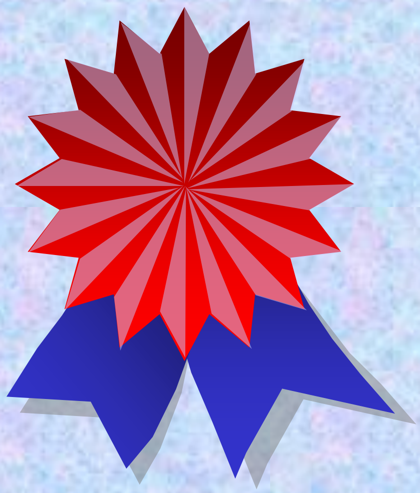
Texas State University- San Marcos
Ingram School of Engineering

2011 Best Product Development Contest Award

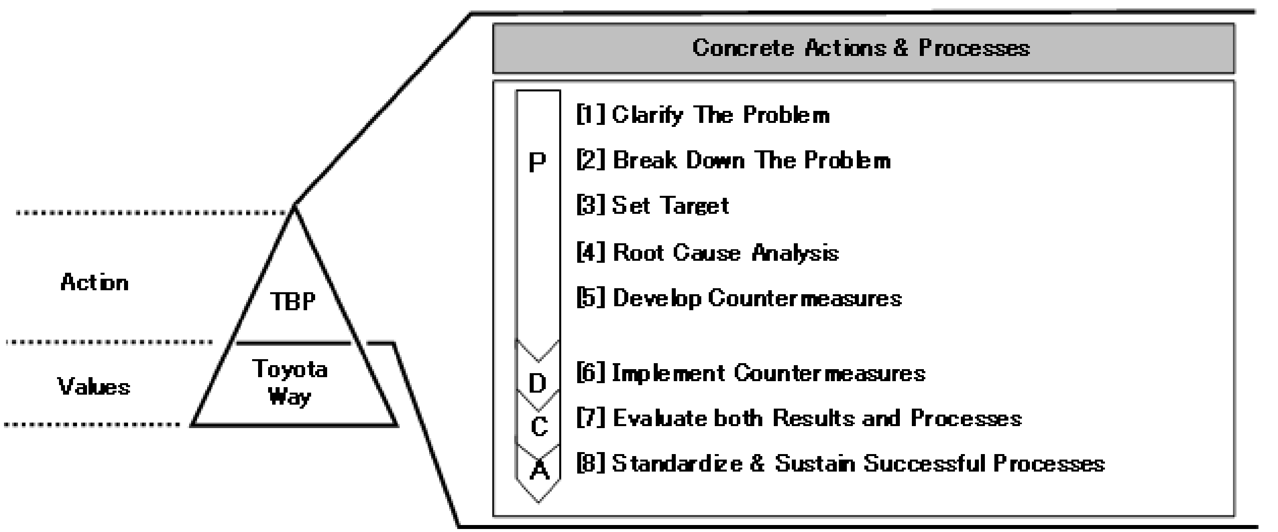


2011 Best Team: **Toyota Tundra Access Panel Jig Design**

Ralph Schultz
Hector Avila
Megan Taylor
Esmer Trevino

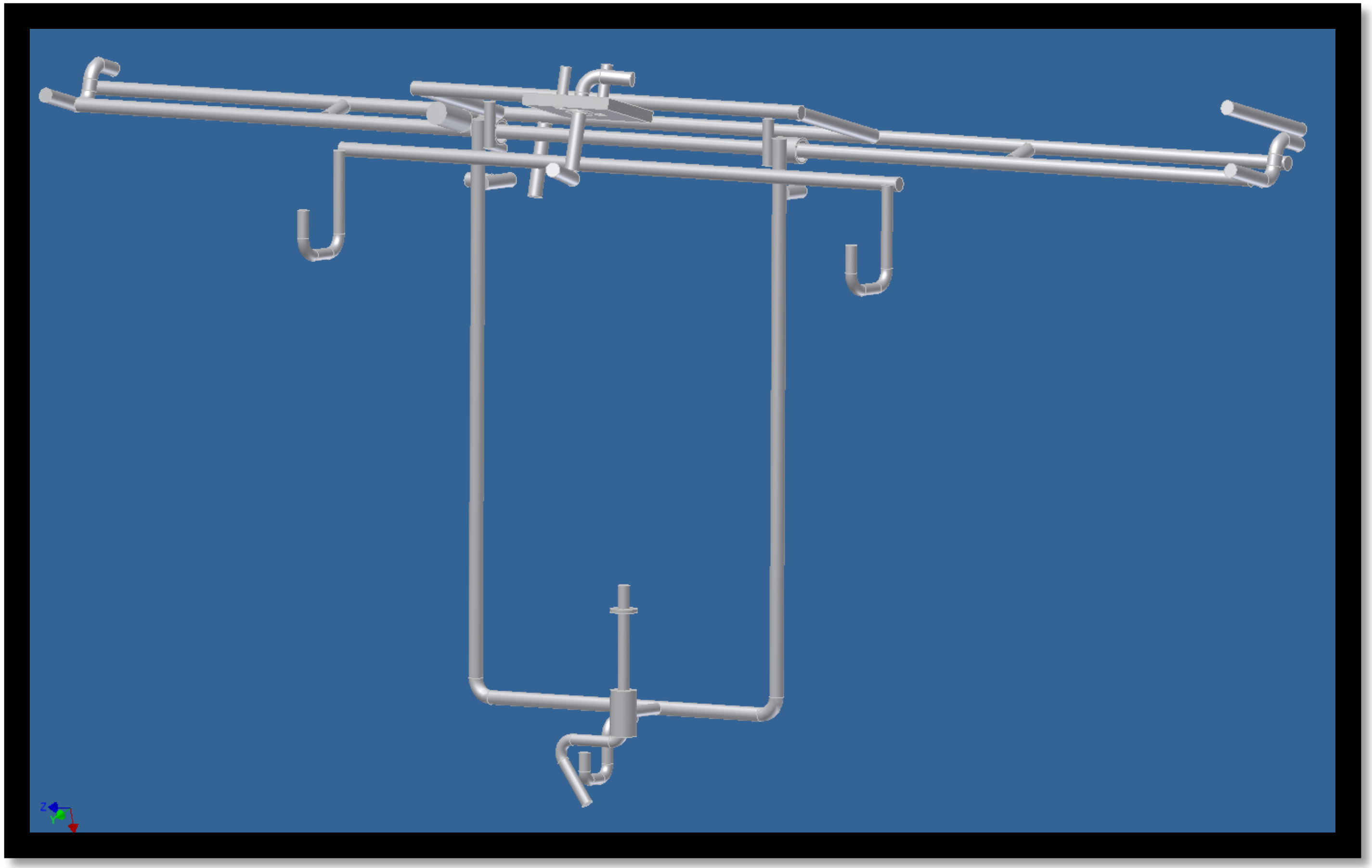
What makes Toyota Successful?

- **Kaizen**- continuous improvement
- **4M**- man, machine, method, material
- **Genchi Genbutsu-** go and see
- **5S**- sort, straighten, shine, standardize, and sustain
- **Just in Time**
- **Problem Solving Methodology -** Focus on the root cause and sustainment of long-term countermeasures



Current Jig - Problems

- Burden for installation/operation
- Does not maintain proper angle relative to painting applicator
- Causes touch marks which require rework
- Parts can be damaged or lost



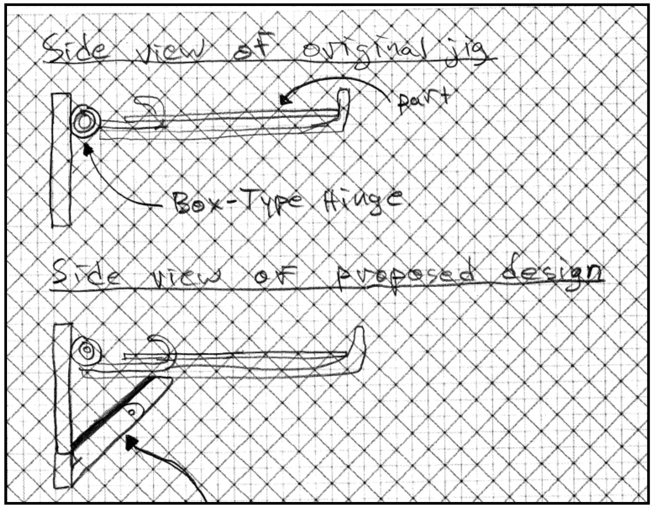
Customer Needs (must haves)

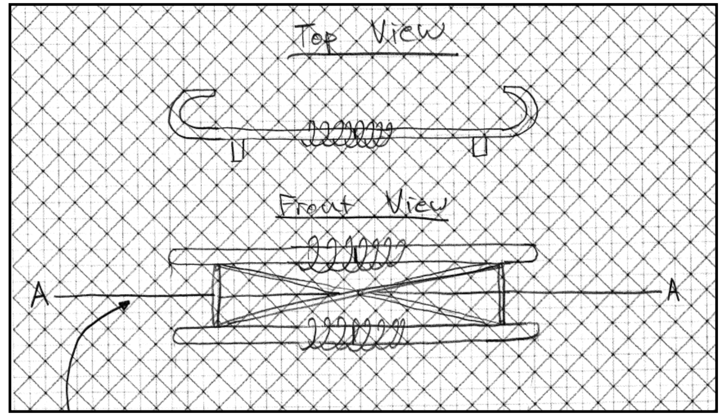
- Safe to use
- Quick installation and ease of operation
- Creates a part that meets design criteria
- Create a long-term jig that supports Toyota’s Just-in-time production system

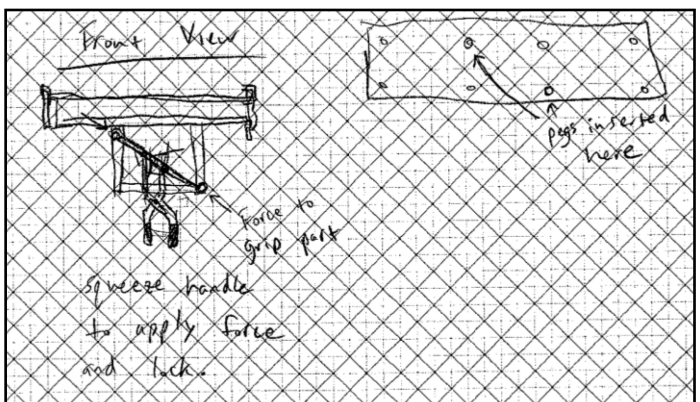
Ideal Situation (desirables)

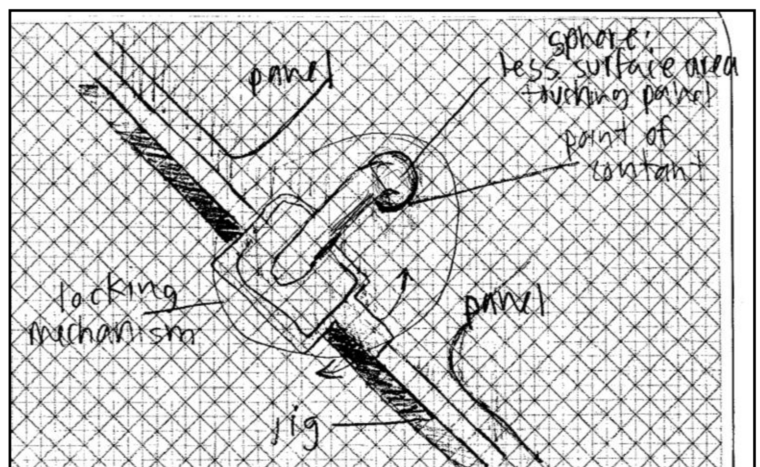
- Durable jig
- Reduce the amount of time jig is being interacted with by operators
- Part mounted to jig meets design quality criteria (paint thickness and cure)
- Reduce the number of lost or damaged parts

Concept generation
Subsystem Designs









Concept Selection Matrix

Longer Latch

"Folding Table Hinge"

