WOLFPACK Engineering

Spring 2012 Design Proposal Report

<u>Team Members:</u>

Dalton Hamilton

Brice Abbott

Levi Edens

<u>Client Sponsor:</u>

Preston-Eastin, Inc.

Kenneth Mui

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Mission Statement

Wolf Pack Engineering strives to provide our customer with innovative solutions. We take the problem of our customer and mold it into a competitive and cost effective idea or methodology to produce a successful product.

Problem Statement

In the fall of 2011 we were presented with the task of evaluating the Preston Eastin PA-30 HD6 welding positioner and determining the best way to increase profit margins. After a few meetings with our client we started an in depth financial analysis of the positioners components and seeing if we could cut costs in any areas from current components to materials used. At the end of the fall semester we concluded that the current model couldn’t produce any cost savings through merely changing out components.

Statement of Work

Company Background

Preston-Eastin is a leading supplier of positioning solutions for the industrial manufacturing and construction industries. Located in Tulsa, Oklahoma they design and build their own complete line of manual and robotic positioners to solve and complete all aspects of welding, fabrication, and thermal spray application successfully and efficiently.

Product

The PA-30 HD6 gear driven rotational positioner has been produced and sold by Preston-Eastin for numerous years with little to no design changes outside of electronic upgrades. Changes have not been a necessity due to the fact that the product is simple, effective, and boasts the high lifetime quality that comes standard with the Preston-Eastin name.

Scope of Work

To accomplish the goals set forth of reviewing the designs and cost incorporated with the creation of the PA-30 HD6 rotational positioner. We developed the reduction of labor to be the major area of interest associated with the cost analysis breakdown to potentially reduce cost of materials used with the final goal of an increased profit margin and viable ideas to incorporate in future designs. The areas associated with labor cost reduction include but are not limited to the in-house machining and production of gear boxes and other parts, along with the workload associated with the assembling and completion of the final product.

Location of Work

All analysis of cost and designs take place on OSU's campus while any and all production of the product will be handled by Preston-Eastin upon their approval. All design changes will be created and communicated through the SolidWorks program while cost breakdown changes will be relayed via this report including comparisons to existing costs.

Introduction to New Design

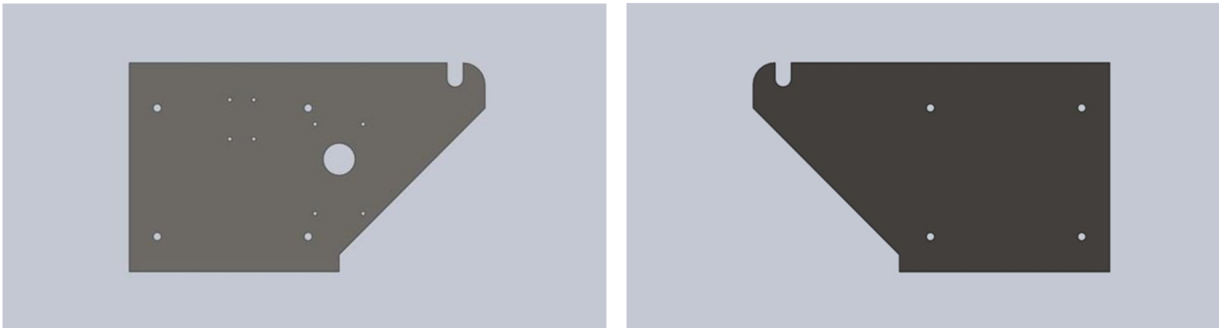
In the spring of 2012 we were at a crossroads with the direction of our project. After meeting with our client we decided that the best option would be to completely redesign a welding positioner from the ground up. In our redesign we had three main goals in achieving higher profit margins, reduce material cost, reduce labor hours, and maintain the high standard of quality Preston-Eastin's customers expect. In the following report we will be going over our ideas and processes for evaluating each individual area of a welding positioner and the best ways to reduce cost.

