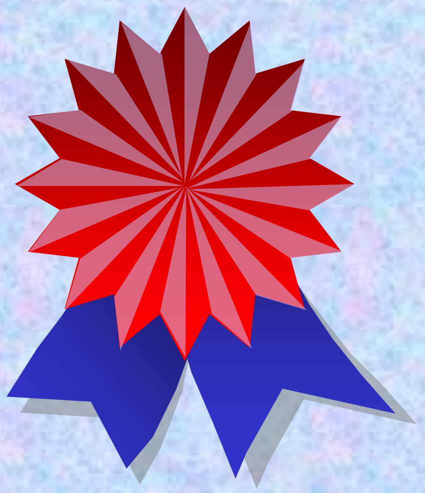
Texas State University- San Marcos
Ingram School of Engineering

2010 Best Product Development Contest Award



2010 Best Team: Treadmill for Wheelchair

Jonathan A. Lightfield
Jephte Medois
Justin L. Henry
Aaron M. Sosa

Product Design and Development

Identifying Customer Needs

- Make lift system universal for all wheelchairs
- Make lift system applicable for all users
- Easy to assemble
- Affordable
- Safe
- Easy to package and ship
- Lightweight
- Minimal number of parts

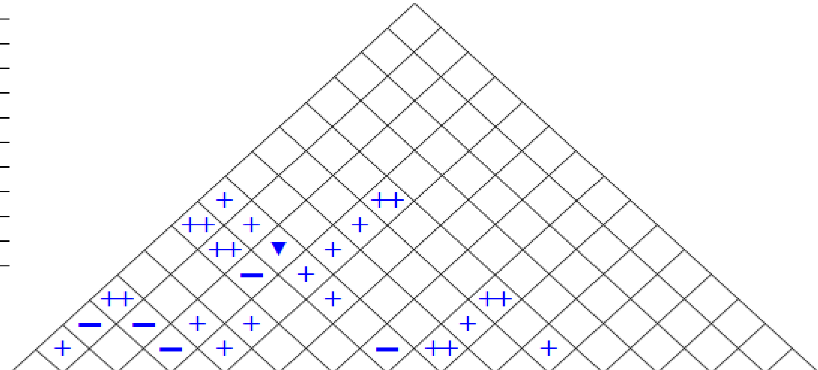
House Of Quality

Title: ______________________

Author: ______________________

Date: ______________________

Notes: ______________________



Legend		
Θ	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	

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")	1 Frame Size (Width, Heighth etc..)	2 Lift Capacity	3 Number of Parts	4 Cost	5 Collapsible	6 Recyclable	7 Weight (Pounds)	8 Appearance	9 Color	10 Round Edge	11 Surface Quality	12	13	14	15	Our Company	Competitor 1	Competitor 2	Competitor 3	Competitor 4	Competitor 5
				Direction of Improvement: Minimize (▼), Maximize (▲), or Target (x)																					
1	9	12.2	10.0	universal lift system (All Wheelchairs)	Θ	Θ	O	▲	▲																
2	9	12.2	10.0	Universal lift system (Body Weight, Size, Age)	O	Θ	O	▲	▲																
3	9	11.0	9.0	Easy to Assemble			Θ	▲	▲																
4	9	11.0	9.0	Affordable	▲	▲	O	Θ																	
5	9	9.8	8.0	Easy to package an ship	O		O	▲	Θ		O														
6	9	8.5	7.0	Environmentally friendly						Θ		▲	▲												
7	3	7.3	6.0	Locally Manufactured				O																	
8	9	7.3	6.0	Light Weight	O	▲	O			▲	Θ														
9	9	8.5	7.0	Manufacturing cost (<$500)		O	▲	Θ				▲	▲	▲	▲										
10	9	12.2	10.0	Safety		▲			O					Θ	Θ										
				Target or Limit Value																					
				Difficulty (0=Easy to Accomplish, 10=Extremely	6	2	7	8	10	2	6	3	0	5	7										
				Max Relationship Value in Column	9	9	9	9	9	9	9	1	1	9	9										
				Weight / Importance	208.5	275.6	264.6	242.7	159.8	84.1	95.1	17.1	17.1	118.3	118.3										
				Relative Weight	13.0	17.2	16.5	15.2	10.0	5.3	5.9	1.1	1.1	7.4	7.4										

Competitive Analysis
(0=Worst, 5=Best)

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

0 1 2 3 4 5

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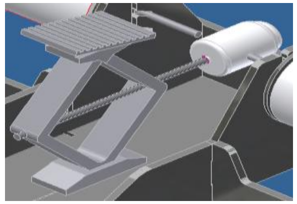
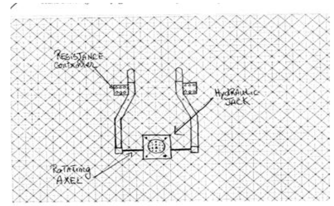
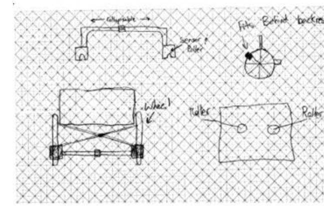
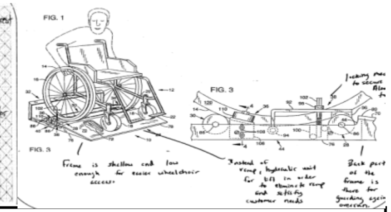
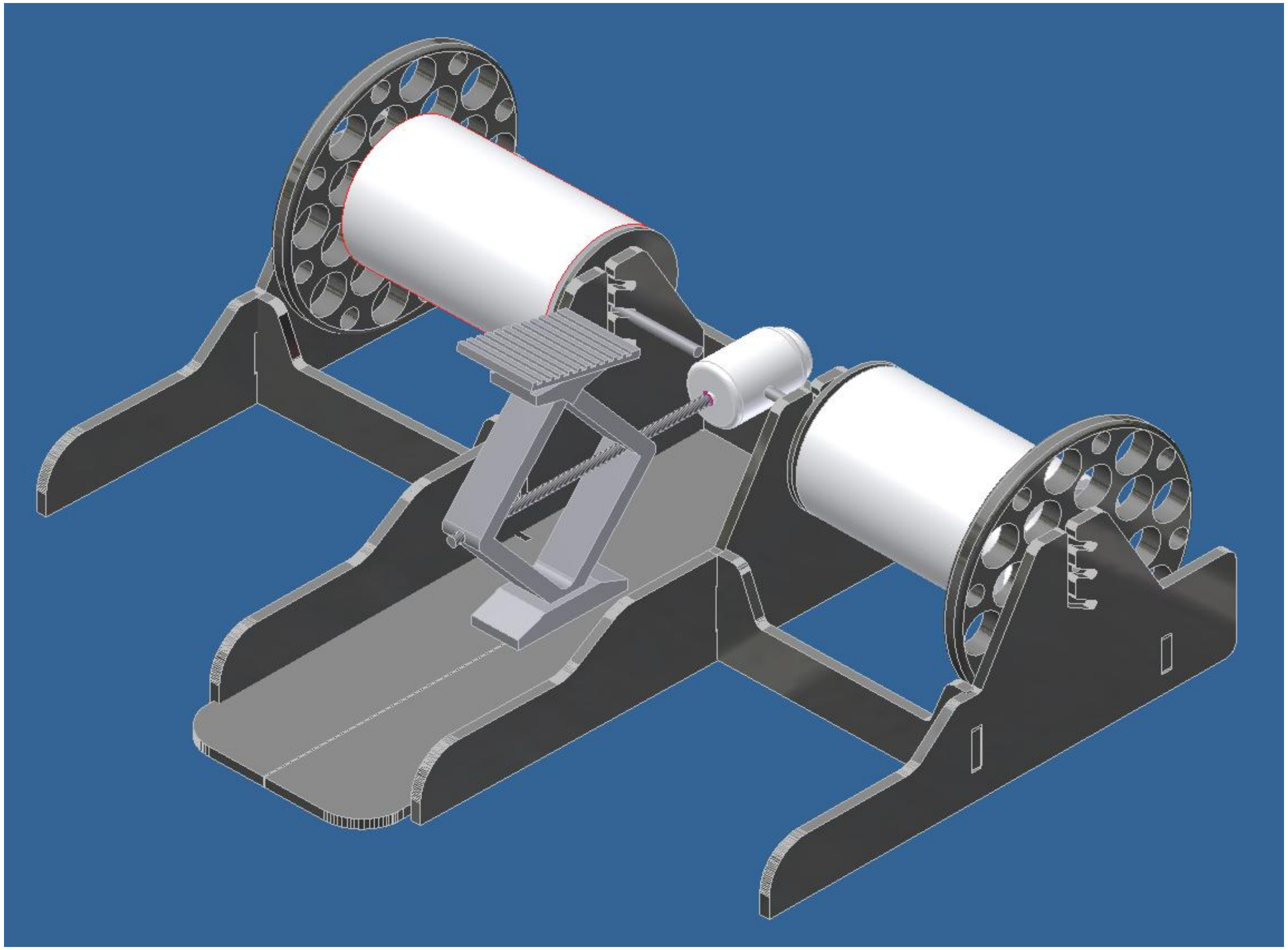