Tension Holder

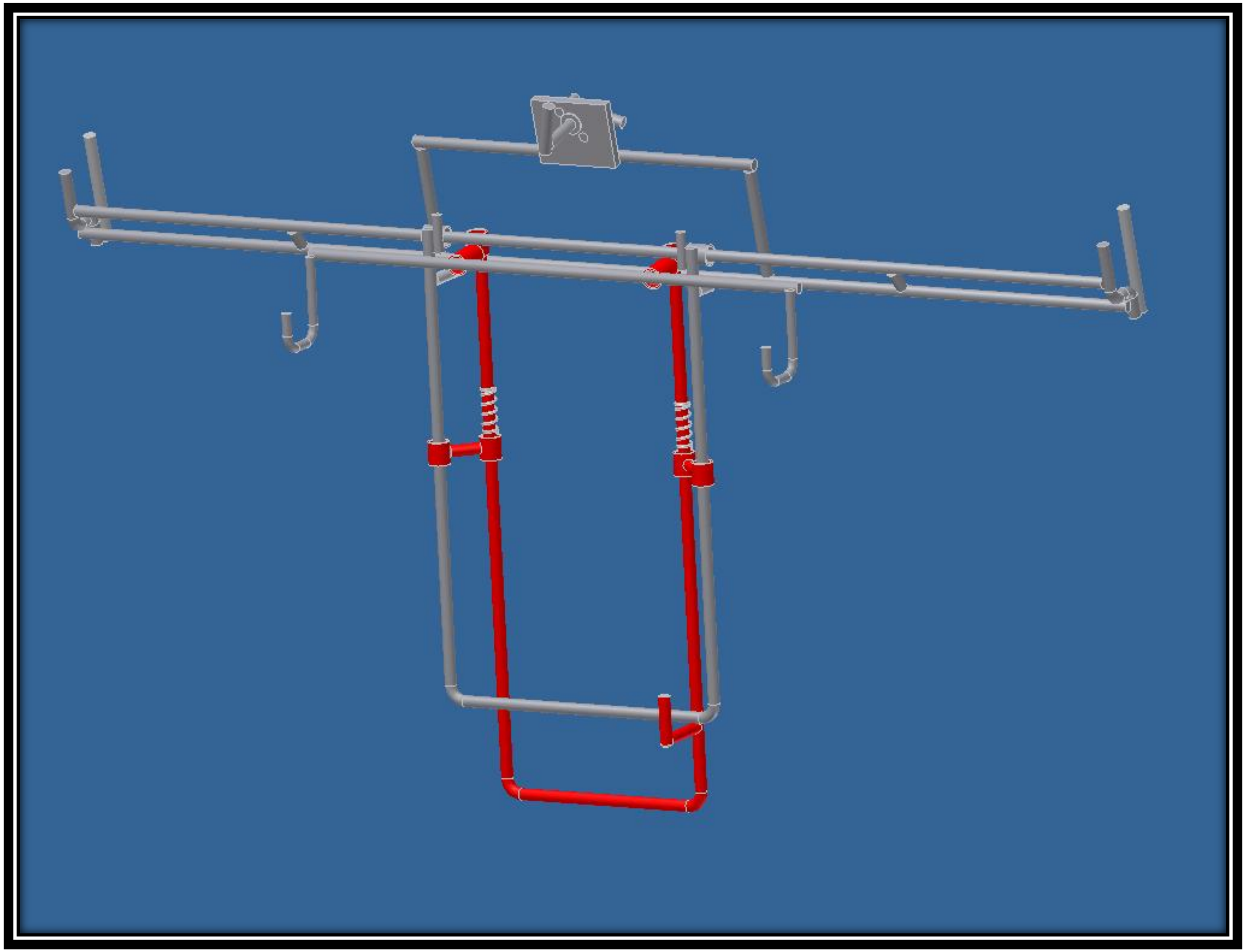
Concept Selection

Selection Criteria	Weight	Original Jig (Reference) Rating	Original Jig (Reference) Weighted Score	Longer Latch Rating	Longer Latch Weighted Score	"Folding Table Hinge" Rating	"Folding Table Hinge" Weighted Score	Tension Holder Rating	Tension Holder Weighted Score	Spring Loaded Rating	Spring Loaded Weighted Score	Ball End Rating	Ball End Weighted Score
Lightweight	9.1	4	36.4	4	36.4	3	27.3	4	36.4	4	36.4	4	36.4
The jig can withstand the cleaning process	6	4	24	4	24	3	18	3	18	3	18	4	24
The jig lasts a long time	9.1	3	27.3	3	27.3	2	18.2	3	27.3	2	18.2	3	27.3
The jig is safe	15.2	4	60.8	5	76	4	60.8	4	60.8	4	60.8	4	60.8
The jig is easy to use	12.1	3	36.3	5	60.5	5	60.5	4	48.4	5	60.5	3	36.3
The jig allows minimal deformation of part	15.2	3	45.6	3	45.6	3	45.6	5	76	3	45.6	4	60.8
The jig stays in set position (90 deg)	15.2	2	30.4	2	30.4	5	76	3	45.6	2	30.4	2	30.4
The jig has minimal touch points	6	3	18	3	18	3	18	5	30	3	18	4	24
The jig is easily maintained with available tools	9.1	4	36.4	4	36.4	4	36.4	3	27.3	4	36.4	4	36.4
The jig is economical to produce	3	2	6	2	6	3	9	2	6	2	6	2	6
Total Score			321.2		360.6		369.8		375.8		330.3		342.4
Rank			6		3		2		1		5		4
Continue?			NO		YES		YES		YES		NO		NO*

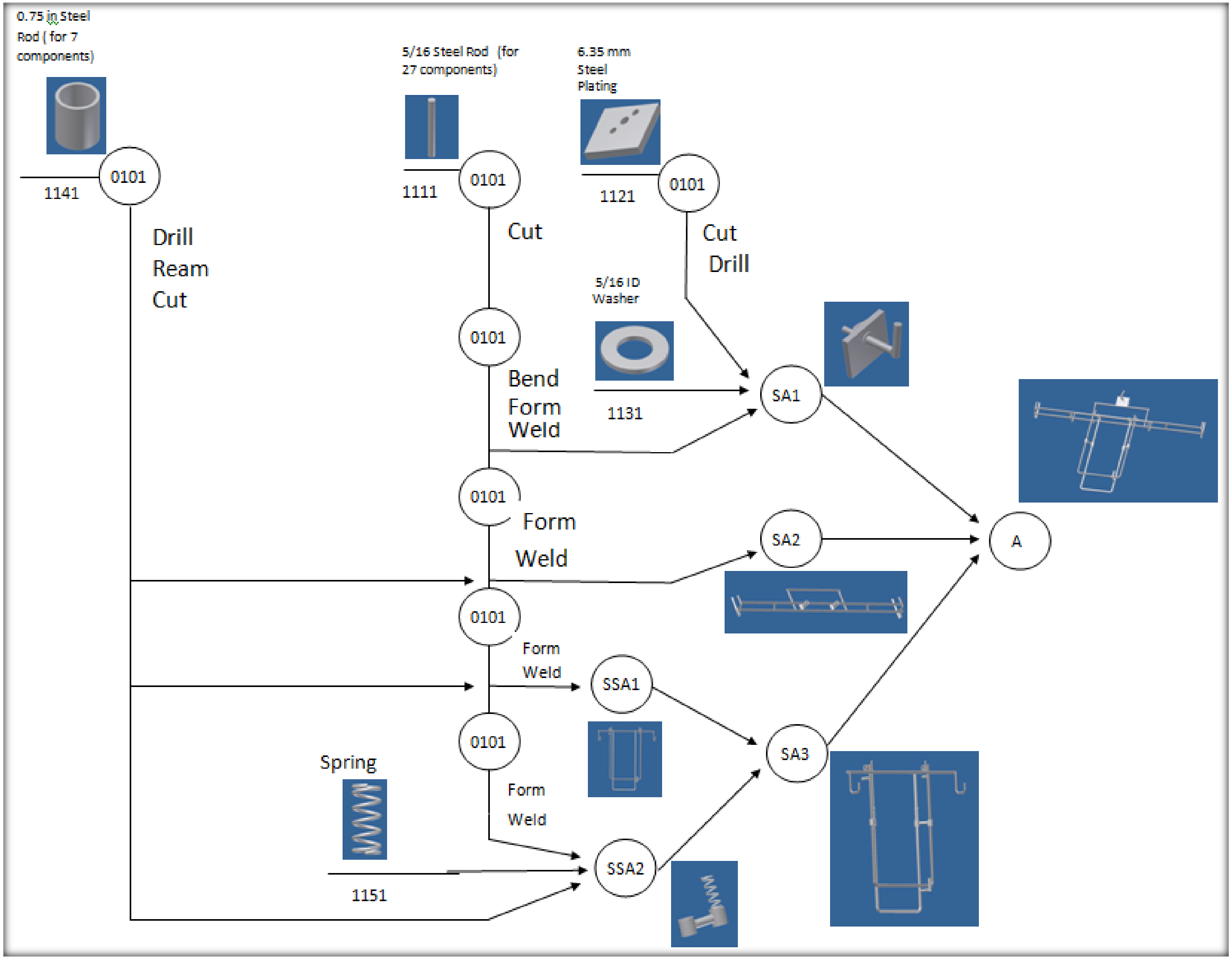
*Ranking negated by Tension Holder design

Longer Latch	"Folding Table Hinge"	Tension Holder
360.6	369.8	375.8
3	2	1
YES	YES	YES

Final Design: U Spring

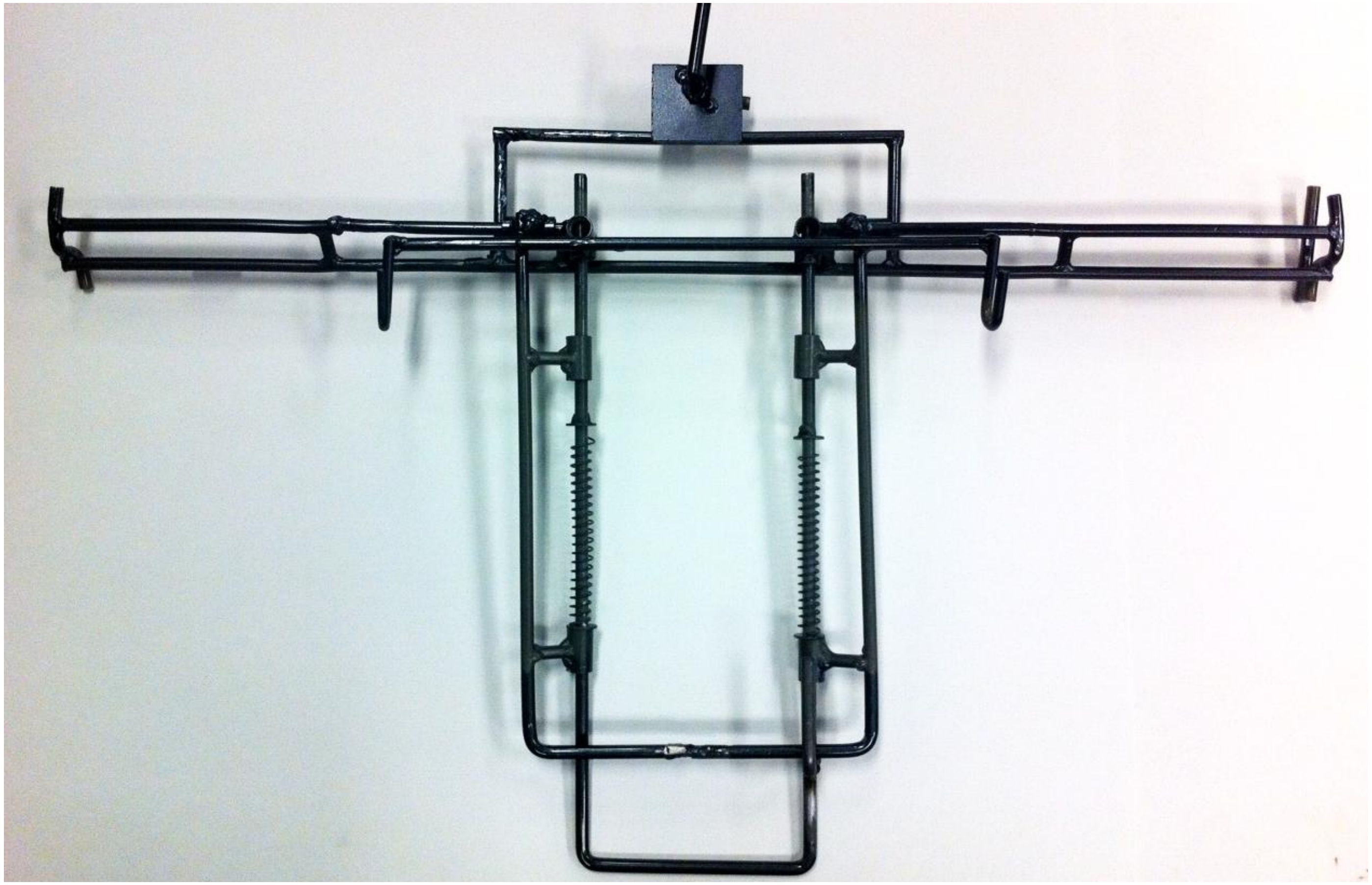


Operations Process Chart



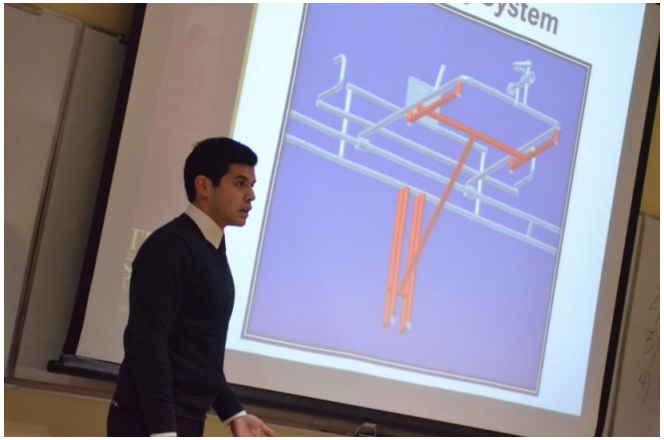
Prototype Manufacturing and Assembly

Final Product



Kentoukai
Knowledge Sharing & “Wrap Up”