Structural Components

Side Plates

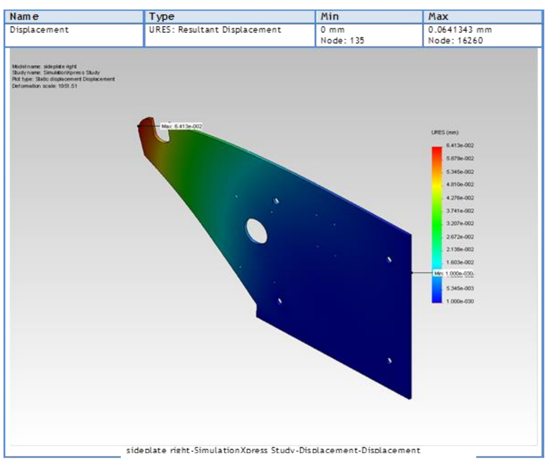
The first structural component we looked at was the side plates attached to the machine. The side plates served as a mounting point for the positioner height adjustment, the bearing assembly for the tilt shaft, and the pillow blocks for trunnion assembly. The original side plates boast 40 precision machined holes, 20 on each side. Analyzing the design used by Preston-Eastin no material could be removed so a focus was put on the machine time. The machined holes were replaced with burned holes, along with the complete removal of over half of the holes in the original plates. The holes for the mounting of the tilt shaft due to the direct drive system, discussed in the power transmission section, as well as the pillow block mounting holes that were replace with a notched hole trunnion cross shaft mounting assembly. Other burned holes in the new design are eight holes for the outside mounting of the tilt reducer, the tilt motor drive, the tilt driveshaft and gear, and the same eight original positioner height adjustment holes.

Original Side Plates



New Side Plates

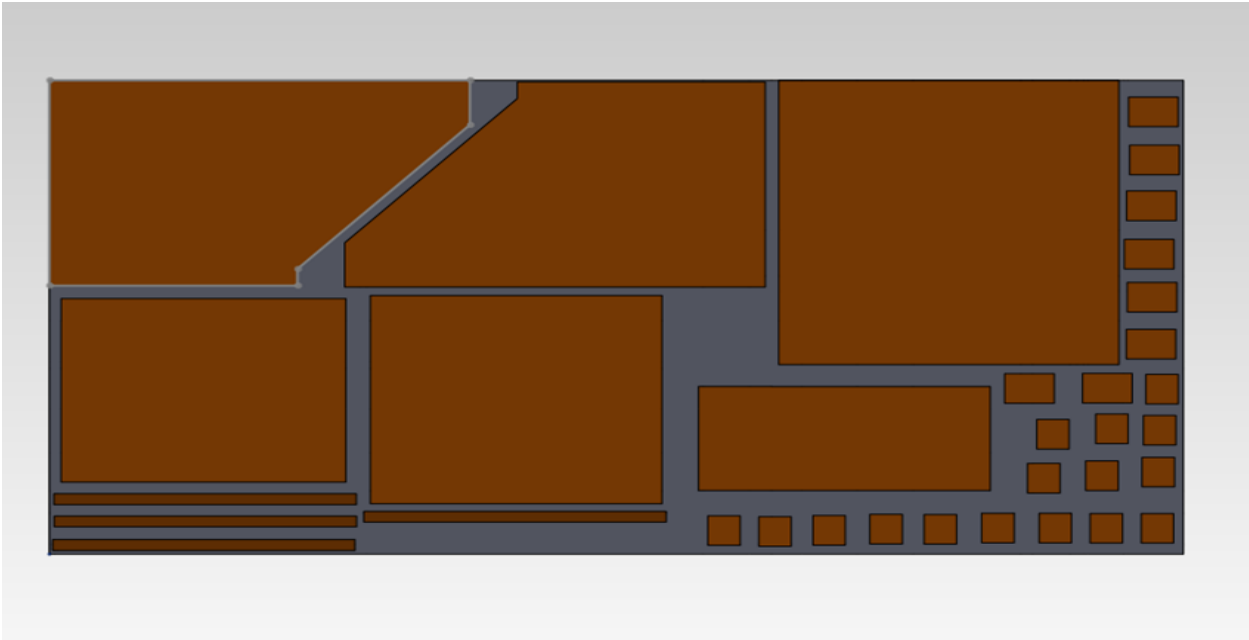
Stress analysis was calculated on the 3/8 inch steel side plates. With the use of two side plates the load is split in half between the two. Knowing that the load is spilt an unrealistic 3000lb load was placed onto one side plate, twice the weight rating for the machine. With this 3000lb load the maximum deflection was .064 millimeters with a factor of safety reaching nearly 6, showing that one side plate is able to withstand an 18,000lb load before failure is reached.