		Concepts (Design Generation)							
		Electric Jack system		Hydraulic Jack System + Handle		Collapsible system		Wheelchair Ramp System	
Selection Criteria	Weight	Rating	Weighted Score	Rating	Weighted Score	Rating	Weighted Score	Rating	Weighted Score
Universal Lift (All Wheelchairs)	25%	4	1	3	.75	2	.5	2	.5
Universal Lift System (body, weight, size, age)	20%	4	.8	2	.4	1	.2	1	.2
Easy to Assemble	12%	4	.48	3	.36	3	.36	3	.36
Affordable	15%	3	.45	2	.3	3	.45	3	.45
Easy to Package/Ship	9%	3	.27	3	.27	4	.36	2	.18
Environmentally friendly	5%	2	.1	2	.1	2	.1	2	.1
Locally Manufactured	3%	3	.09	3	.09	3	.09	3	.09
Light Weight	2%	4	.08	4	.08	4	.08	2	.08
Manufacturing Cost	4%	3	.12	2	.08	2	.08	1	.04
Safety	5%	3	.15	3	.15	2	.1	2	.1
Total Score		3.54		2.58		2.32		2.10	
Rank		1		2		3		4	
Continue?		Yes		Maybe		No		No	

Final Design (Clinical Version)



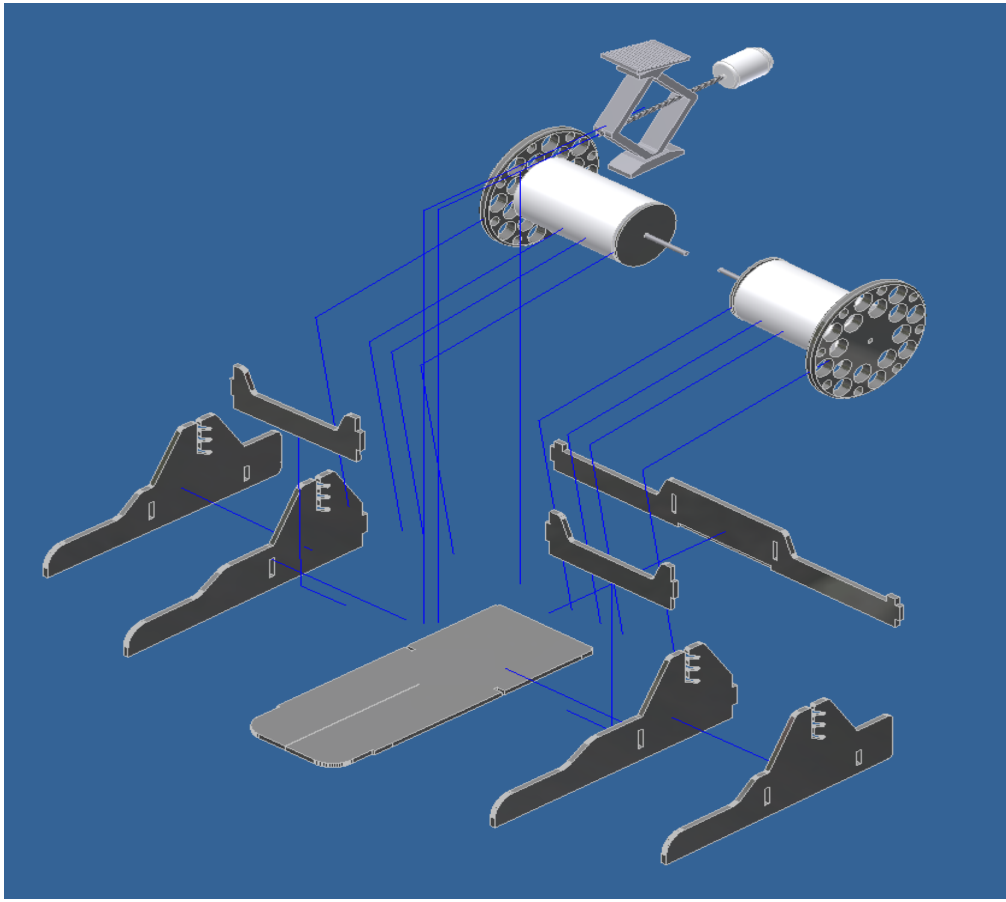
Design for manufacturing

- ❖ 2D AutoCAD for waterjet
- ❖Lightweight
- ❖Non-corrosive
- ❖Universal parts
- ❖Low manufacturing cost
- ❖Standard features (grooves, slots, holes, etc.)

Design for Assembly

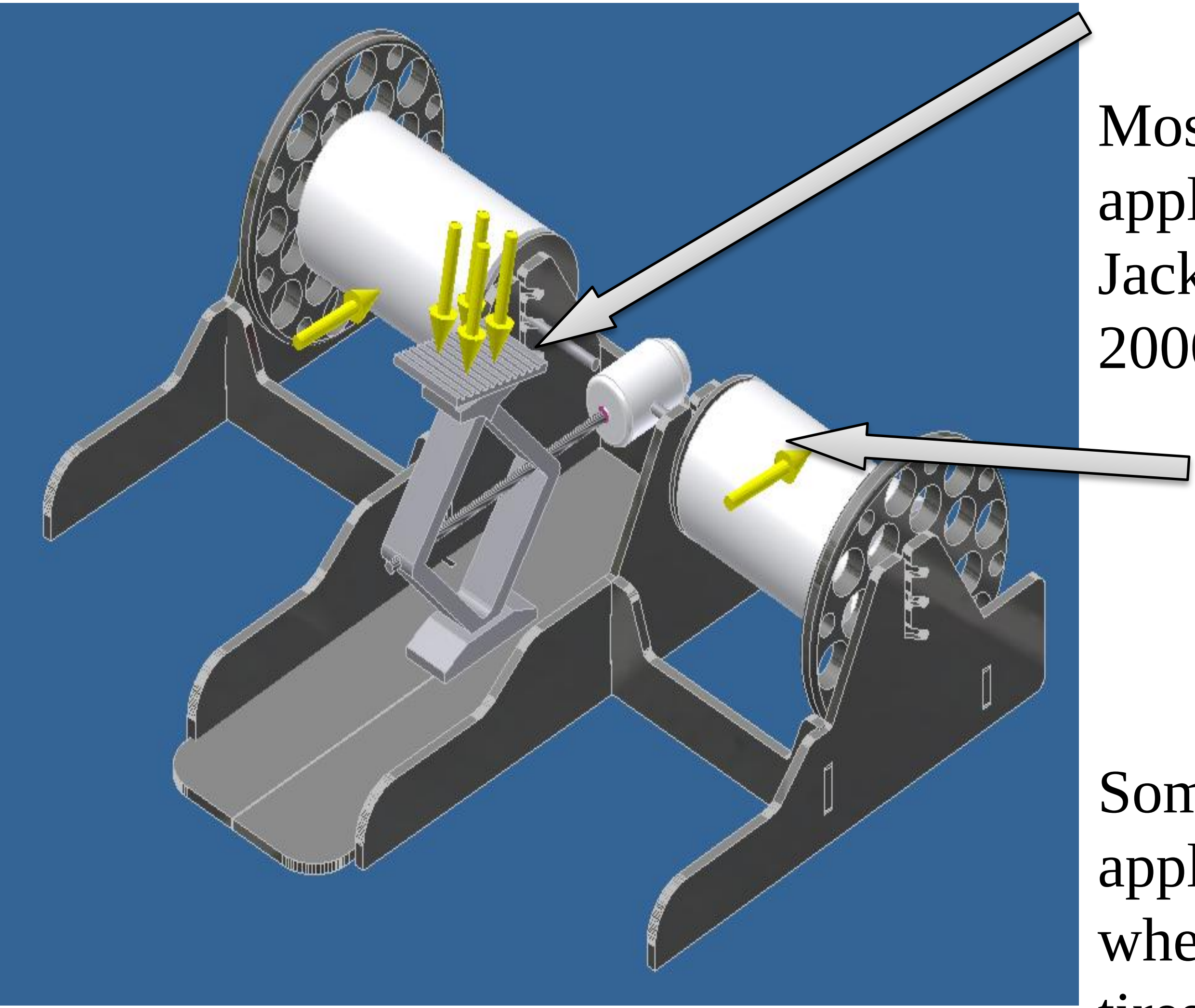
- ❖Standard features (grooves, slots, holes, etc.)
- ❖Grooved parts
- ❖Squared edges