Prototype Testing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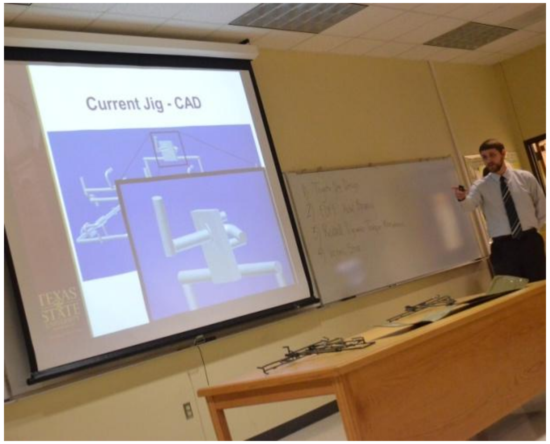
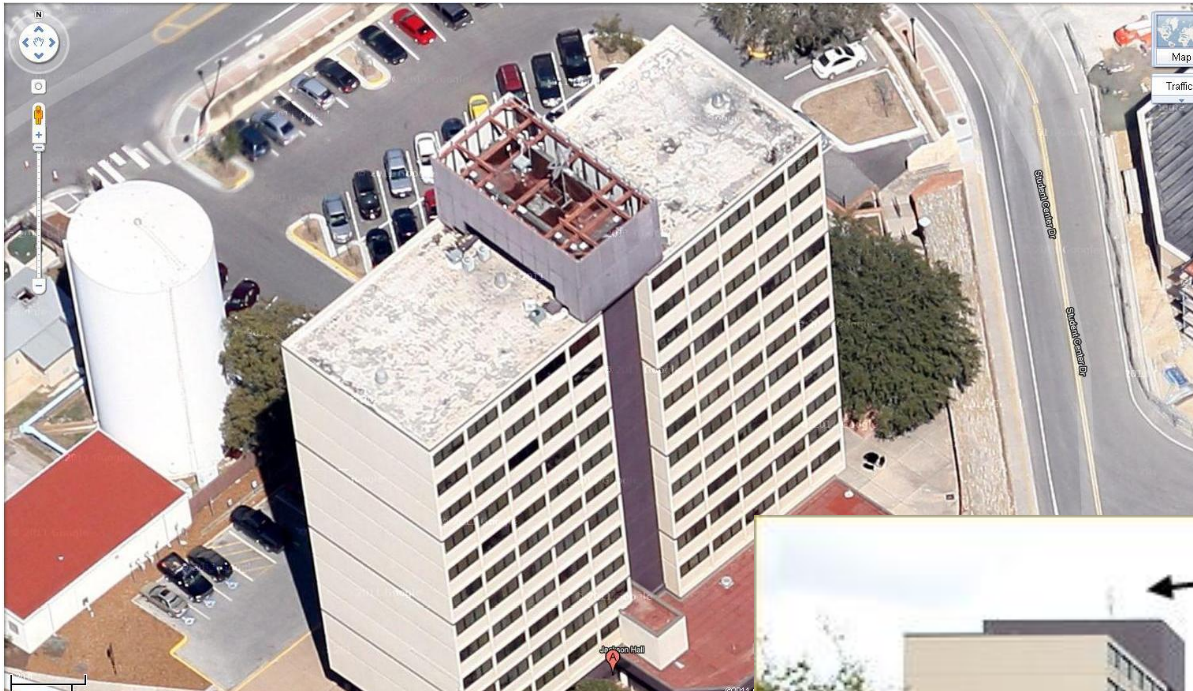
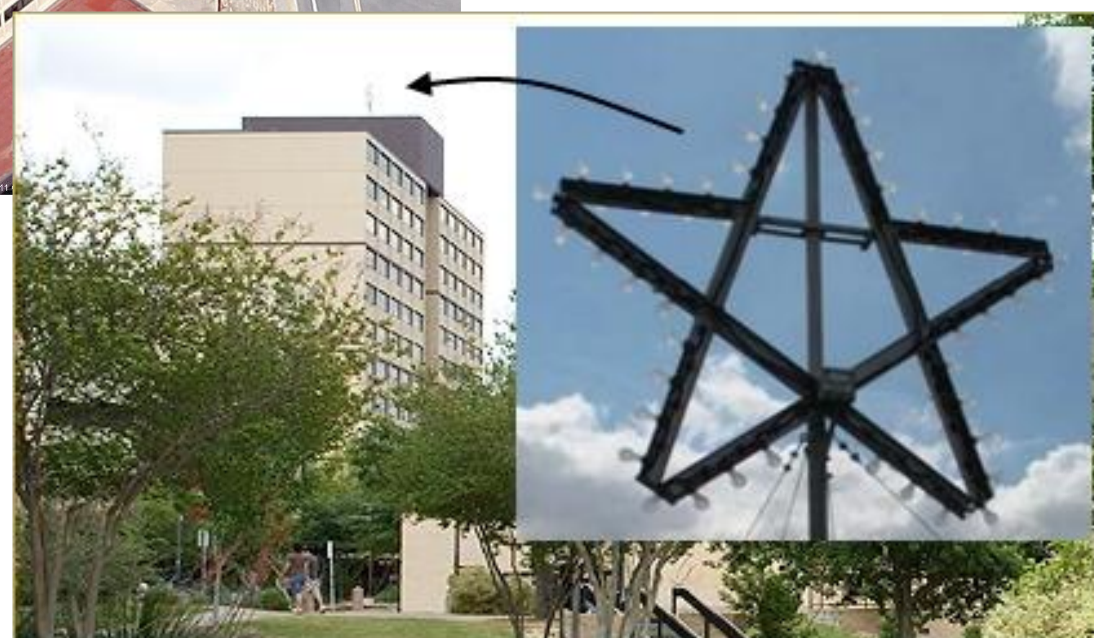

Current Jig - CAD

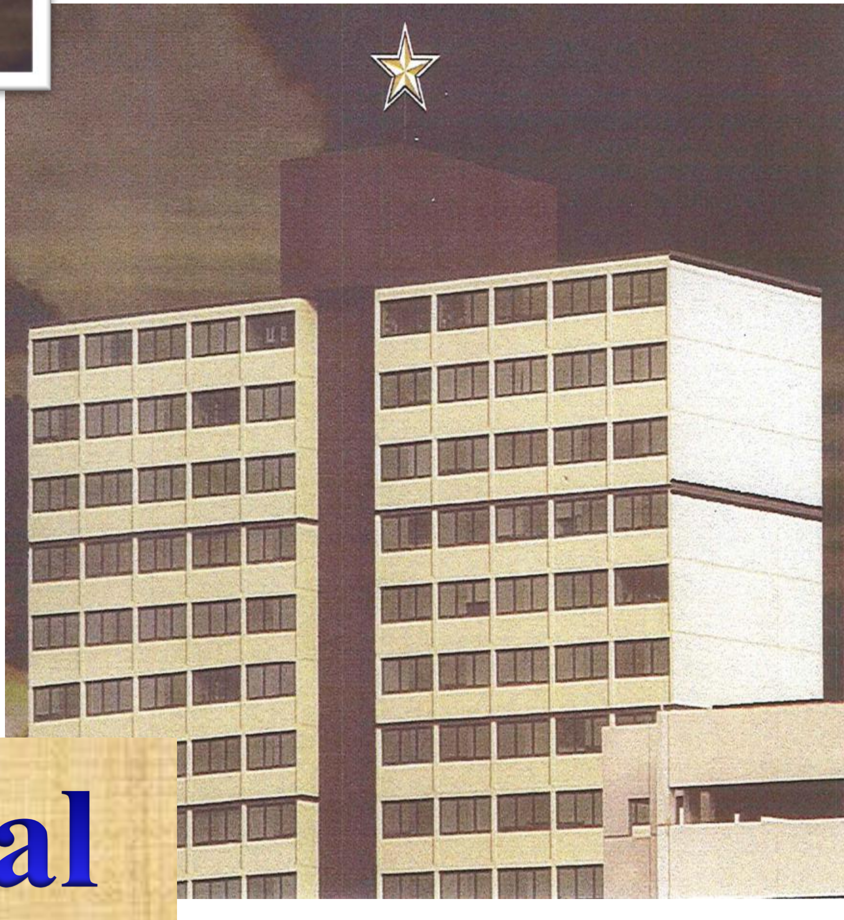
Lindsey Whitworth
Nick Worley
Robert Fischer
Wes Poirier

Victory Star

Overhead view: Jackson Hall Dormitory







Original Proposal

Customer Needs

•permanently mounted and supported securely.
•impervious to most weather conditions.
•unaffected by high background microwave radiation.
•appears professionally built during the day
•larger than previous version.
•greater illumination than previous
•2 programmable illumination patterns.
•rotates 180 degrees.
•low maintanance
•overall costs
•ease of manufacturing
•ease of installation
•high efficiency

