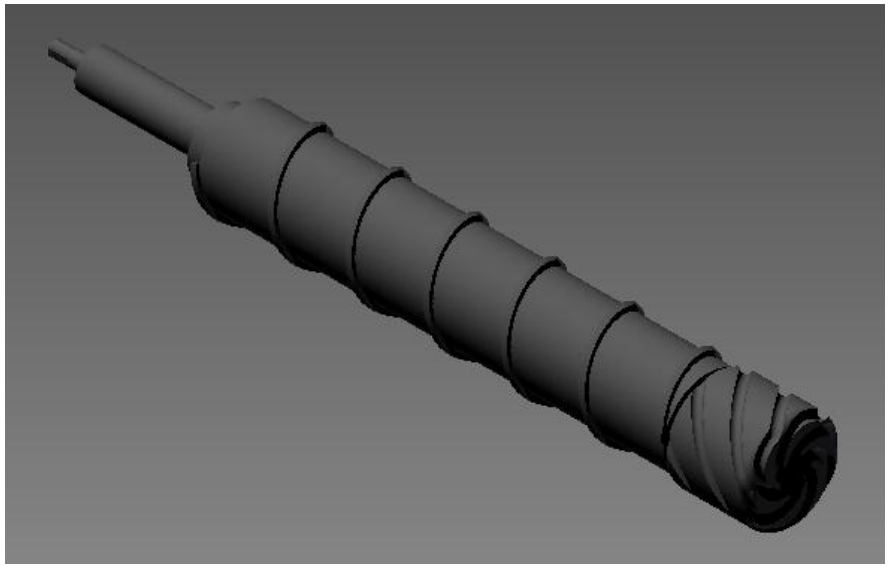
*Only the top two concepts are displayed