Bill of Material



Back Frame2	Normal	Each	1
Bottom Frame	Normal	Each	1
Side Frame	Normal	Each	2
Part10	Normal	Each	2
Front Frame	Normal	Each	2
wheel	Normal	Each	2
roller	Normal	Each	2
cap	Normal	Each	2
Bar	Normal	Each	2
jackassembly	Normal	Each	1

Finite Element Analysis (FEA)



Maximum Load

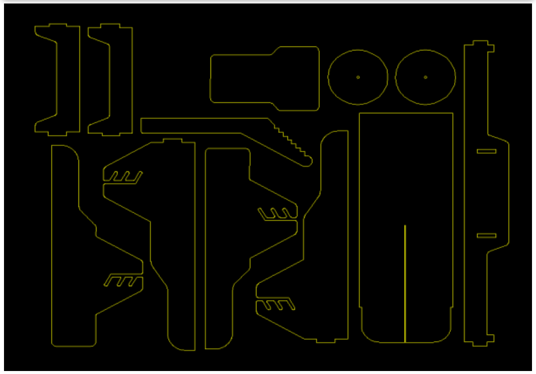
Most of the weight will applied onto the Electric Jack plate which has a 2000 pounds capacity.

Minimum Load

Some weight will be applied to the rollers where the wheelchairs tires will rest

Manufacturing Process

Auto-CAD DRAWING



CODE (IGEMS)

Water cutter machine

Assembly

Final Assembly of Prototype

Prototype Components

Final Assembly

Financial Statements

Start up requirement

Start-up	
Requirements	
Start-up Expenses	
Legal	$5,000
Marketing	$2,000
Insurance	$6,000
Mortgage	$1,000
Patents	$3,500
Materials	$4,000
Total Start-up Expenses	$21,500
Start-up Assets	
Cash Required	$10,000
Other Current Assets	$2,000
Long-term Assets	$10,000
Total Assets	$22,000
Total Requirements	$43,500

Sales Projections

Market Analysis							
		2011	2012	2013	2014	2015	
Potential Customers	Growth						CAGR
Gyms (24 Hrs Fitness, Gold Gym)	25%	15	30	150	400	2,500	278.21%
Rehab Center	30%	15	30	50	75	2,000	266.07%
Individual	35%	15	30	80	150	3,500	297.57%
Schools(College, High Schools Gym)	15%	10	20	150	400	2,500	301.71%
Total	285.86%	55	110	430	1,025	10,500	285.86%

(2015 sales are based on the assumptions that insurance companies would cover major portion of the cost of the machine under their policy.)