CONCEPT GENERATION

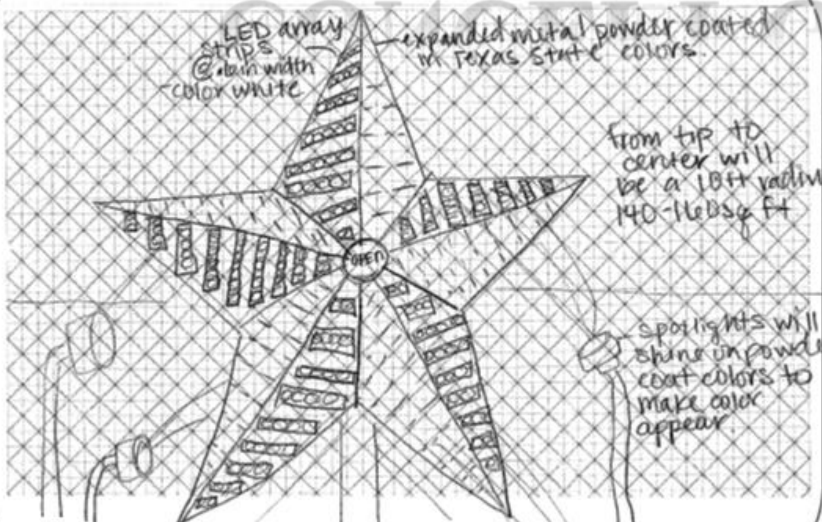


Fig. 1 Half LED array, Half Reflective Powder Coating

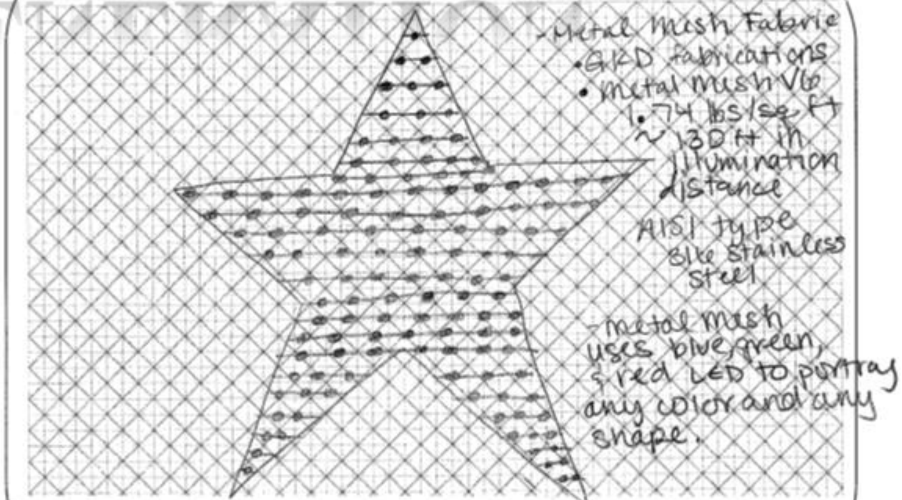


Fig. 2 Metal Mesh Fabric with LEDs installed

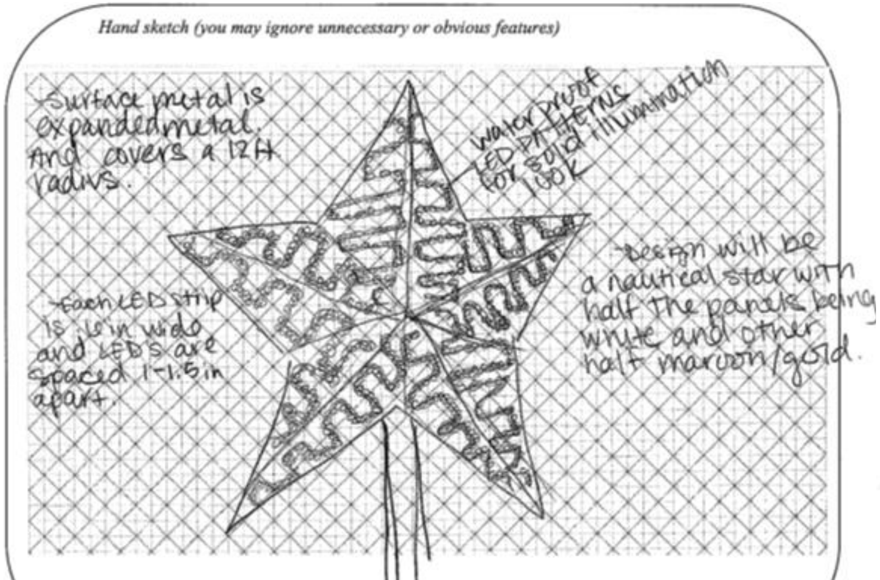


Fig. 3 All LED lighting

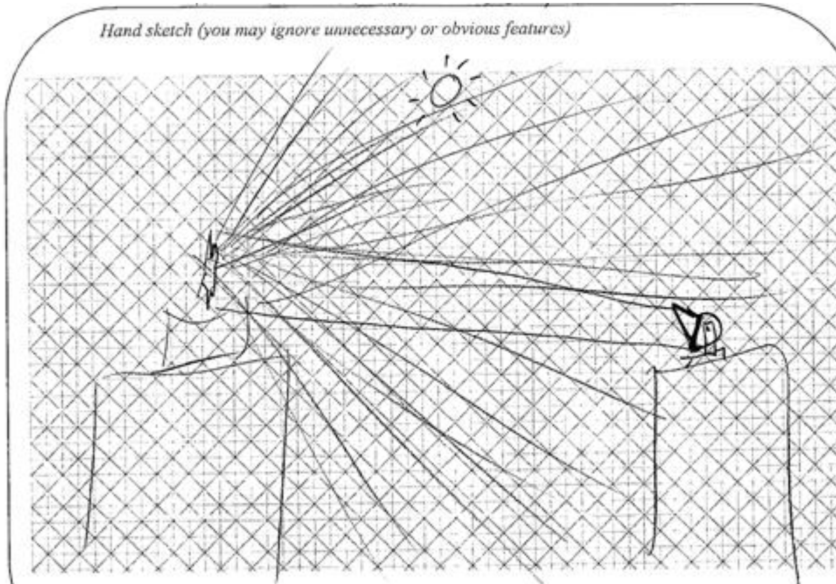
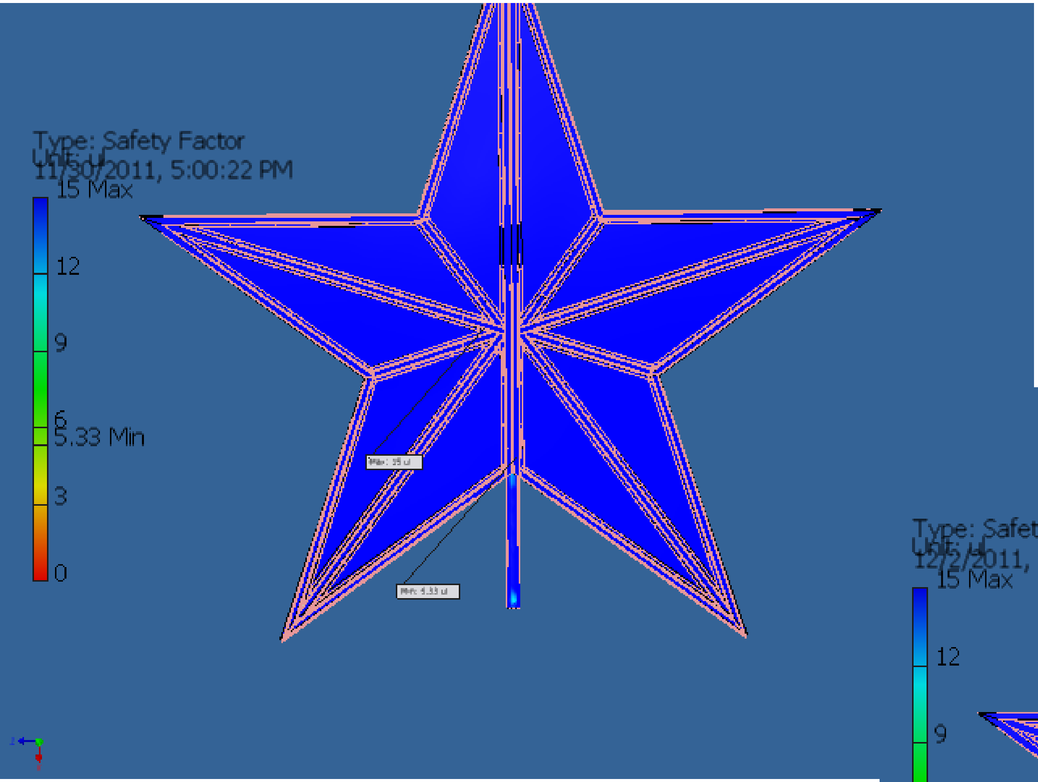


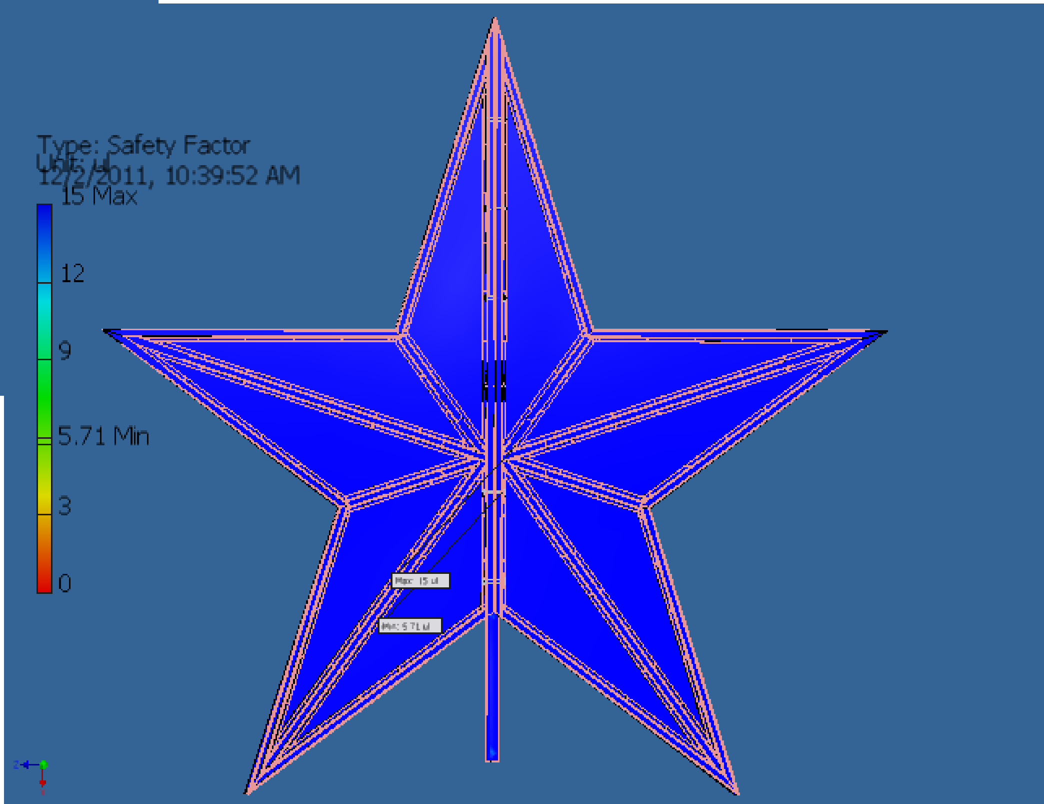
Fig. 4 Mirror array by use of light reflection