CAD/Solid Modeling

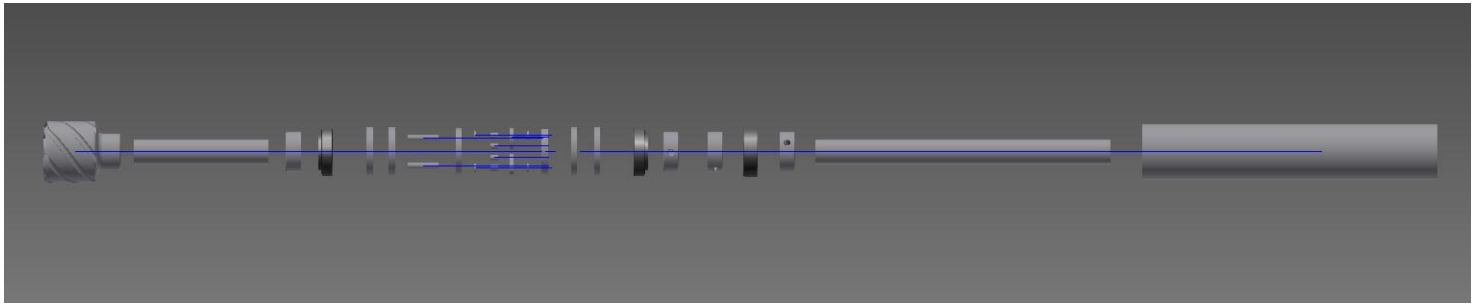
Cutting mechanism



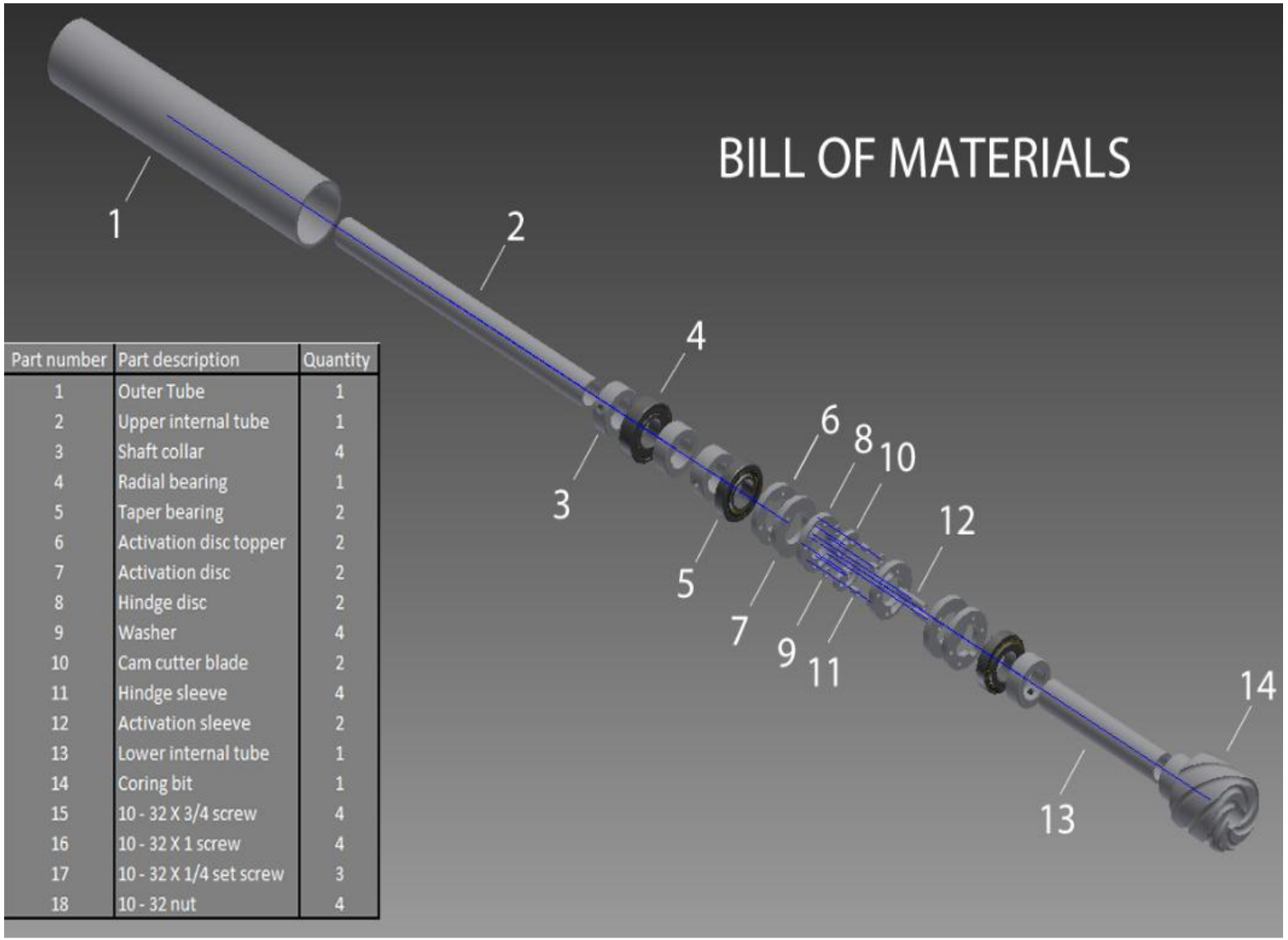
Full assembly



Exploded view

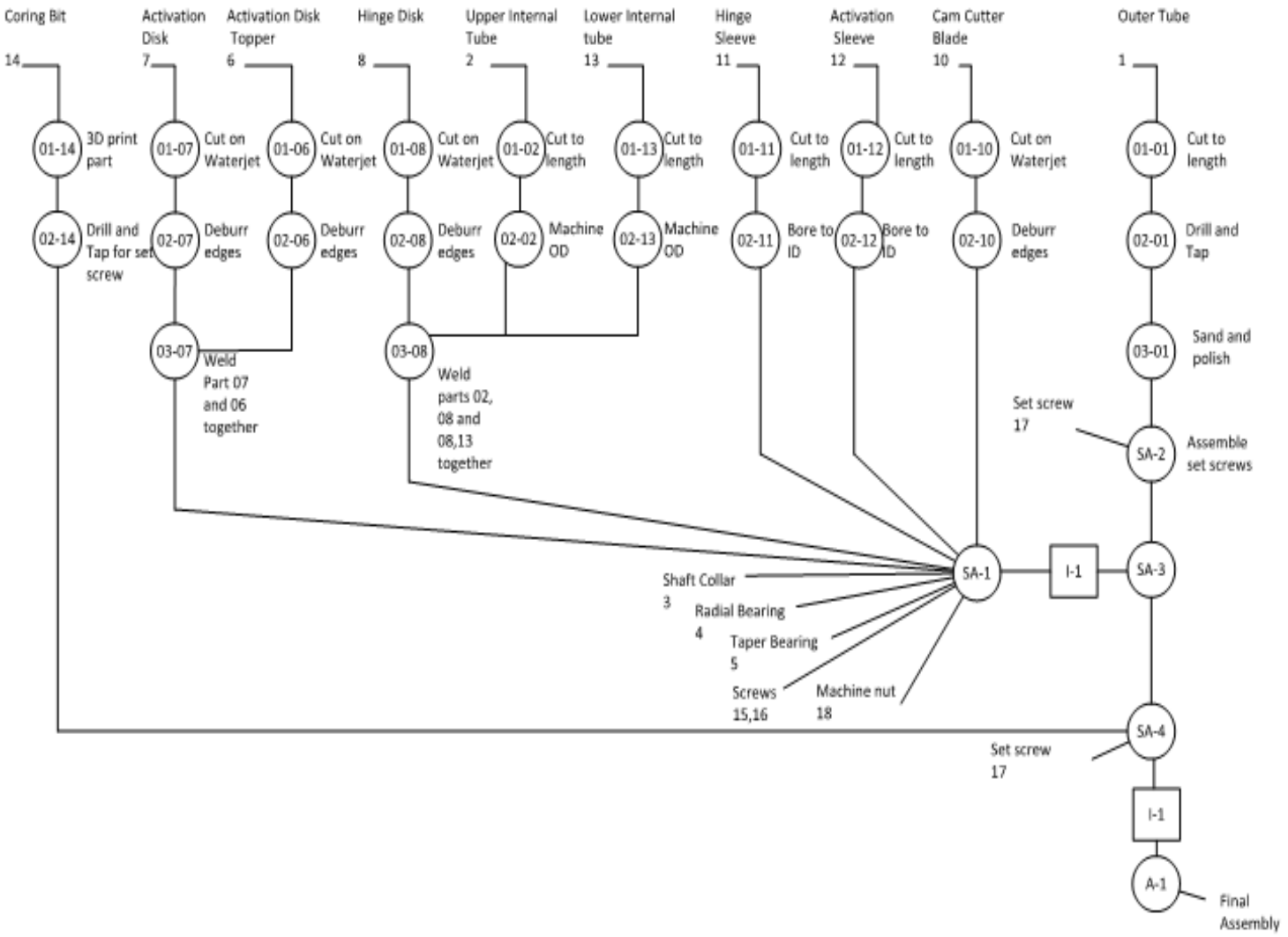


Bill of Materials



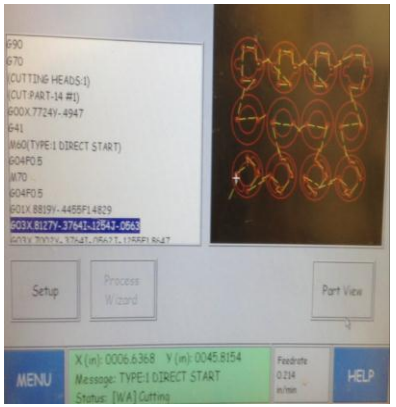
Part number	Part description	Quantity
1	Outer Tube	1
2	Upper internal tube	1
3	Shaft collar	4
4	Radial bearing	1
5	Taper bearing	2
6	Activation disc topper	2
7	Activation disc	2
8	Hindge disc	2
9	Washer	4