FE Analysis Screenshot

Single Plate Design

The current positioner model, PA-30 HD6, uses several different steel sizes ranging from 1/4 inch to 3/8 inch. Analyzing the cost and structural necessity of these pieces led our team to come to the conclusion that the usage of one single size steel was a more viable option. Through the investigation of other positioner designs the realization was made that most other companies chose a single plate size for a model that will also be effective structurally for other models of positioner they offer. This in turn saving them money on a long term outlook as they are providing the same frame material for different model sizes. Our particular project was focused on cost savings on one model however, so we avoided research into sizing for multiple models but the idea was helpful as we integrated those ideas into our analysis. Cutting the material out of a single sheet gave us the opportunity to purchase a larger quantity at once lowering the overall steel price per square inch. We were able to increase the overall thickness, again not for multiple models but to increase structural integrity, to 3/8 inch steel. The image below shows all of the components on a 5 foot by 10 foot sheet. An overall reduction in materials was also made. The shortening of the top plate, removal of the bottom plate and angled front plate, as well as decreasing the amount of strap used around the legs, resulted in a decrease in size from 4,360 square inches to 3,165 square inches. This material reduction in turn with the efficiencies of a single size led to a total cost reduction without labor reduction considerations of approximately 30%.

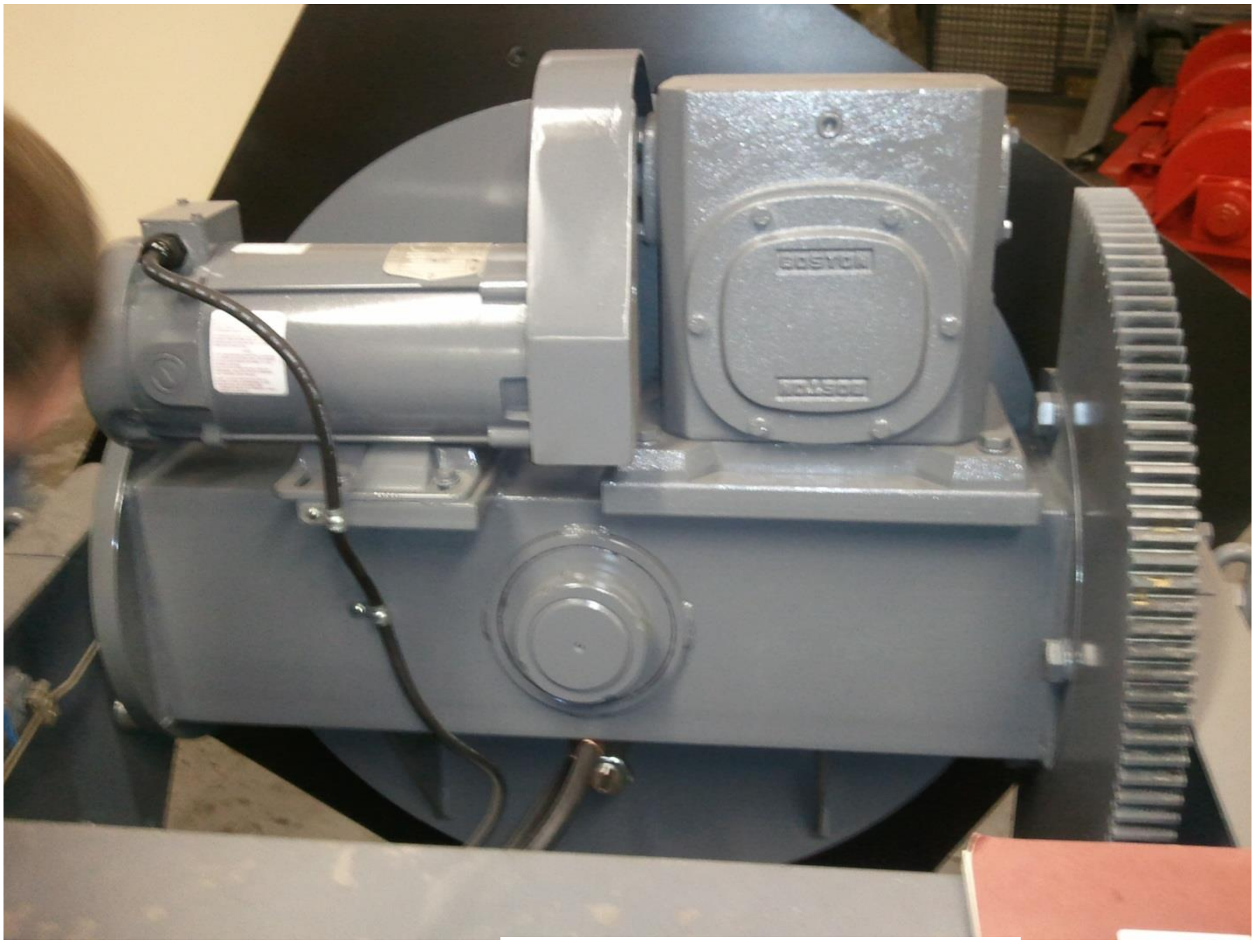


Single Sheet Cut-Outs

The pieces shown are the two side plates, top plate, front plate, back plate, mounting table, edge strap for the mounting table, and the table height adjustment brackets.

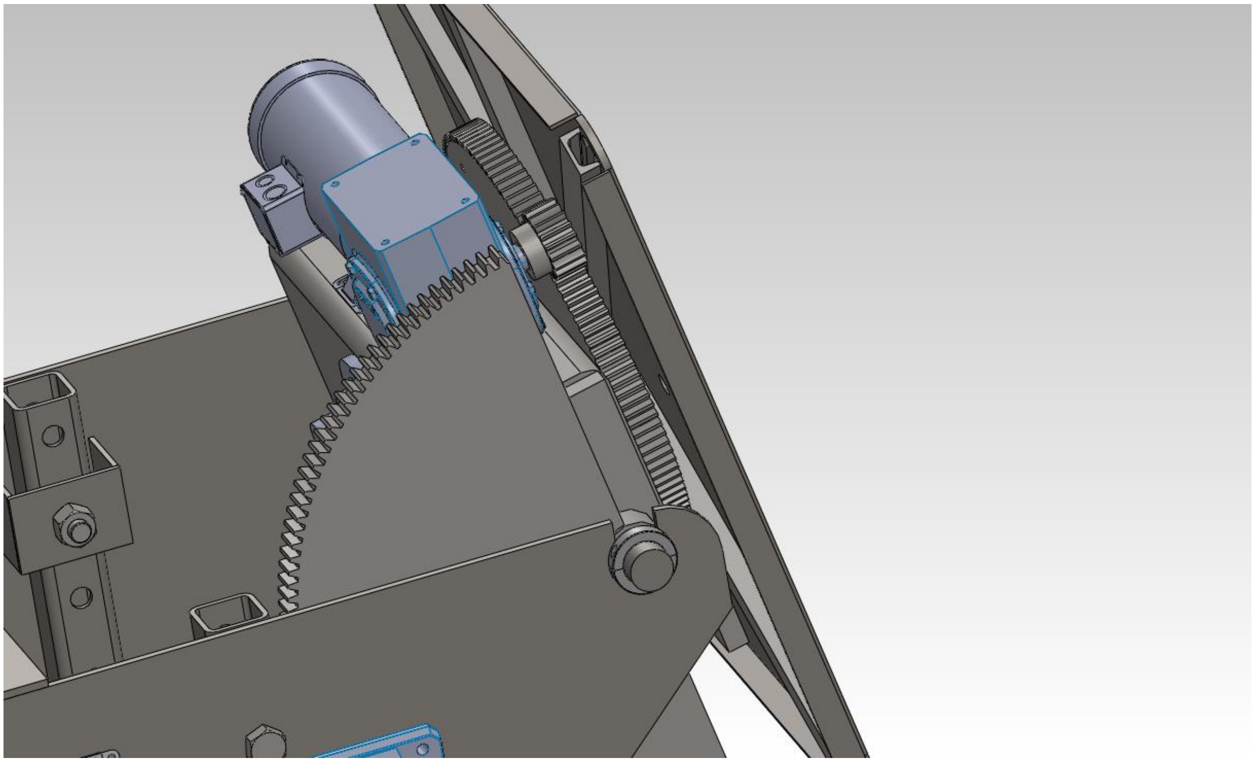
Trunnion Mounting Design

When analyzing the current Preston-Eastin design for the trunnion mounting we found that there was a large amount of precision machining has to be done to perfectly level the trunnion box. The current design requires each of the side plates to be machined exactly the same so the trunnion will fit properly and be perfectly aligned.