STATE

Interview with David Scott KXAN Austin news anchor

Calendaring Roll Mill

Charles Jacobs,

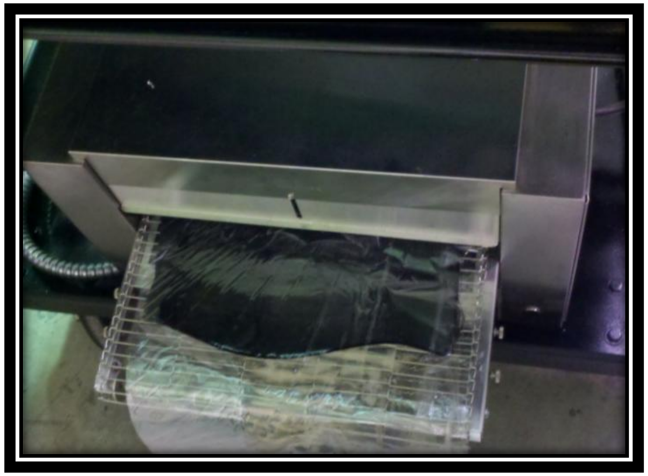
Alex Herrera,

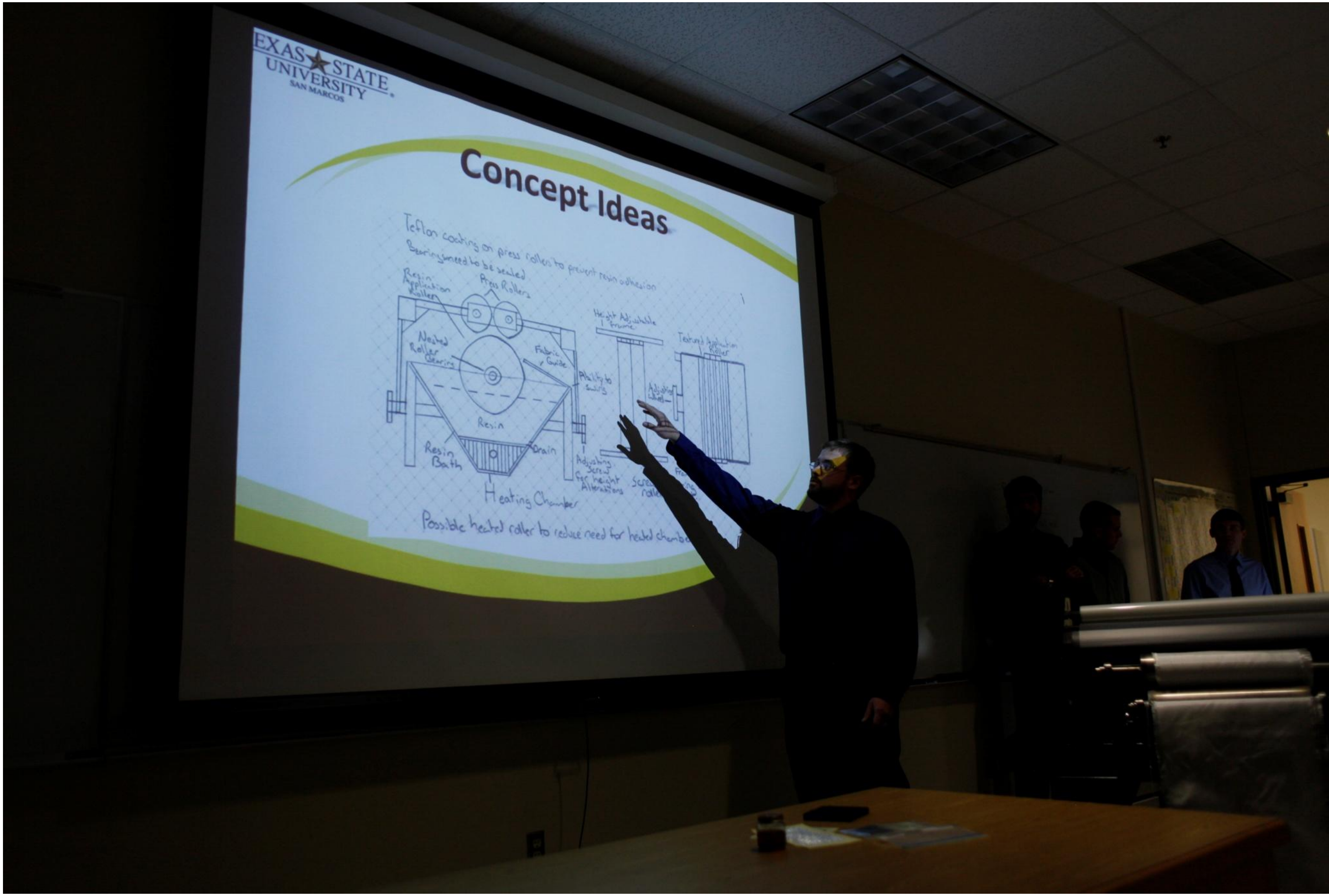
Aaron Hollingshead,

Ben Olson

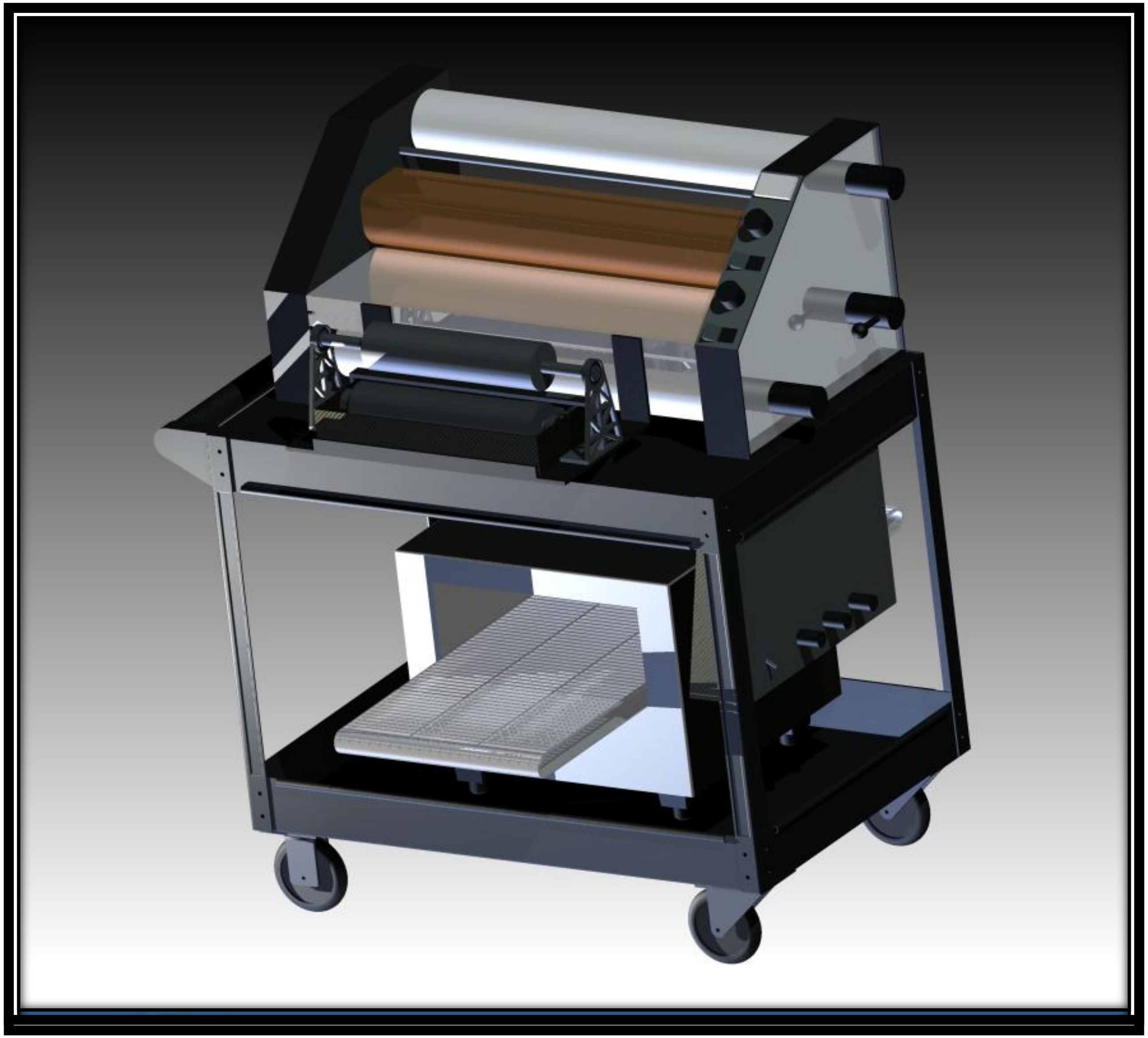
What Are Prepregs?

- Reinforcement and Matrix
  - Reinforcement generally carbon fiber or fiberglass
  - Matrix generally thermoset
- Partially Cured (B-stage)
  - Stored in freezer
  - Conforms to various shapes
- Widely used in aerospace industry

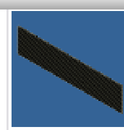
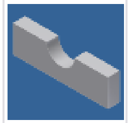
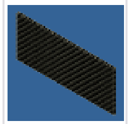
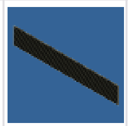
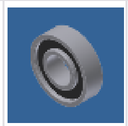
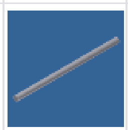
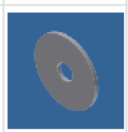
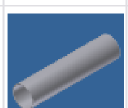



Concept Ideas
Teflon coating on press rollers to prevent resin adhesion
Bearings need to be sealed
Resin Application Roller
Press Rollers
Heated Roller
Bearing
Fabric Guide
Ability to swing
Resin
Resin Bath
Drain
Heating Chamber
Height Adjustable Frame
Textured Application Roller
Adjusting Screw for height Alterations
Possible heated roller to reduce need for heated

Design



Bill of Materials

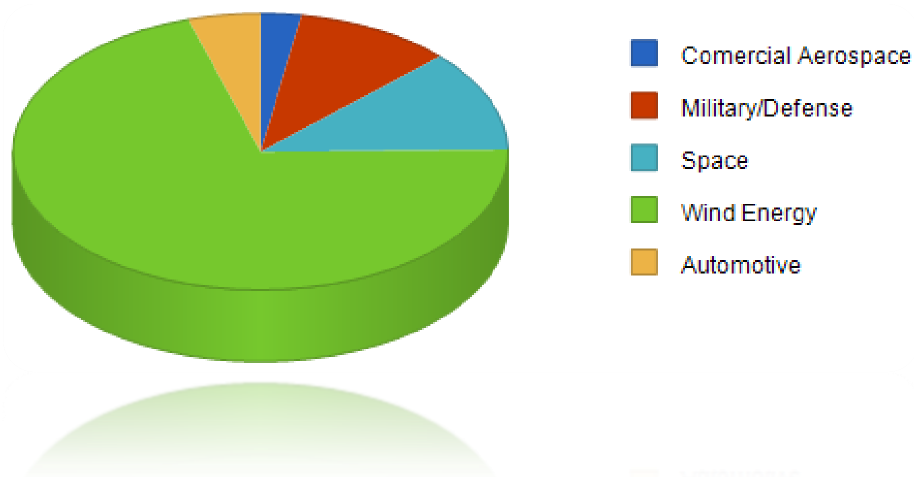
sloped bottom		Normal	Each	2	Carbon Fiber Panel	1
bearing inserts		Normal	Each	2	Carbon Fiber Panel	0
outerwall		Normal	Each	2	Carbon Fiber Panel	1
outerwall2		Normal	Each	2	Carbon Fiber Panel	1
bearing		Normal	Each	2	Stainless Steel Bearing	0
lower roller		Inseparable	Each	1	Stainless Steel Roller	1
middle rod		Normal	Each	1	.75" Stainless Steel Rod	0
weld plate		Normal	Each	2	.15" Stainless Steel End Cap	0
outer roller pipe		Normal	Each	1	3" Stainless Steel Pipe	0