10	Cam cutter blade	2
11	Hindge sleeve	4
12	Activation sleeve	2
13	Lower internal tube	1
14	Coring bit	1
15	10 - 32 X 3/4 screw	4
16	10 - 32 X 1 screw	4
17	10 - 32 X 1/4 set screw	3
18	10 - 32 nut	4

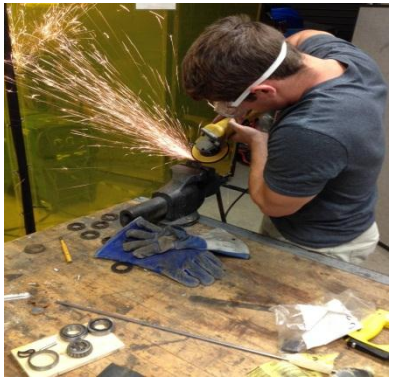
Operation Process Chart

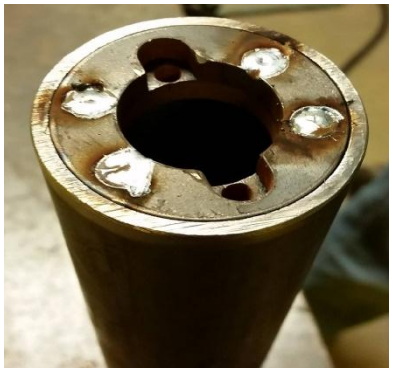


Manufacturing Processes

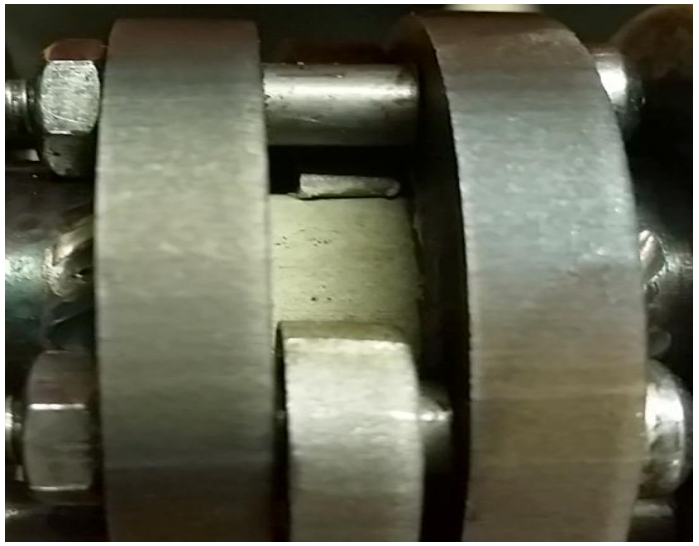
- Rapid Prototyping
- Water jet Cutting
- Grinding
- Welding
- Drilling
- Bolting