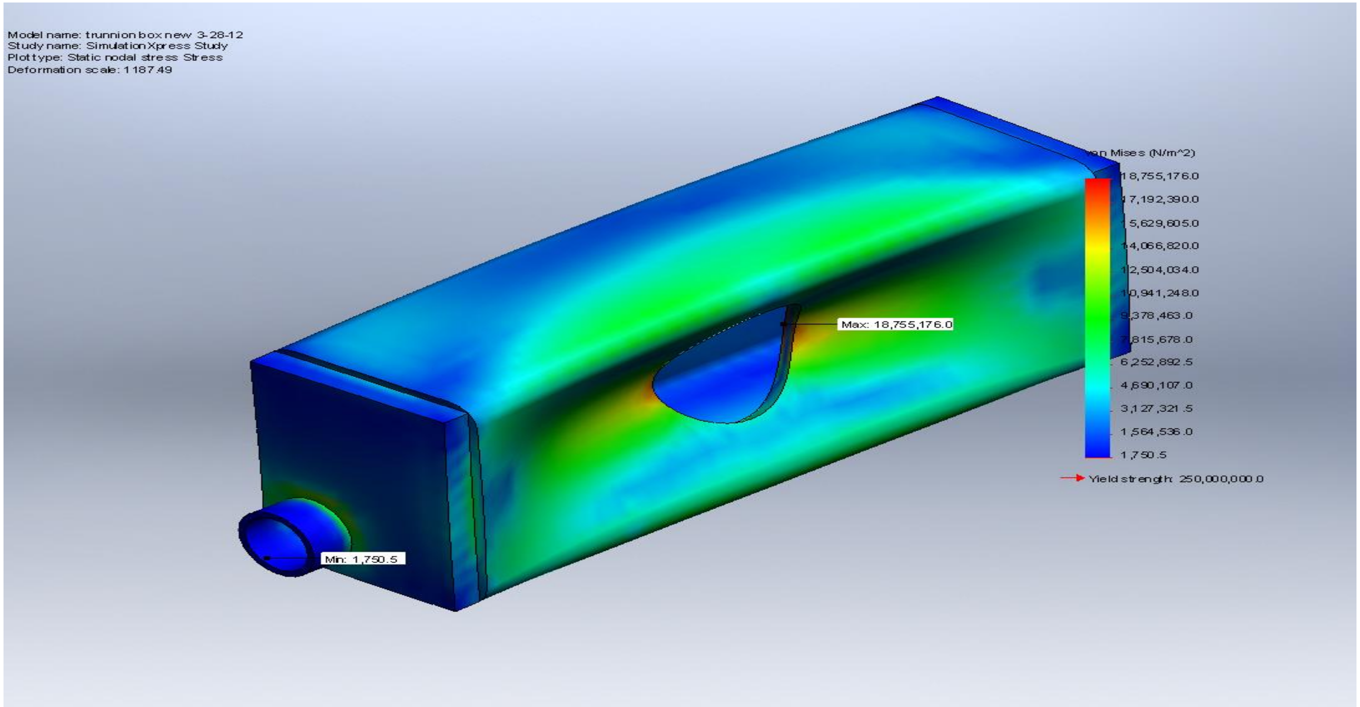
Original Mounting Design

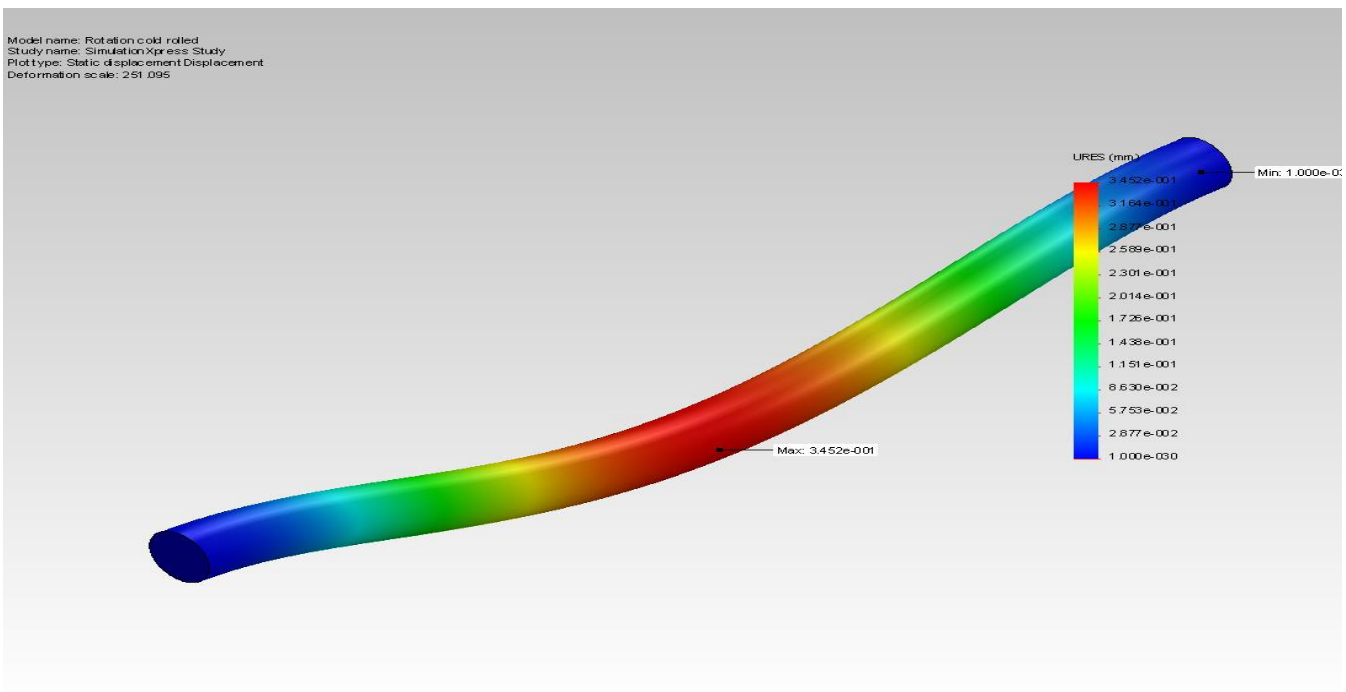
In our new trunnion design we wanted to eliminate as many labor hours as we possibly could. First we decided to reduce or completely eliminate any time spent on precision machining so our solution came from examining one of their main competitor’s designs. The new design has a notch cut into each side plate which allows the trunnion box to rotate around a shaft which rests in the side plate notches. This design simplifies the trunnion mounting process because now the trunnion has to be tacked on one side, leveled, and then welded into place. This type of mounting style eliminates all of the precision machining from the process which greatly reduces labor cost.