Manufacture

Final Product

PRODUCT MARKET SEGMENT

- Prepreg fabric
- Laboratory size Calendaring Roll



- Aerospace
- Military/Defense
- Automotive
- Wind Turbines
- Sporting Goods

Business Plan

Pro Forma Profit and Loss			
	Year 1	Year 2	Year 3
Sales	$1,979,500	$4,272,500	$7,046,125
Direct Cost of Sales	$1,185,250	$3,020,525	$5,097,679
Other Costs of Goods	$0	$0	$0
Total Cost of Sales	$1,185,250	$3,020,525	$5,097,679
Gross Margin	$794,250	$1,251,975	$1,948,446
Gross Margin %	40.12%	29.30%	27.65%
Expenses			
Payroll	$159,230	$191,000	$237,000
Sales and Marketing and Other Expenses	$216,000	$200,000	$250,000
Depreciation	$0	$0	$0
Advertising & Marketing Collateral	$295,000	$350,000	$425,000
Industrial Design	$64,284	$75,000	$80,000
Rent	$22,800	$26,000	$30,000
Telephone	$7,500	$10,000	$15,000
Utilities	$14,400	$18,000	$20,000
Insurance	$6,000	$7,500	$7,500
Payroll Taxes	$50,200	$85,500	$113,250
Company Vehicles and related expenses	$16,800	$18,000	$19,000
Trade Shows & Events	$30,000	$0	$0
Total Operating Expenses	$882,214	$981,000	$1,196,750
Profit Before Interest and Taxes	($87,964)	$270,975	$751,696
EBITDA	($87,964)	$270,975	$751,696
Interest Expense	$40,200	$40,200	$40,200
Taxes Incurred	$0	$69,233	$213,449
Net Profit	($128,164)	$161,543	$498,047
Net Profit/Sales	-6.47%	3.78%	7.07%

Layer Alignment System for a FDFF Process

Matthew Loerwald

Wes Luckenbach

Emery Calame

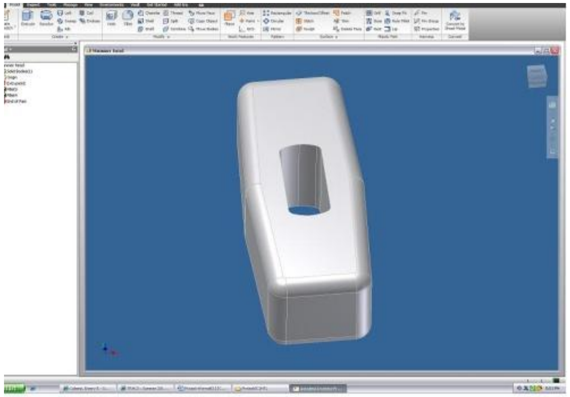
Matthew Creamer

Fully Dense Freeform Fabrication

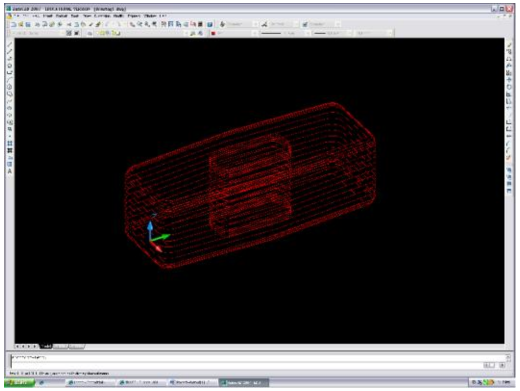
- Fully Dense Freeform Fabrication (FDFF) is a rapid prototyping process involving metal layers joined by a soldering agent.
- Basic Process for FDFF:
  a) Design a Geometry (Part) in a CAD (Computer Assisted Design) program.
  b) Use CAD program to slice the geometry into separate (virtual) layers. (with desired thicknesses)
  c) Take slice data from computer and cut the individual slices from sheet metal. (Water jet, laser cutter,…etc.)
  d) Apply soldering agent (tin, bismuth, zinc) to layers.
  e) Recombine (stack) layers to form the Original geometry from the CAD program.
  f) Apply the needed pressure and heat for soldering, then let cool.
  g) Final product.

Process

1. Design in CAD software.



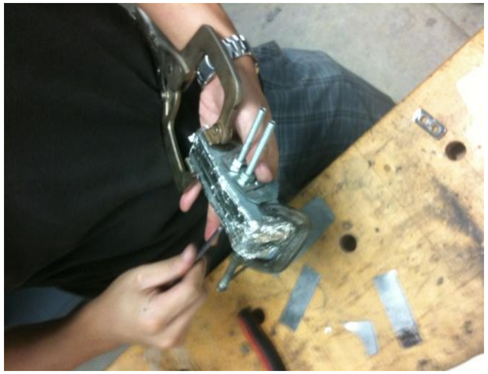
2. Decompose to STL "slices".



3. Cut Slices out of material.

4. Prepare Surfaces

5. Assemble



6. Fuse Layers

Quality Function Deployment

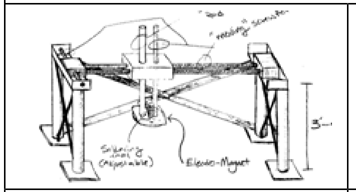
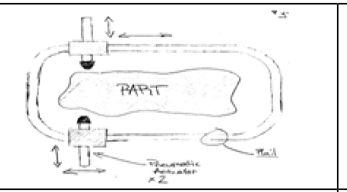
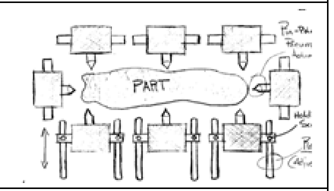
Customer Desires

- Parts are stacked accurately
- Use a common power source
- Build multiple geometries
- Z-table must support parts
- Align parts of different thicknesses
- Quickly ready to accept next layer
- Means of temporary attachment of layers
- Safe to operate
- Needs to be compatible with Group 4