STRESS ANALYSIS RESULTS

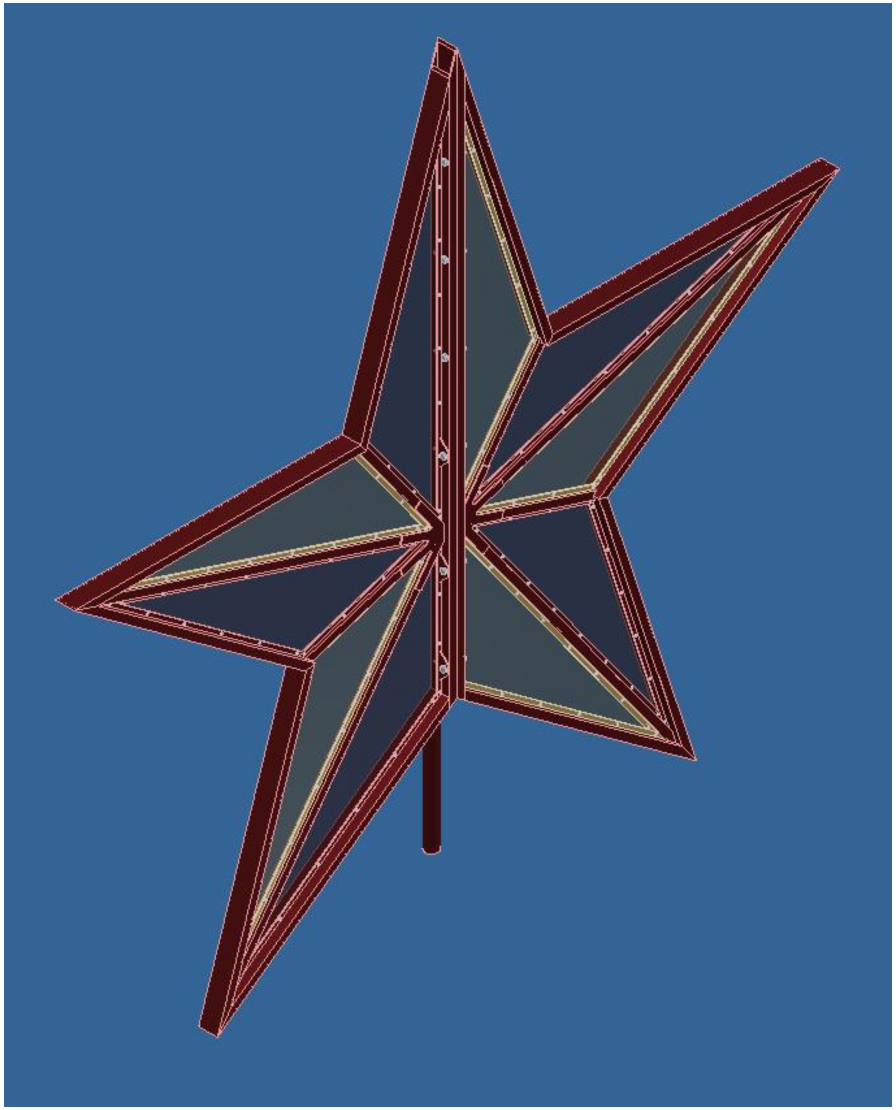


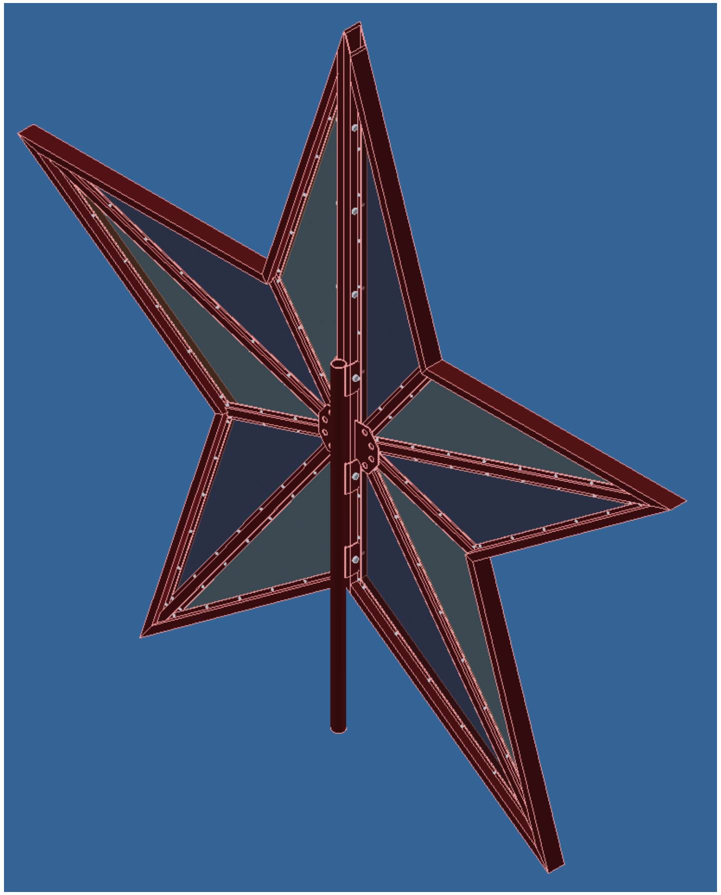
MOD. 3A
SF - 5.33

MOD. 3B
SF - 5.71

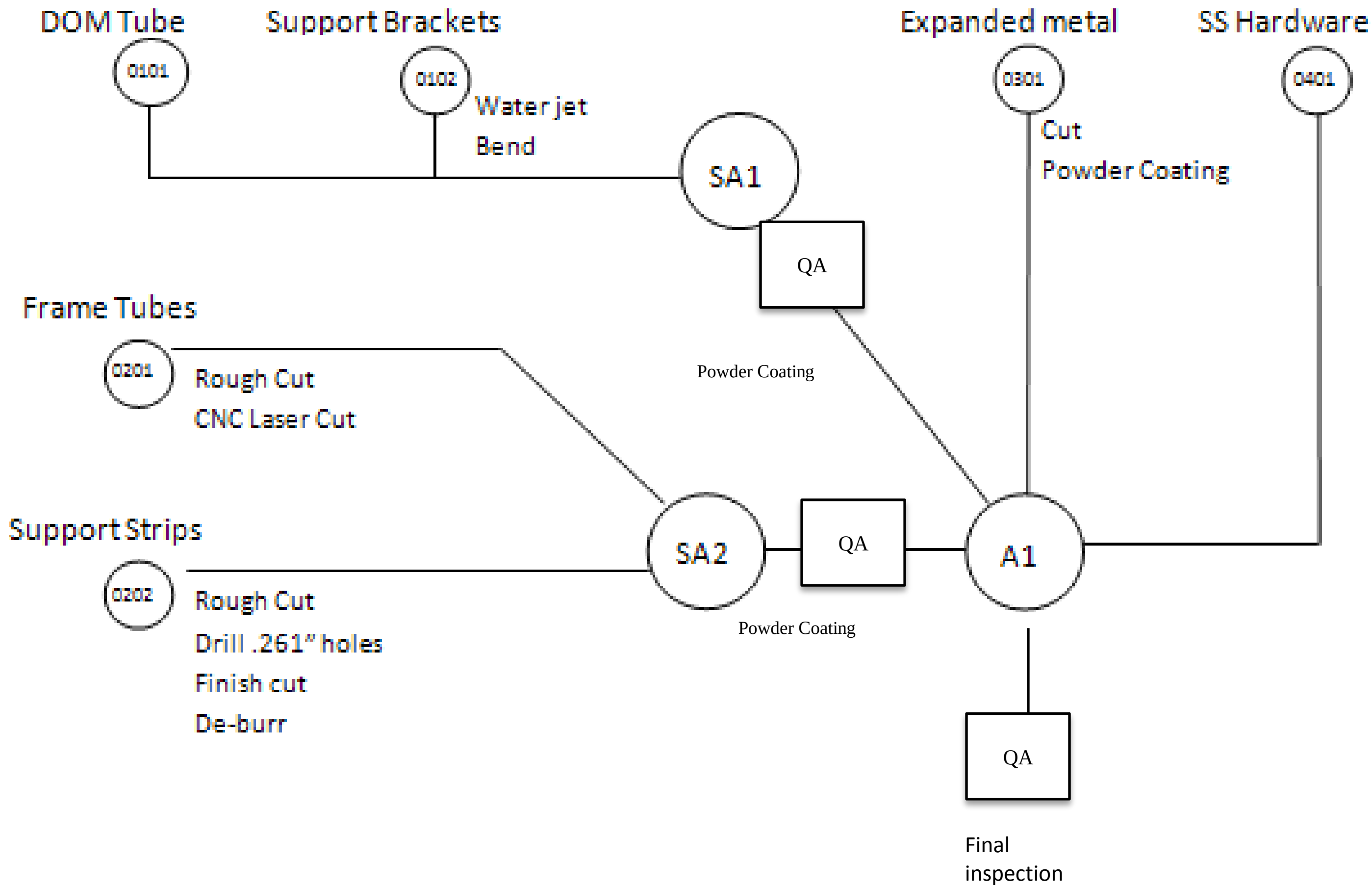


Final CAD Images

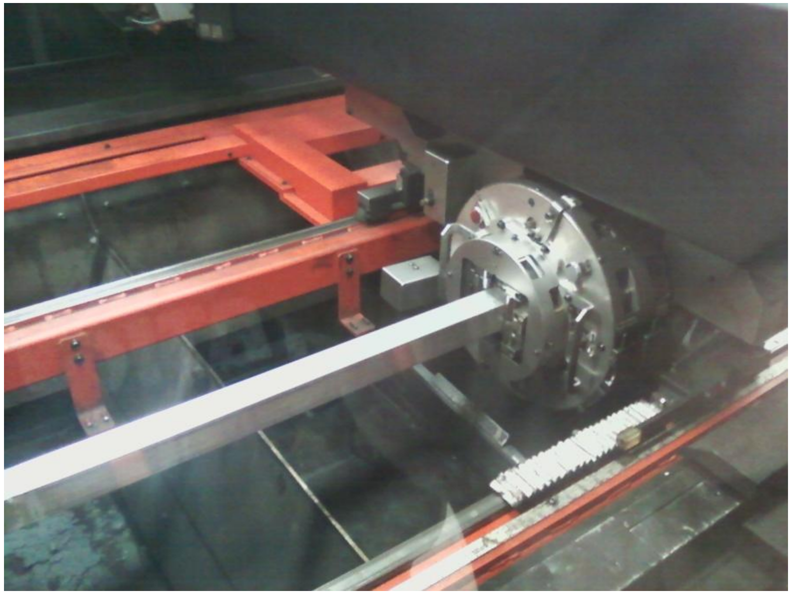


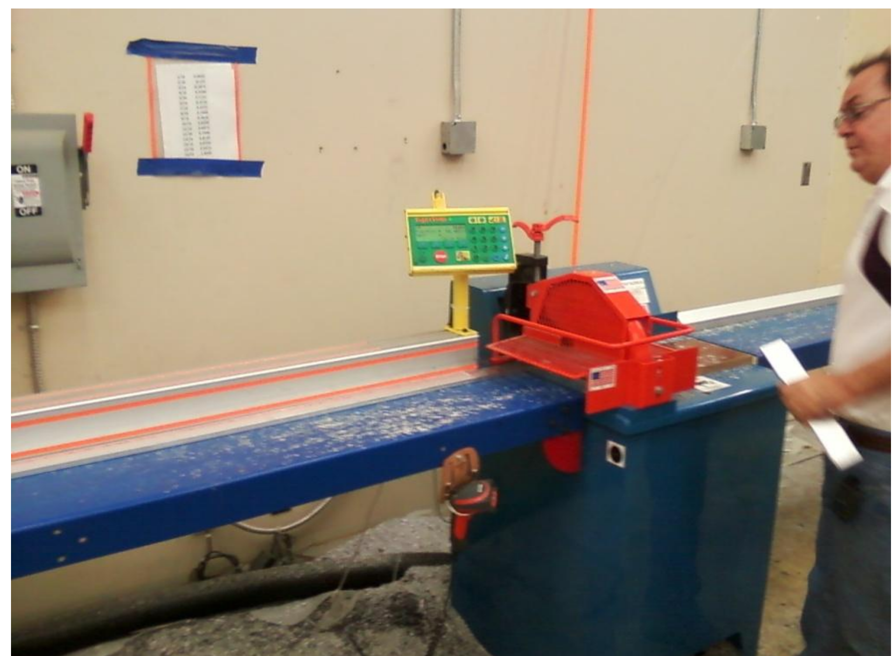


Operations Process Chart



Manufacturing: Cutting





Manufacturing: Welding

Manufacturing: Expanded Metal

Final Process: Power Coating

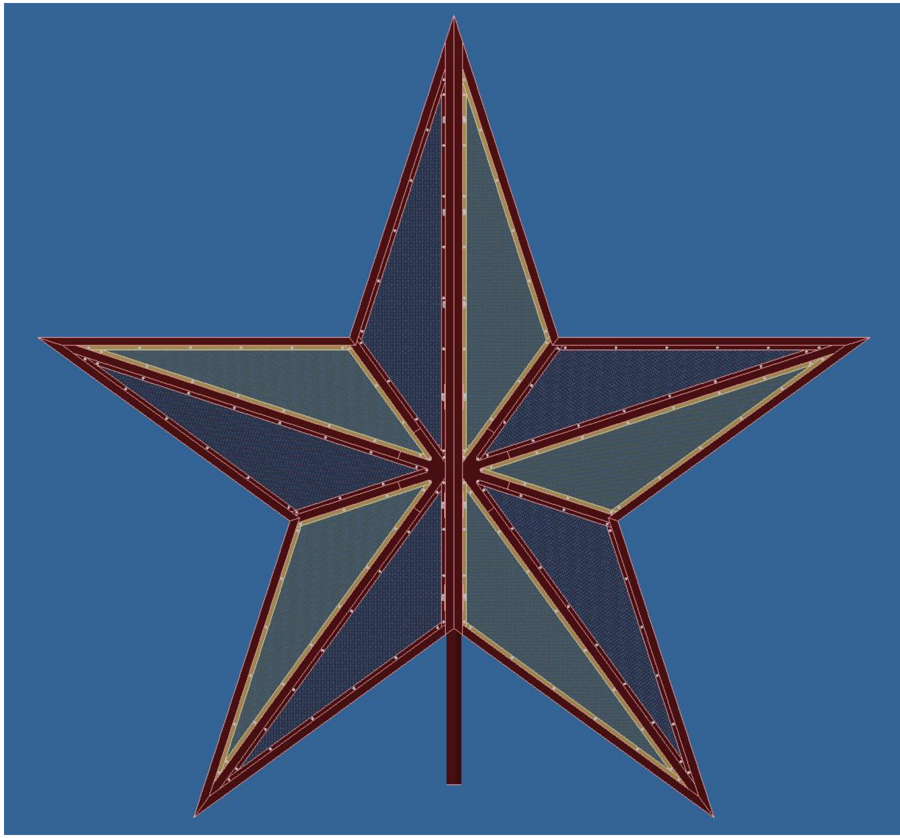
- To protect face from visual oxidation effects, to provide a surface for electronics, & aesthetic appeal
- Drop off - Friday morning

  Pick up - Monday
- Powder coating frame:

  Maroon
- Powder coating expanded

  metal: Gold and Maroon
- Powder coating strips:

  Gold and Maroon



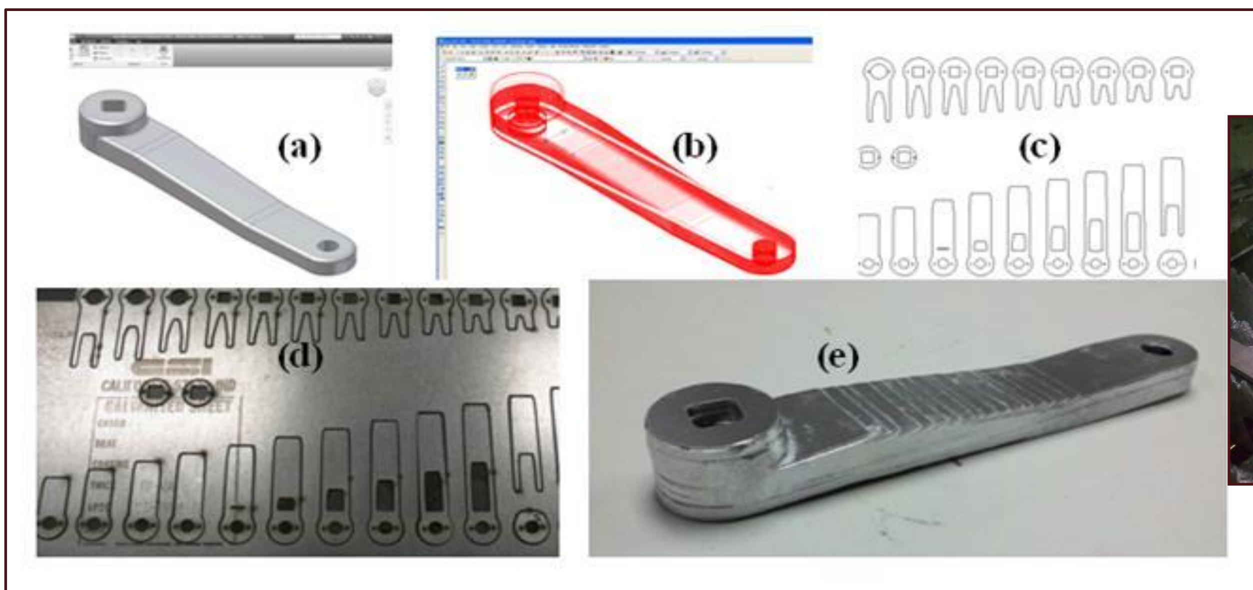
Layer Alignment & Bonding for the (FDFF) Process

Tyler Davis
Cameron Gentles
Bret Mackie

FDFF Process: Slicing & Outputting Data

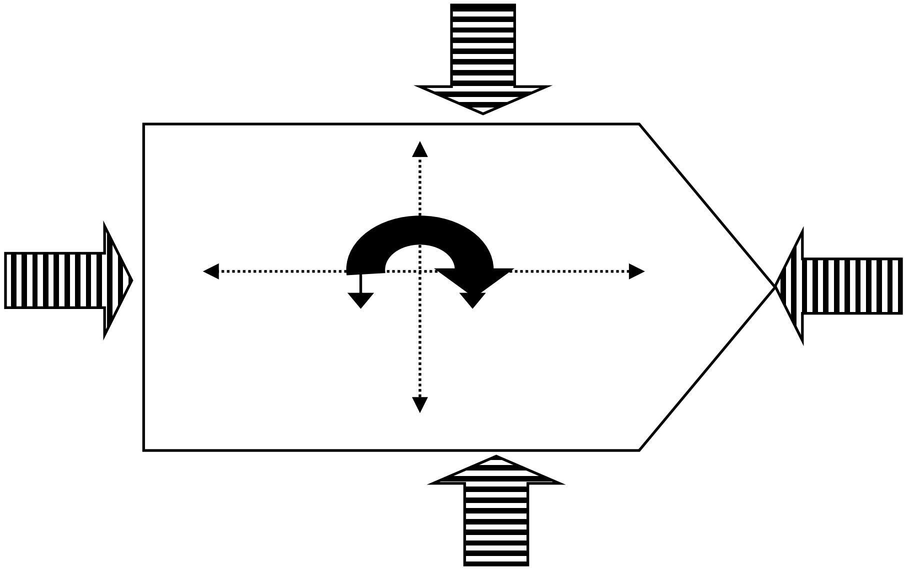
FDFF Adaptive Slicing Software:

- Developed in-house in a parallel research
- Utilizes visual basic codes to manipulate the 3D software, 'Inventor'
- Takes 3D CAD model and slices it into layers that are then translated into 2D patterns that are compatible with several types of cutters and CNC machines.



FDFF Process: Stacking & Alignment

- For alignment, six movements along 3 axes need to be limited to align layers.
- At least four locating points must be contacting all layers.



FDFF Process Improvement

Goals:

1) Determine the best method of heating and bonding
2) Develop a method of aligning layers
3) Develop a method of compressing layers during bonding

Previous Research in Heating

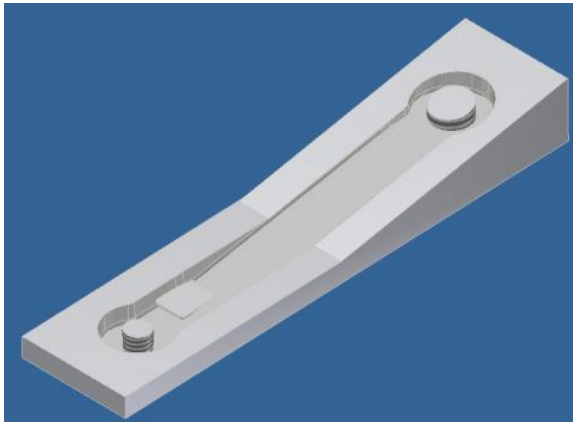
Flame

Benefit:
- Fast

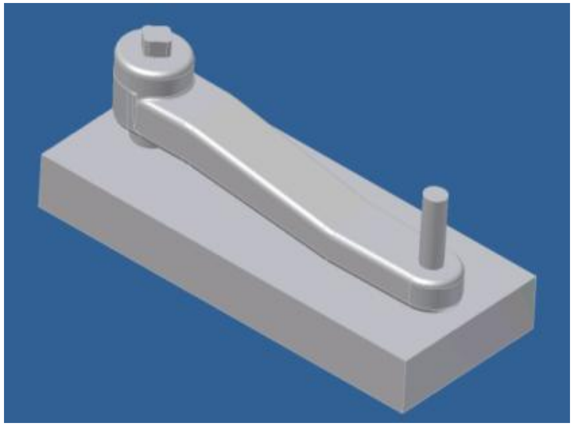
Drawbacks:
- Did not reach brazing temperature
- Oxidation was an issue