New Mounting Design

As shown above the new design was changed from two welded pieces of C channel to 8 inch by 10 inch by 1 inch box tube and a solid 2 in shaft replaced the original 2 ½ inch end studs. The rotation drive and trunnion assembly were not changed because no substantial savings could be found by altering them. As shown below Stress analysis was run on the trunnion box and the 2 inch shaft. The trunnion box has a maximum displacement of 0.064 millimeters and a minimum factor of safety of 13. The solid shaft has a maximum displacement of 0.345 millimeters and a minimum factor of safety of 5





FE Analysis Screenshots

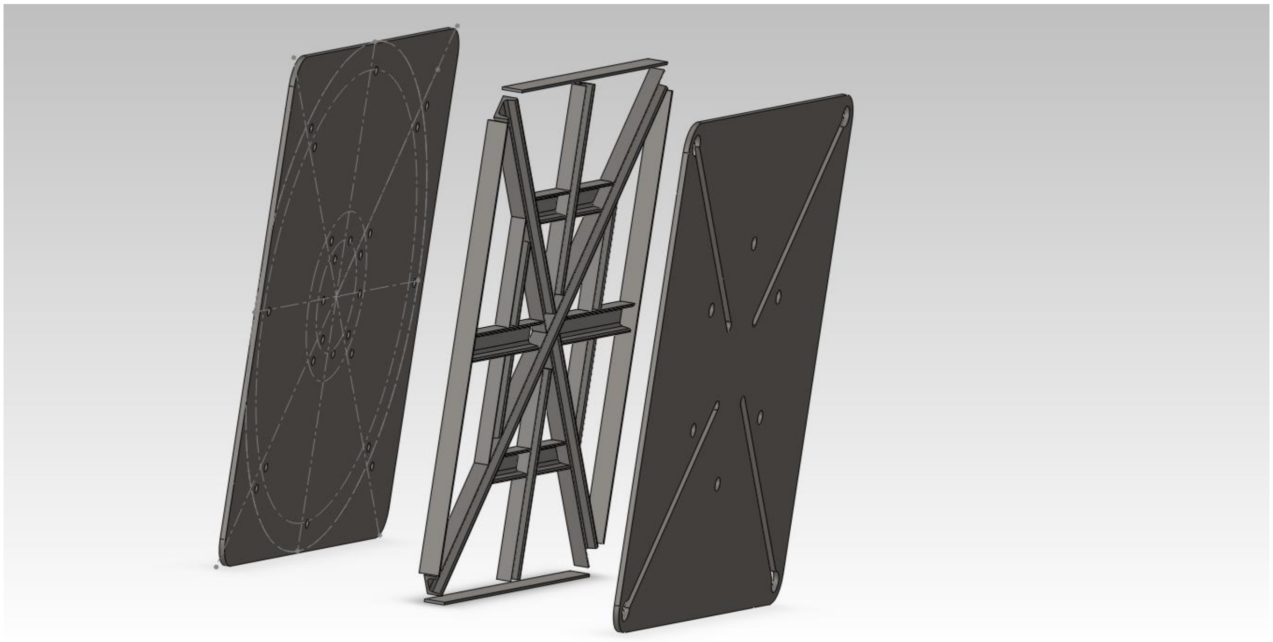
As shown below these changes made significant labor reductions.