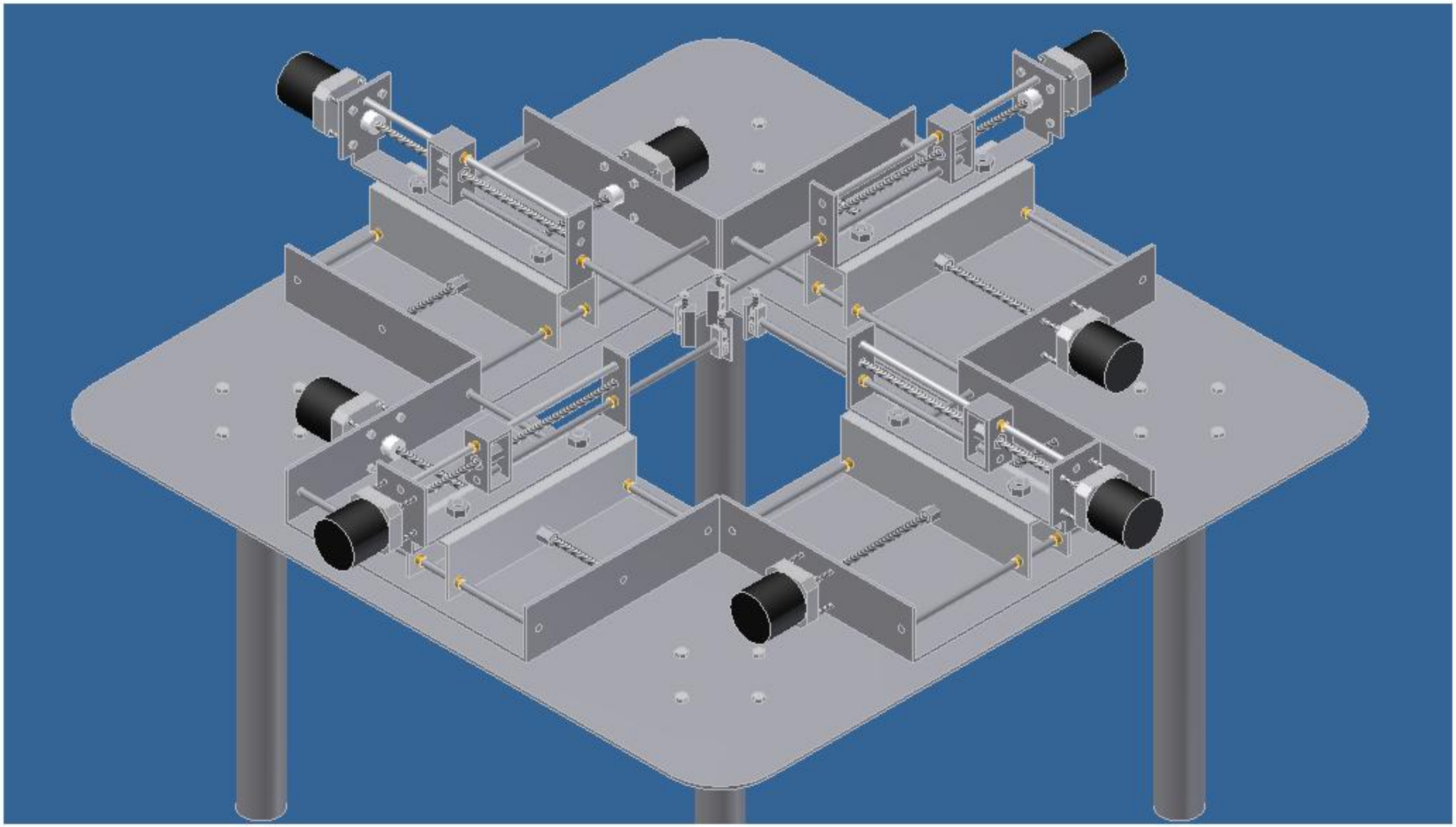
Function Requirements

- Tolerances
- Voltage
- Number of Geometries
- Weight
- Number of sizes
- Time
- Strength
- Number of hazards

Concept Selection

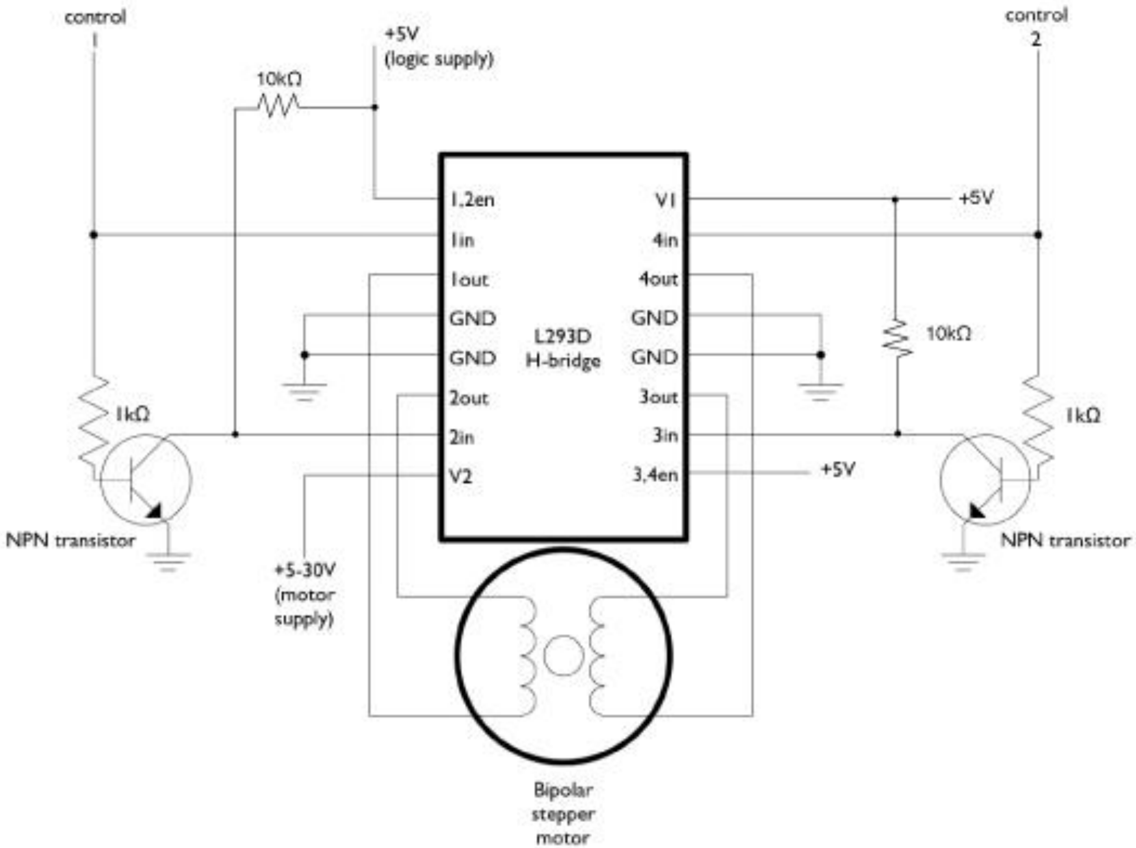
Team Eagle Concept Selection October 7, 2010		Concepts					
						 	
		Concept 1		Concept 2		Concept 3	
Selection Criteria	Weight	Rating	Weighted Score	Rating	Weighted Score	Rating	Weighted Score
Ease of Use	15%	4	0.6	3	0.45	3	0.45
Accuracy	25%	3	0.75	2	0.5	4	1
Durability	20%	2	0.4	3	0.6	3	0.6
Cost to Build	15%	1	0.15	4	0.6	3	0.45
Manual labor	5%	5	0.25	2	0.1	2	0.1
System Speed	5%	2	0.1	2	0.1	3	0.15
Programmability	15%	2	0.3	3	0.45	3	0.45
	Total Score	2.55		2.8		3.2	
	Rank	3		2		1	
	Continue?	No		No		Develop	