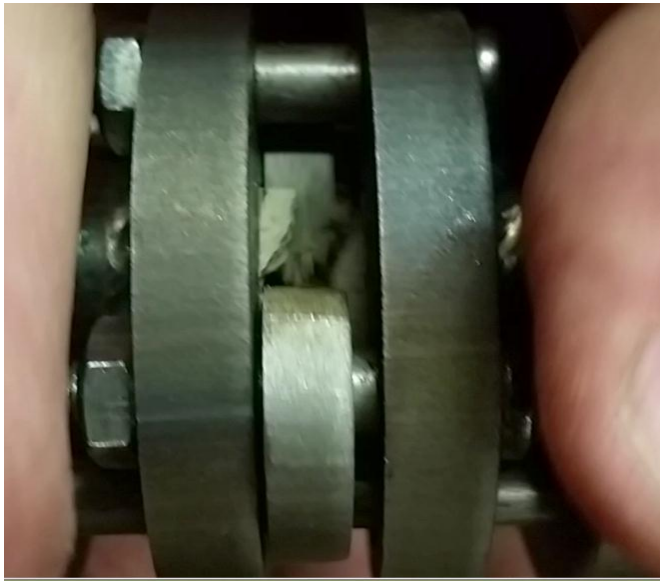






Testing





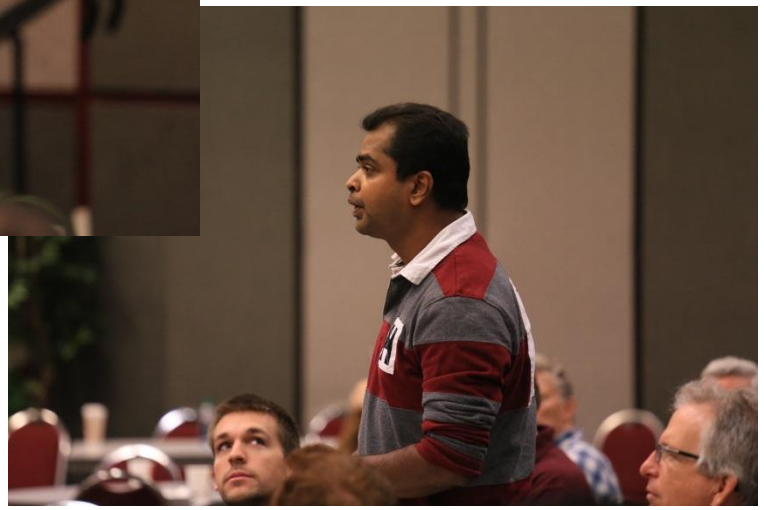
Business Plan

- NASA applications:
  - MARS water exploration
  - Moon mining
  - Asteroid mining
- Oil and Gas
- Construction
  - Road
    - Concrete testing
    - Testing compaction of soil
  - Housing market
    - Testing soils before building
    - Geological samples

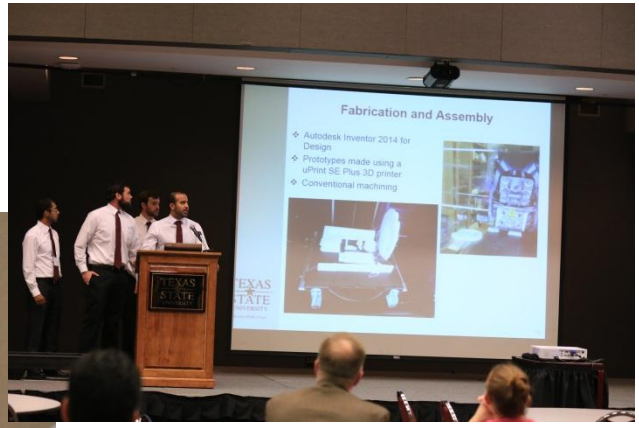
Multi-Culturalism

- Ambidextrous- Can be operated either left or right handed.
- Can be used by any gender, or race
- Can be easily converted to S.I. Units
- International coalition of students, educators, and professionals to achieve common goal
- Inspiration to many K-12 kids pursuing STEM programs


TEXAS
STATE
UNIVERSITY
TEXAS
STATE
UNIVERSITY



Sponsors,
Panel of experts,
Technical
consultants



Sponsors,
Panel of experts,
Technical consultants


LBJSC
And the best 2014 team is…….
Mars Drillers
NASA