Trunion Box/Mounting			
Box MC8-22.8# channel 27 1/2" (2)^	100.13	Box Square tube 10" X 8" X 25" X 1"^	180
End Plates 1" THK X 13 1/4" dia.^	76.76	End Plates 9 7/16" X 7 7/16" X 1"^	46.5
Tilt Rod 11" X 2 1/2" DIA HR1020*	24.76	Tilt Rod 34 1/8" X 2" DIA CR1020*	37.54
Mounting Plates 18 13/16" X 8" X 2"^	56.91		
Total Material	258.56	Total Material	264.04
Manufaturing Time Hrs(32)	1664	Manufaturing Time Hrs(10)	520

Cost Comparison Table

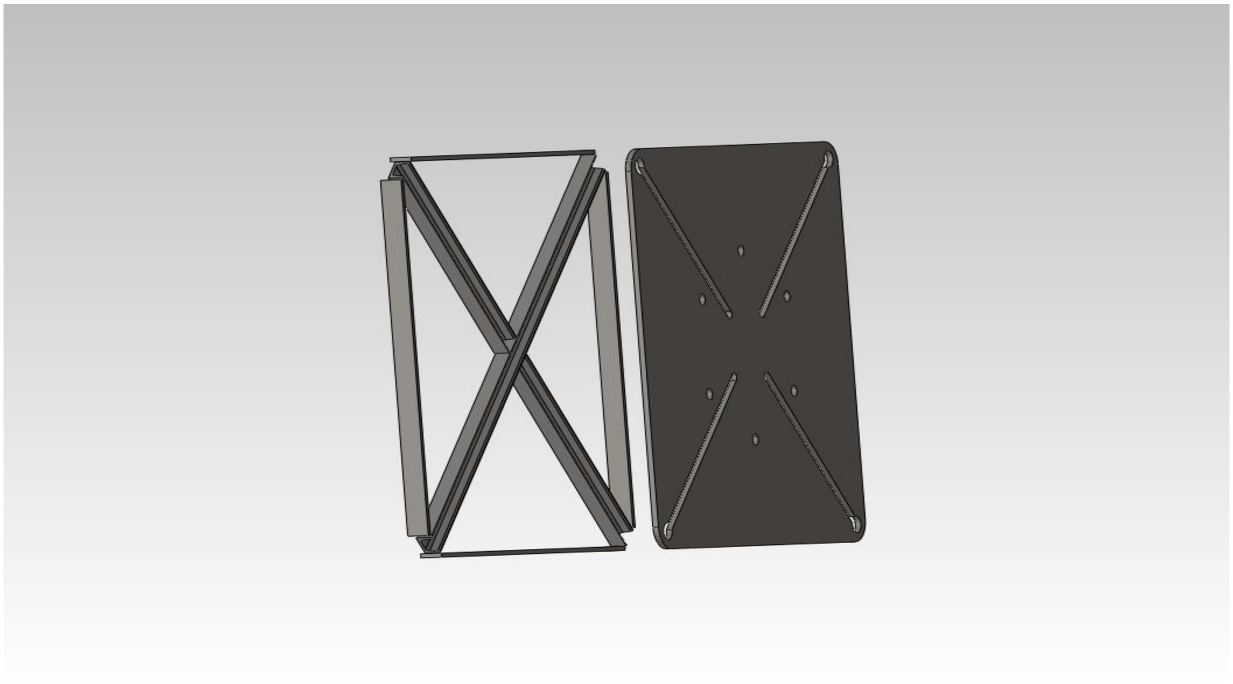
Sandwich Table Design

One of the main components of a welding positioner is the sandwich table on which loads are mounted on. When looking at the sandwich table we noticed that the original table was over-engineered to be highly durable and rigid. The table is composed of two plates of 3/8in steel welded to a spider web of fifteen pieces of C channel steel for rigidity as you can see from the figure below.