Design

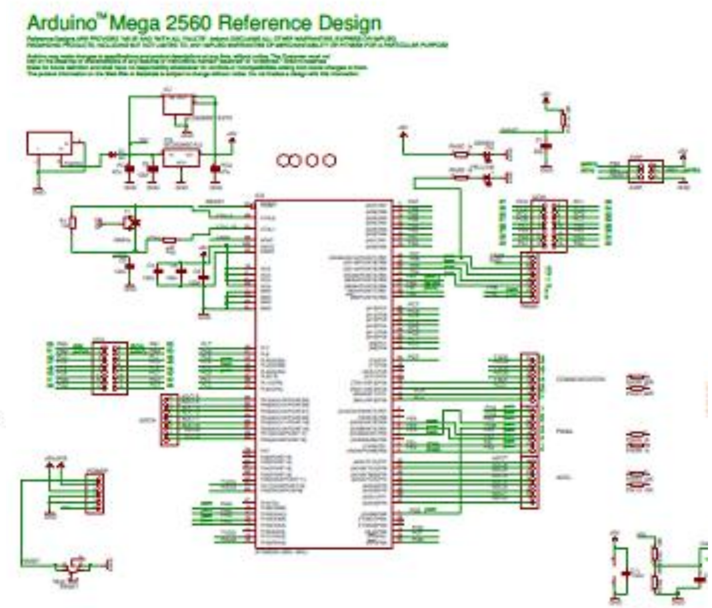


Computer Programming

Stepper Motor



Microcontroller



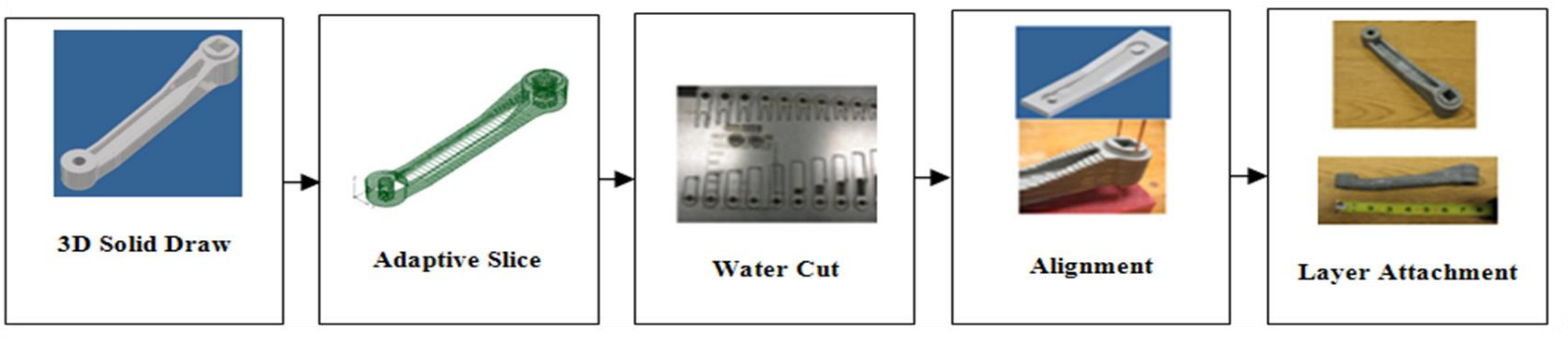
Final Product

Heating And Clamping Design For FDFF Process

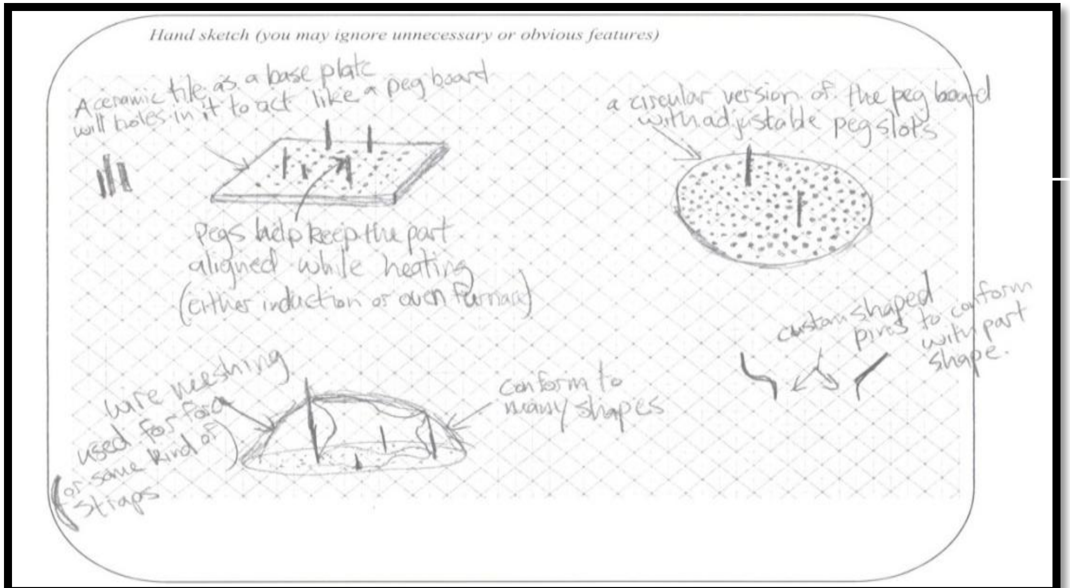
Tony Le,
Andre Hartfield,
Ryan Kemmy,
Thomas Wilson

Problem Statement

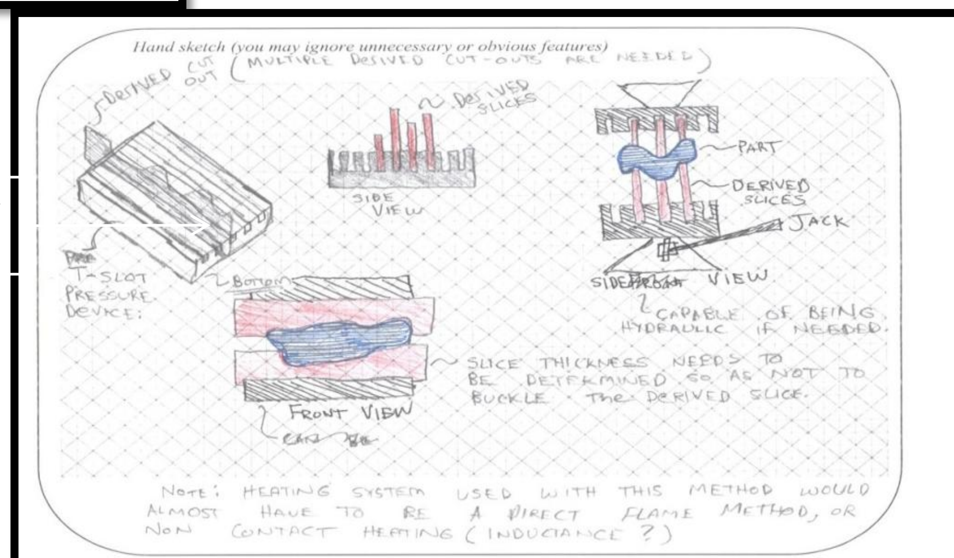
The purpose of this research was to find a universal method for heating, clamping and force application for the Fully Dense Freeform Fabrication (FDFF) process. Our mechanism provides force while supplying enough uniform heat to allow bonding of metal layers with optimal properties.



Concept generation sketches



Conceptual Design using Pins to hold part in place and provide alignment



Concept Design involving Force Application using Derived Slices in T-Slot Holder

FMEA(Failure Mode Effect Analysis)

POTENTIAL FAILURE MODE AND EFFECTS ANALYSIS

◯ Design FMEA ◯ Process FMEA ☐ Inter

◯ System ◉ Subsystem ◯ Component

Page

FMEA Number

Part Number

Design or Process Responsibility

Prepared by Hot Cross Bonds!

Telephone #

Original FMEA Date 10/7/2010

FMEA Revision Date

Core Team Andre Hartfield, Thomas Wilson, Tony Le, Ryan Kemmy

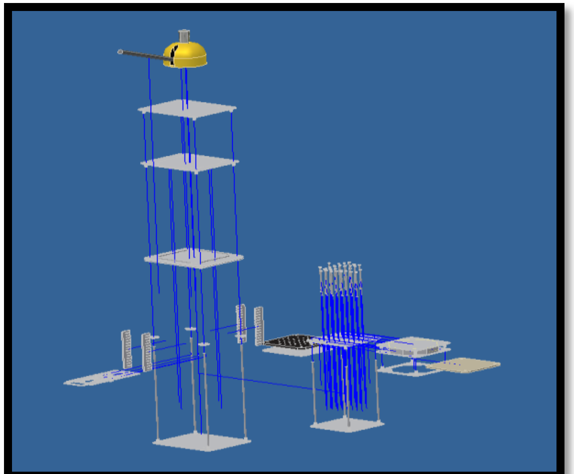
Design Item or Process Function Requirements	Potential Failure Mode	Potential Effect(s) of Failure	Sev	Class	Potential Cause(s) / Mechanism(s) of Failure	Occ	Current Design or ProcessControls	Det	RPN	Recommended Actions	Responsibility & Target Completion Date	Actions Taken
Gas Heating	Loss of Fuel	Failure to reach minimum heating temperature	2		Lack of guages, small tank	6	Interchangeable tanks	1	12			
	Fuel Leak	Safety hazard, Explosions or gas inhalation	7		poor quality hoses - manufacturing defect	2	pressure testers	5	70	Low Pressure Sensor		
	Left unattended	System gets too hot	4		lack of safeguards	4	Process Planning	5	80	Shut off Timer		
	Uneven Heating	Poor bonding in part	8		insufficient design	3	none	7	168	Ensure High Heat is pumped into system		
Derived Clamping	Broken Slice	Poor bonding in part, Safety of flying shrapnel	7		poor material, alignment during setup	1	Re-cut a replacement slice	2	14			
	Mis-aligned slice	Uneven force distribution,Safety of flying shrapnel	7		group 3's fault	3	Rework the clamp system	3	63	Visual Checking of Slice		
Pneumatic Force Applicator	Loss of air	insufficient Force	5		defect in hoses	1	pressure guage	1	5			
	Components breaking	Safety hazard, insufficient Force applied	8		part wear over time and environment conditions	2	purchase quailty components	1	16			