Previous Research in Layer Alignment

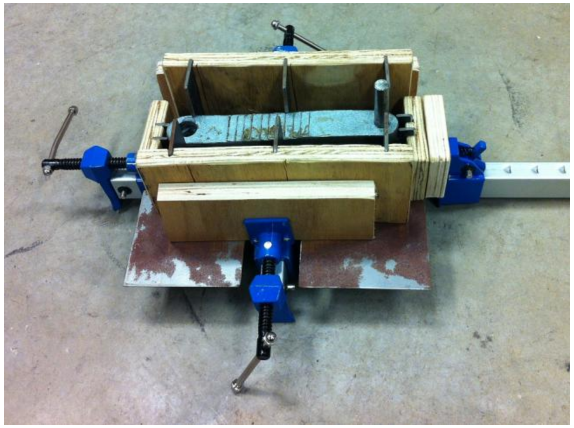
Drawbacks



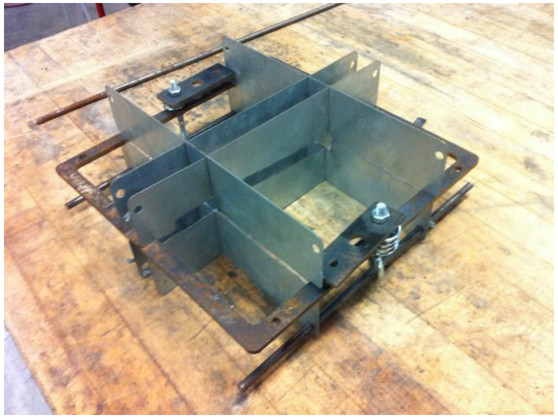
Tooling needs machining



Requires modification of part



Bulky system

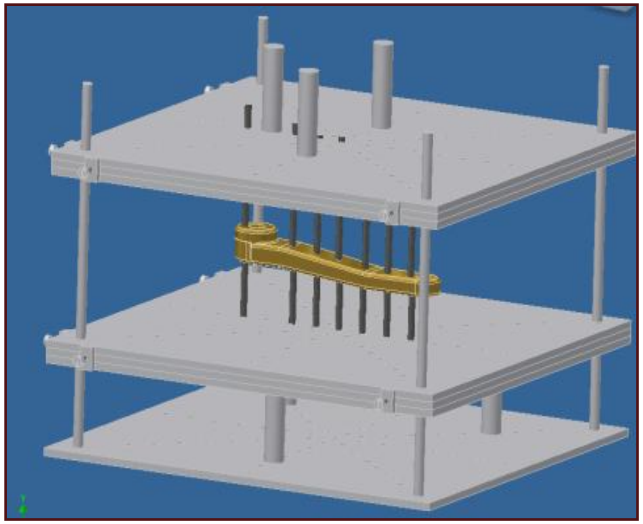


Incompatible with induction system

Previous Research in Layer Compression

How it works:

- Pins are lowered onto the part by gravity
- Pins are locked by sliding plates
- Plates are drawn together to compress part

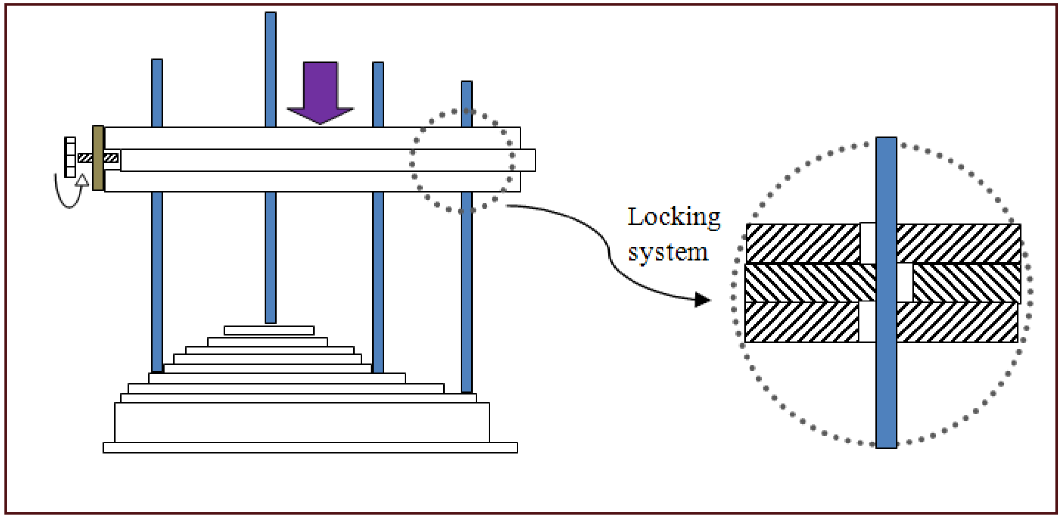


Advantages:

- Applies even pressure to irregular surface

Drawbacks:

- Low resolution
- Damaged by heat



Customer Needs

#	Need	Importance
1	Compress any possible geometry.	***
2	Apply enough pressure for good bonding.	***
3	Heat work piece to soldering temperature, possibly brazing temperature, and possible direct bonding of metal to metal	***
4	Bond bike crank size parts	**
5	Align layers as well as compress	***
6	Heat any possible geometry	*
7	Mobile/Quick set-up time	*
8	Bond different kinds of metals	*

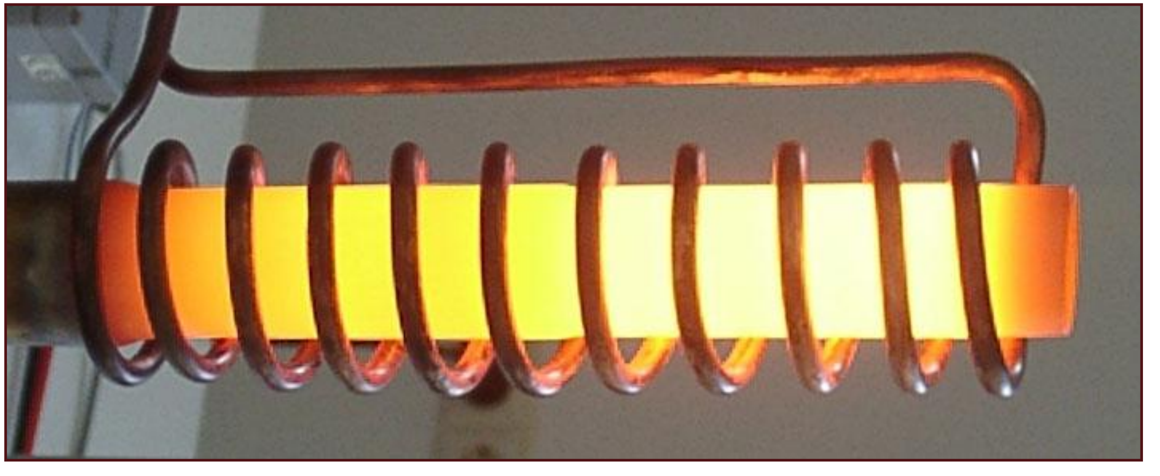
Idea Generation & Concept Selection: Heating

Chosen Method: *Induction*

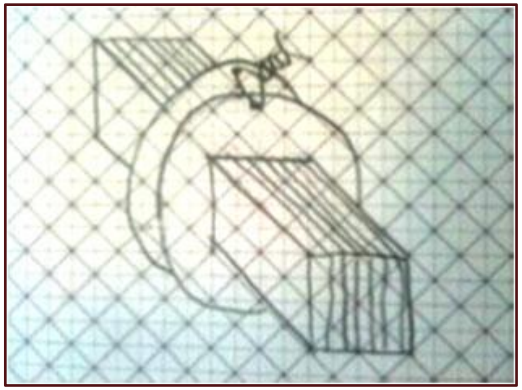
- Due to problems with other methods, induction heat was chosen as the only other viable alternative.
- Uses a rapidly fluctuating magnetic field to heat magnetic metals.

Advantages :

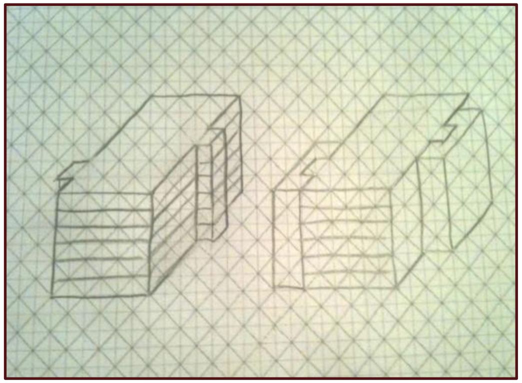
- Speed: Heats part to brazing temperature in under 1 minute



Idea Generation & Concept Selection: Alignment Approaches



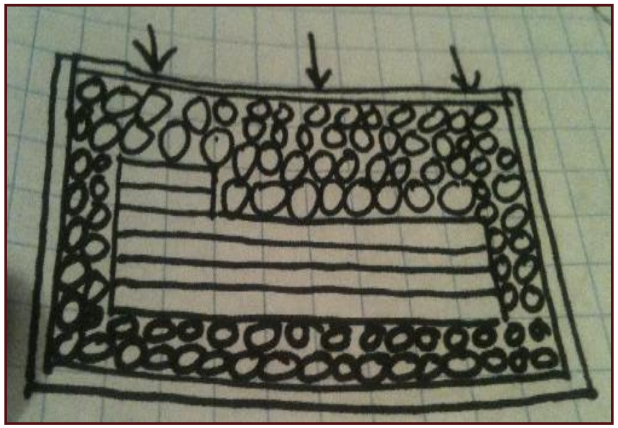
Cinch Disks
- Form fitting discs slip over part to align
- Low rating due to incompatibility with induction heating system



Tabbed Alignment
- Uses External features to align.
- High Rating due to simplicity & compatibility with induction

Tabbed Alignment working example

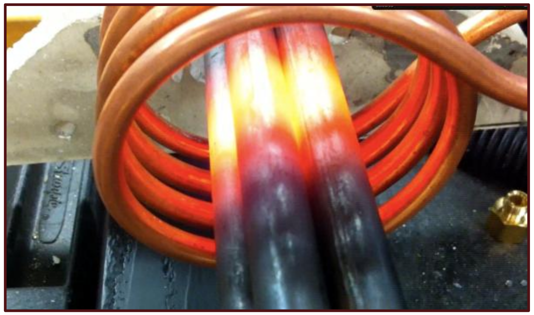
Idea Generation & Concept Selection: Compression Approaches



Bead Box
- Bead media packed around part transfers compressive force onto part
- High rating due to high resolution compression of any geometry & compatible with induction

Straps
- Layers are wrapped tightly with heat proof straps
- Low rating due to lack of materials compatible with induction

Preliminary Experiments: What materials can be heated?
(8cm Diameter Coil)



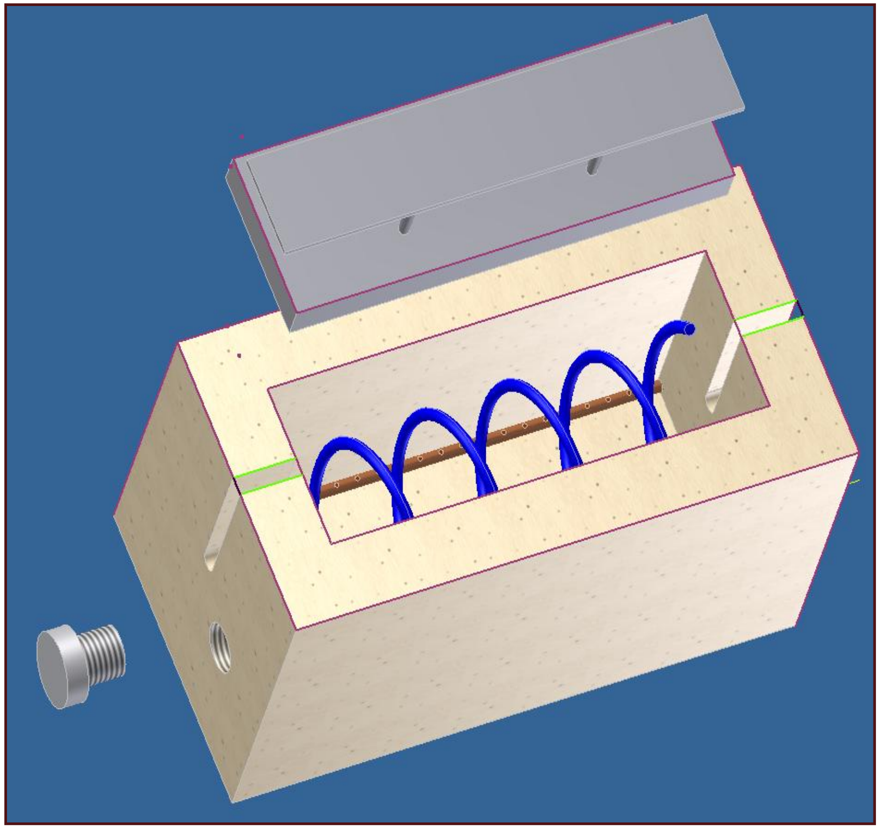
0.5” Steel Bar:
- 1500°F within 30 seconds

0.5” Aluminum Bar:
- 200°F within 60 seconds

Galvanized Steel Strips:
- 1700F Within 10 Seconds

Conclusion: Mild Steel and Galvanized Steel heats very well. Focused on steel sheet stock for future experiments.