Bill of Material

Frame	Normal	Each	1
Base	Normal	Each	2
BaseSlide	Normal	Each	2
Rod375	Normal	Each	4
Sleeve3-8x1-2x1	Normal	Each	16
Guide	Normal	Each	8
Distributor	Normal	Each	1
Washer	Normal	Each	4
Platform	Normal	Each	1
PlatformSlide	Normal	Each	1
Spacer	Normal	Each	4
PlatformRod	Normal	Each	2

HoldBase	Normal	Each	2
PinAlign	Normal	Each	2
HeatShield	Normal	Each	1
Pin	Normal	Each	37
HoldRod	Normal	Each	4
Sleeve3-8x1-2x1	Normal	Each	16
MoldCover	Normal	Each	1
Diaphram	Normal	Each	1
MoldBox	Normal	Each	1
MoldWallA	Normal	Each	4
MoldWallB	Normal	Each	4
Filler	Normal	Each	1

Frame	Normal	Each	1
Holder	Normal	Each	1
Force	Normal	Each	1
Jack	Normal	Each	1
Press	Normal	Each	1
Handle	Normal	Each	1
HandleBar	Normal	Each	1

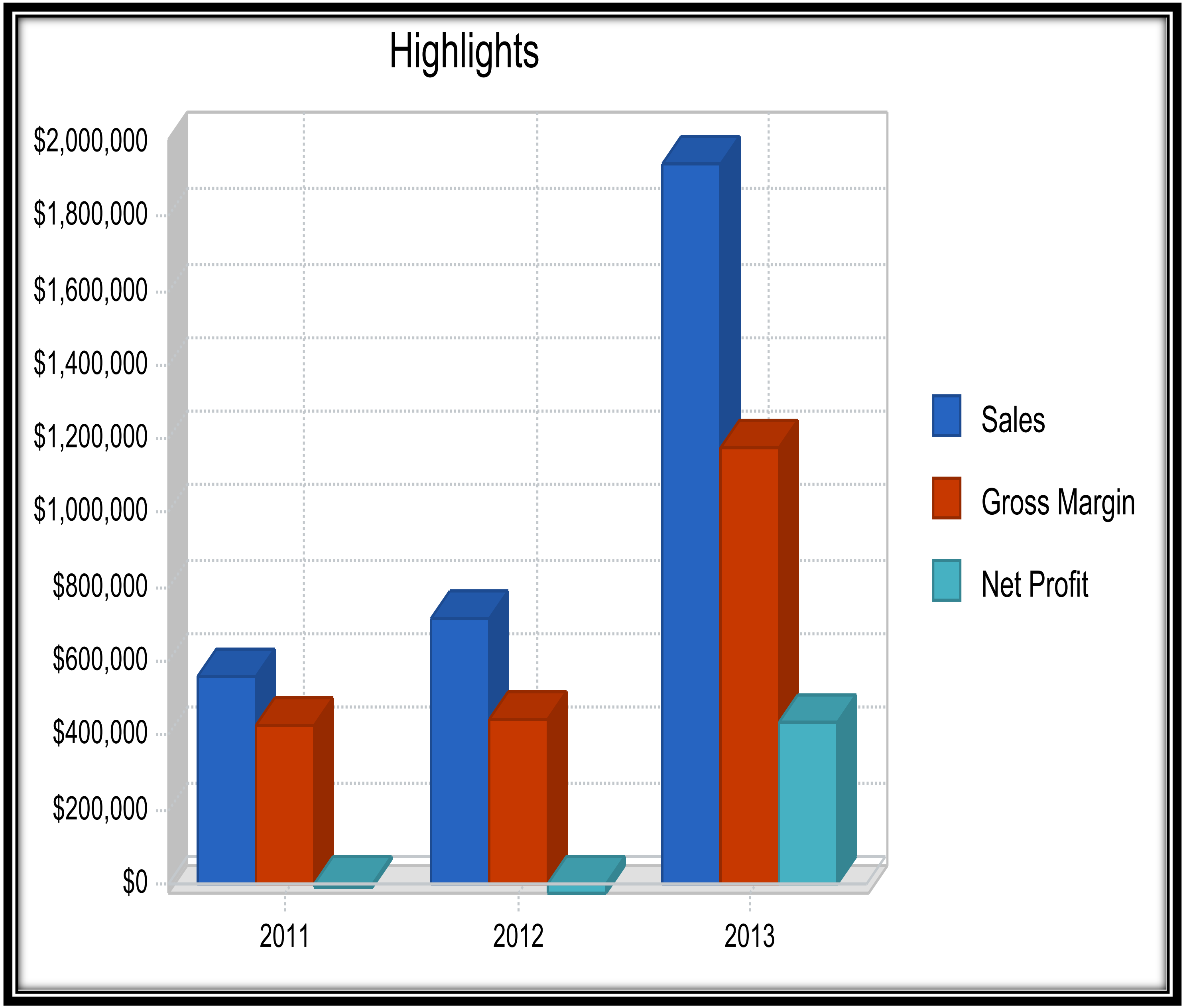


Final Prototype (Press mechanism)

Our Business: HOT! CROSS! BONDS!

Services we provide are listed below and will start off with having 6 people working for the company.

- FDFF machine
- Service
  - Custom design tooling, parts, prototypes with metal
  - Laser Cutting
  - Forming
  - Welding
  - CAD file submission online for users and returning Manufactured Part


Highlights
$2,000,000
$1,800,000
$1,600,000
$1,400,000
$1,200,000
$1,000,000
$800,000
$600,000
$400,000
$200,000
$0
2011
2012
2013
Sales
Gross Margin
Net Profit

Financial statement

- Hot Cross Bonds has a goal of selling 100 units in its first year and increasing in sales by about 10% each year after.
- We will be able to withstand greater growth with the possibility of seasonal part time workers.

Start-up Funding	
Start-up Expenses to Fund	$47,500
Start-up Assets to Fund	$380,000
Total Funding Required	$427,500
Assets	
Non-cash Assets from Start-up	$305,000
Cash Requirements from Start-up	$75,000
Additional Cash Raised	$0
Cash Balance on Starting Date	$75,000
Total Assets	$380,000
Liabilities and Capital	
Liabilities	
Current Borrowing	$75,000
Long-term Liabilities	$200,000
Accounts Payable (Outstanding Bills)	$0
Other Current Liabilities (interest-free)	$15,000
Total Liabilities	$290,000
Capital	
Planned Investment	
Tony	$25,000
Thomas	$25,000
Andre	$25,000
Ryan	$25,000
Cumulative Investors	$37,500
Additional Investment Requirement	$0
Total Planned Investment	$137,500
Loss at Start-up (Start-up Expenses)	($47,500)
Total Capital	$90,000
Total Capital and Liabilities	$380,000
Total Funding	$427,500


Sponsor
Christopher Stanford
President and Design Engineer
TrekEase (Translational & Rotational Equivalent Kinetic Energy Aerobic Stationary Exer-tainment)
Austin, TX 78748
Activities: Retired Air force Captain, Research and Development
Focus of this research: Provide Exer-tainment for wheelchair users

Audience

Panel of Experts

And the best 2010 team is….