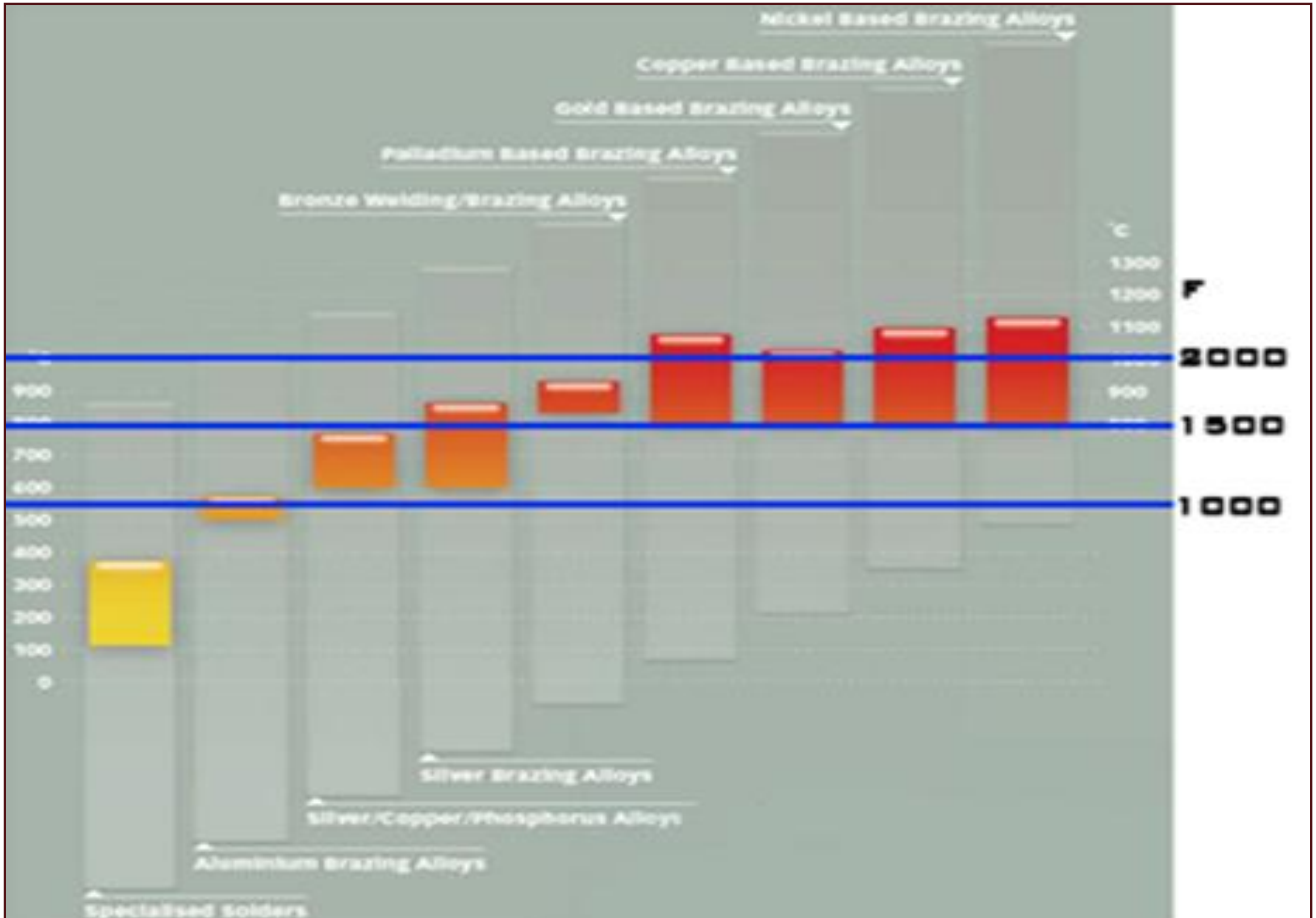
Bead Box Compression System: Design & Construction



Requirements:

- Withstand outward pressure of bead compaction
- Beads must be heat resistant and strong enough to transfer compressive force to workpiece
- Air quenching system needed to help speed up cooling

Brazing Temperatures



Brazing Material Experiments

Purpose: Determine best filler metal for optimal bonding.

Filler metals were chosen based on melting point temperatures achieved during coil experiments. (1500-1600F).

Findings:

- Temp too low for copper alloy to melt
- Temp perfect for silver alloy brazing. Tests show excellent bonding and wetting.
- Aluminum too brittle, weak bond with steel.

Conclusions: Silver alloys are best for low temp brazing of steel.

Short Coil Experiment with Traversing System

Purpose:

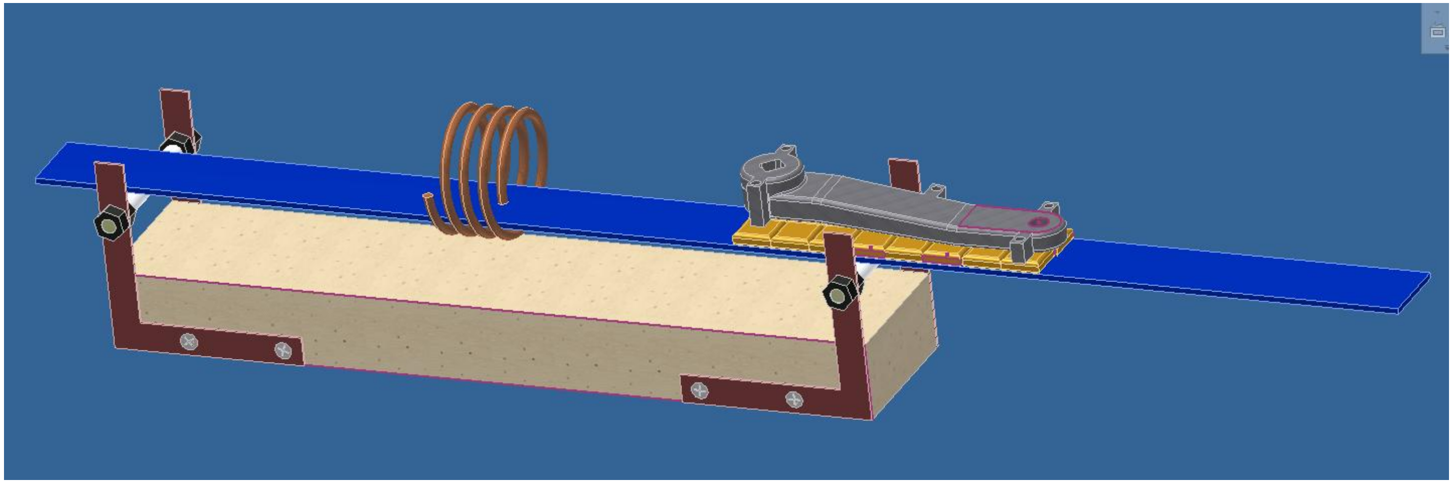
Design a system utilizing a moving platform to heat a long workpeice by moving it through a short coil.

Criteria:

Platform must be benign to magnetic field and resist heat up to 2000F

Solution:

Use wood and ceramic tile for platform, and a rolling track



Short Coil Experiment with Traversing System

Operational test:

Braze Bike Crank Using Traversing system

Findings:

Bike crank was brazed, but the bolts melted and the layers misaligned.

Conclusions:

Galvanized bolts are melting, need to find alternative material for bolts.

Heating Experiment:
Stainless Steel Bolt vs Galvanized

Findings:

- Stainless steel bolt remained relatively cool compared to the galvanized steel bolt.

Conclusions:

- Use stainless steel bolts

Overall Conclusions of Experiments

- Bead box compression is obsolete compared to tabbed alignment & compression.
- The parts created are hypothetically stronger than any produced before by an FDFF process.
- Further research into finding the right bolts to use for tab compression will surely yield a complete and viable technology.

Optimal Parameters For Success	
Sheet Stock	Galvanized steel or medium carbon steel
Filler Material	Silver Alloy Braze 560
Flux	Sure Flo flux
Software	Inventor and Adaptive Slicing Script
Alignment	Tabs
Compression	Tabs with Stainless Bolts
Heating Method	Induction
Induction Setting	700 Amps (Max)
Coil Type	Water cooled 4 turn 4cm diameter

Dynamic Torque Measurement System Design and Development

Sara Camacho
Emerson Dawson
Chris Gonzalez
Sergio Rios

Introduction

- Rodrill is currently using a static torque meter, meaning it only measures max torque at O RPM.
- They want to design a dynamic torque meter that will produce a torque curve at a range of speeds.

Critical Customer Needs

- Measures Dynamic Torque
- Measures Up to 300,000 Ft. Lb.
- Exercise equipment for long period of time
- Data intake while drill is spinning
- Graph-able readouts

Theory:
Dynamic VS Static Torque

Torque = **Force** X Distance

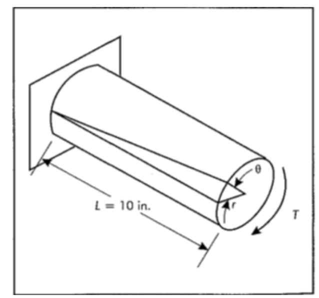
- The Type of Force changes
  - Dynamic **force** involves acceleration, where a static **force** does not have angular acceleration

- Dynamic **Torque** involves uniform rotational motion overcoming turning resistance

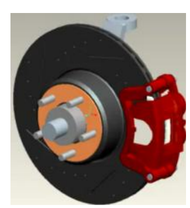
- Static **Torque** does not involve any rotational or circular movement

Four Testing Methods

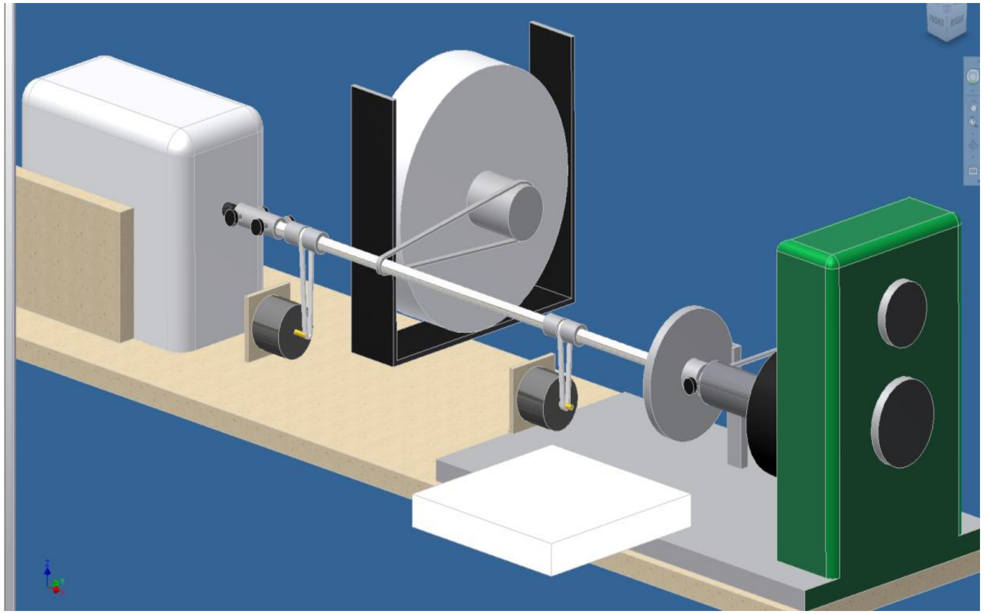
- Water Brake
  - Horsepower = (Force(lb)*RPM)/10,000
- Angle of Twist $\theta = \frac{Tl}{JG}$



- Frictional Loading
  - Torque = Force * Distance
- Generating Power

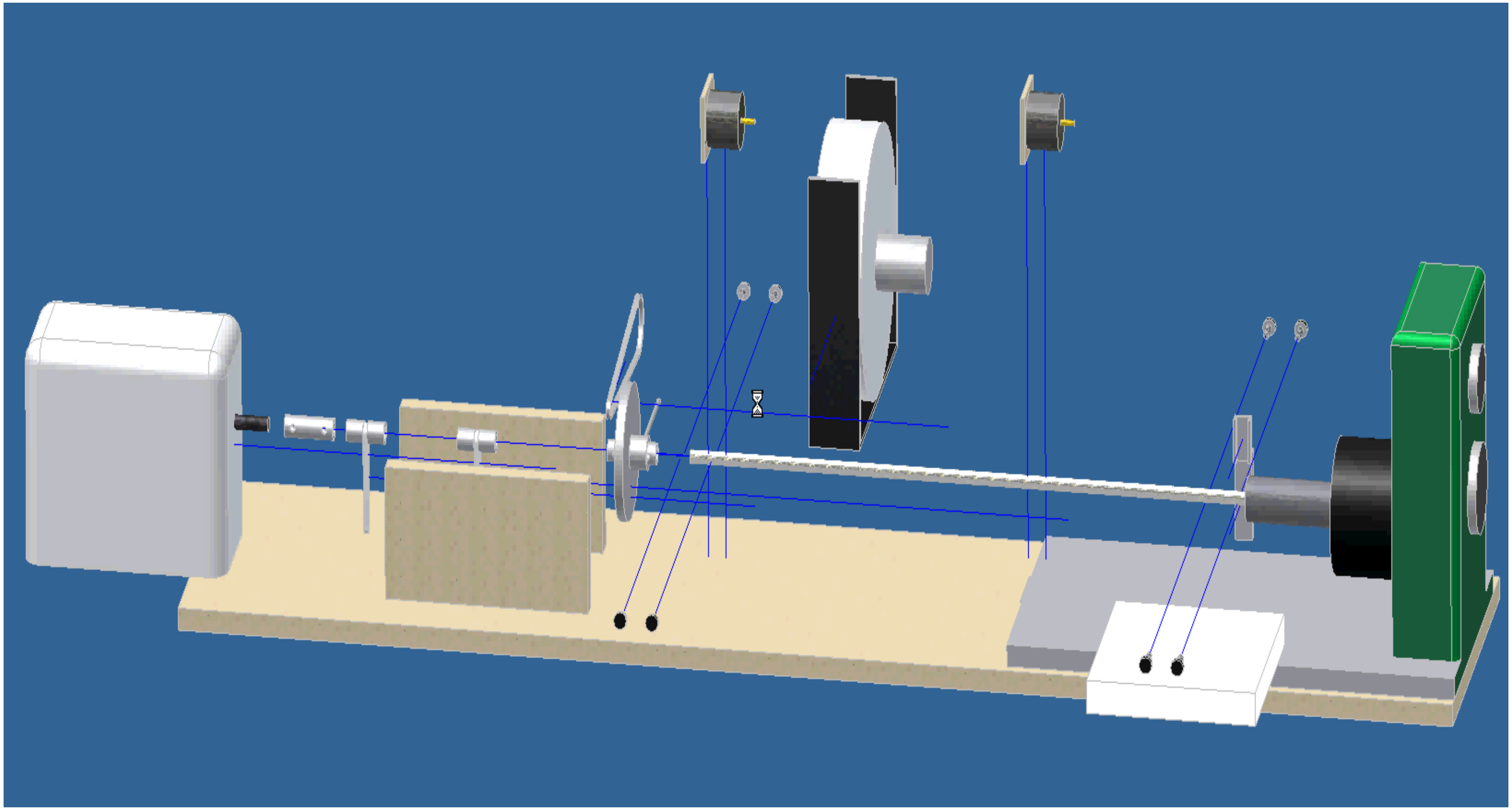


Testing System Design

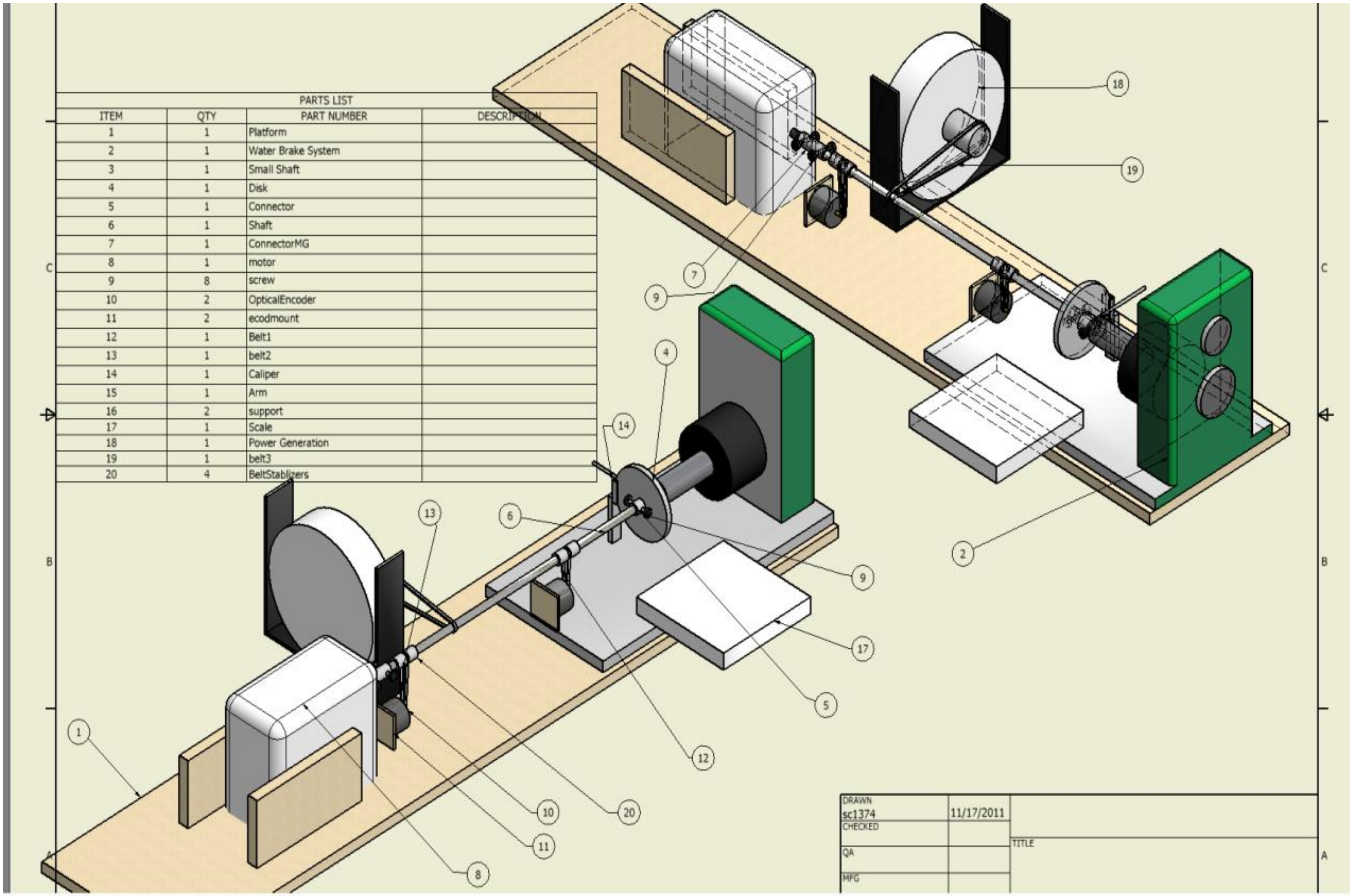


- This is one system that can test 4 methods of measuring torque
- This can also test for possible power generation

Assembly of Testing System

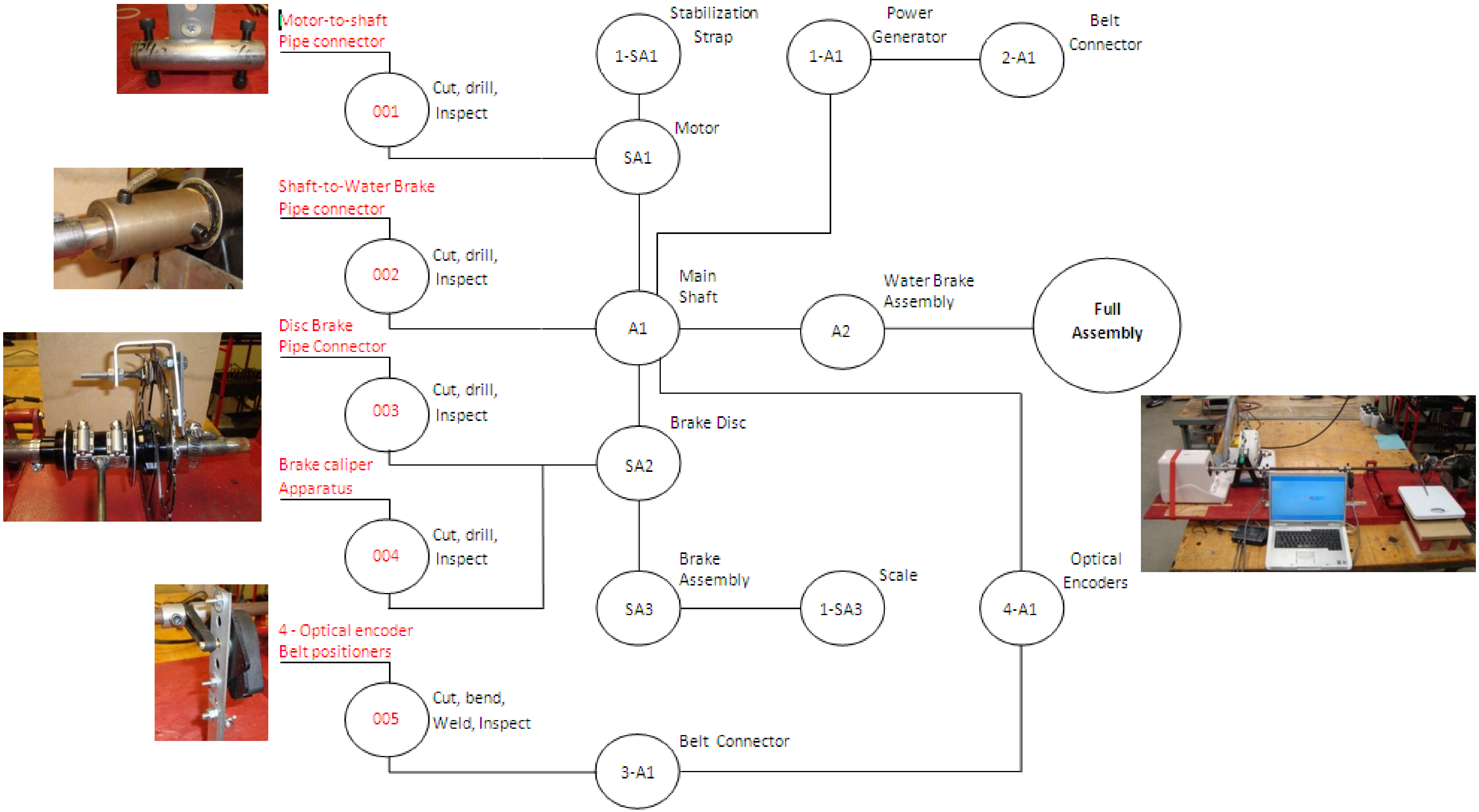


Complete Bill Of Materials



PARTS LIST			
ITEM	QTY	PART NUMBER	DESCRIPTION
1	1	Platform	
2	1	Water Brake System	
3	1	Small Shaft	
4	1	Disk	
5	1	Connector	
6	1	Shaft	
7	1	ConnectorMG	
8	1	motor	
9	8	screw	
10	2	OpticalEncoder	
11	2	ecodmount	
12	1	Belt1	
13	1	belt2	
14	1	Caliper	
15	1	Arm	
16	2	support	
17	1	Scale	
18	1	Power Generation	
19	1	belt3	
20	4	BeltStablizers	

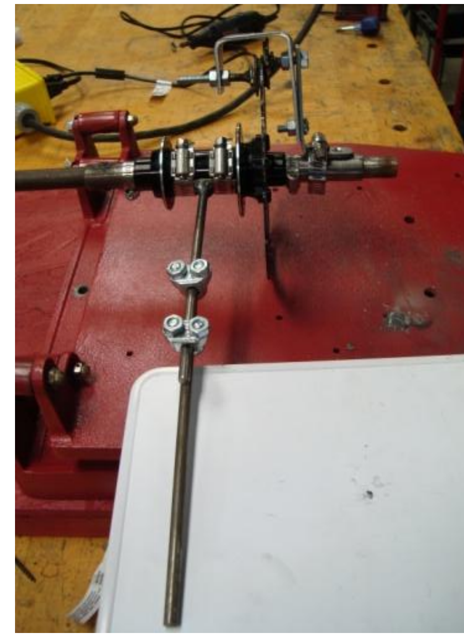
Operations Chart



Manufactured Parts

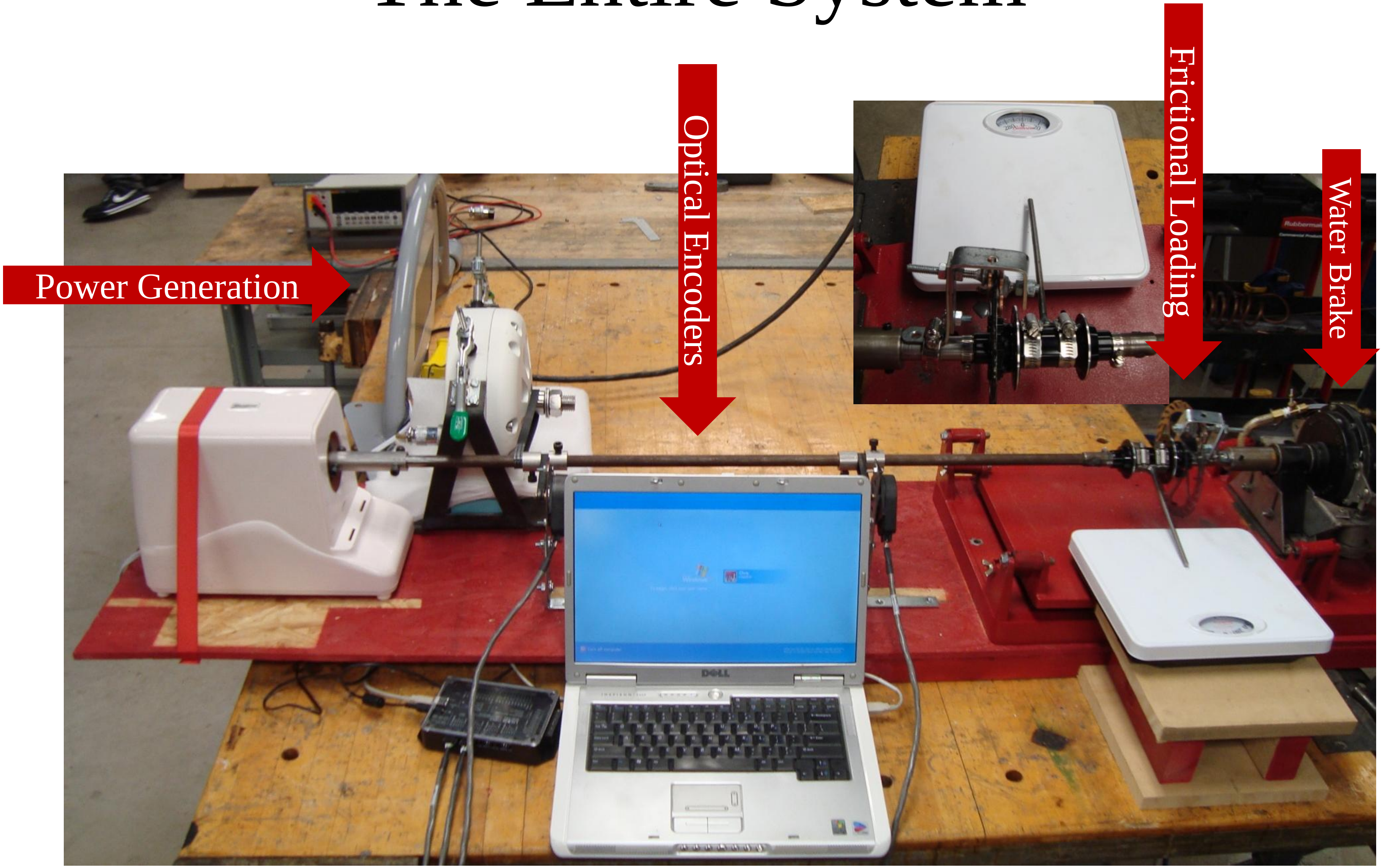
Connecting Pipes

Mounting Encoders



Low Profile Caliper
&
Extendable Arm

The Entire System



Networking

Sponsors and
Panel of experts

And the best 2011 team is….Toyota