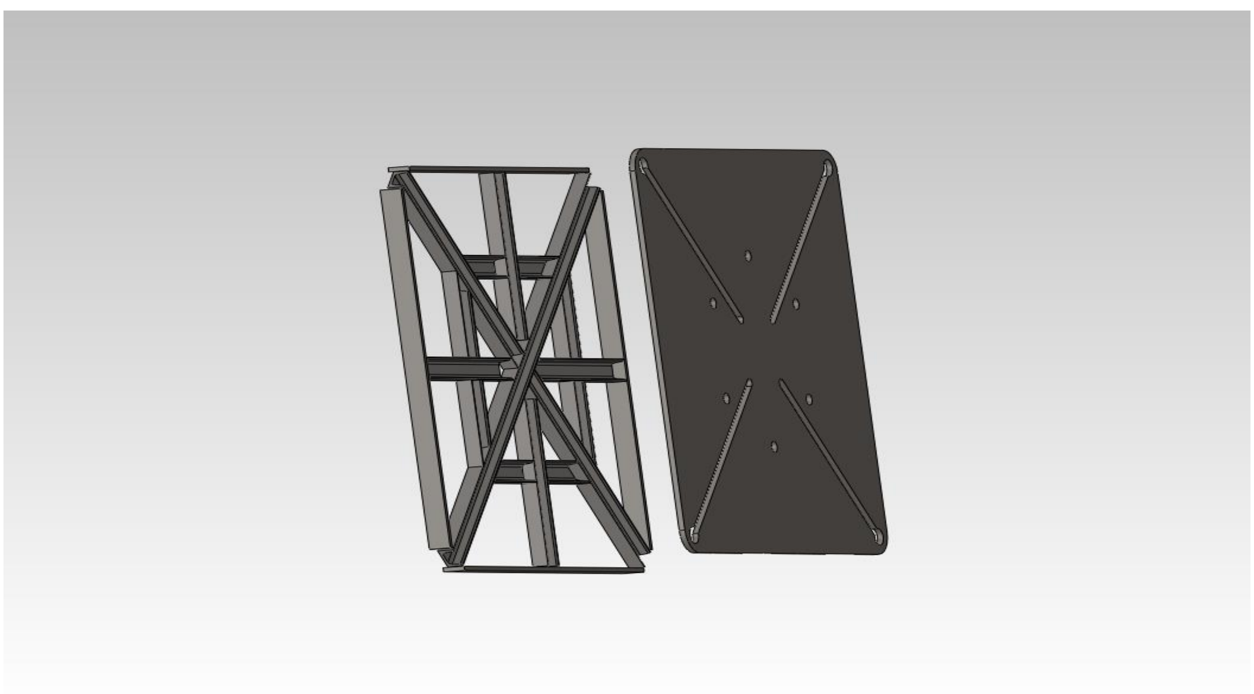


Original Preston-Eastin Design.

When it came to cutting the cost of this particular aspect the idea surfaced of the necessity of the c-channel and bottom plate material to the rigidity of the table. First item removed was the bottom plate. Upon analysis of the table we came to the conclusion, regarding the bottom plate, that it was unnecessary in achieving our goal of minimal material that meets required load parameters. Secondly, we analyzed the c-channel, from the full c-channel web all the way down to a simple “X” shape. We came to the conclusion that with slightly increasing the size of the strap around the edges, from 3/16 to 3/8 and redesigning the c-channel to the “X” shape, the table could maintain an appropriate safety factor. Lastly, the table mounting was changed to a simple six bolt attachment design. The bolts were attached to the rotation gear from the top of the table through threaded spacers in order to decrease the shear forces applied from tilting loads. These decisions came as a compromise between cost efficiency and durability for our design. Below is shown the table design we chose for positioner model and the design of the single table with full c-channel web enclosed.

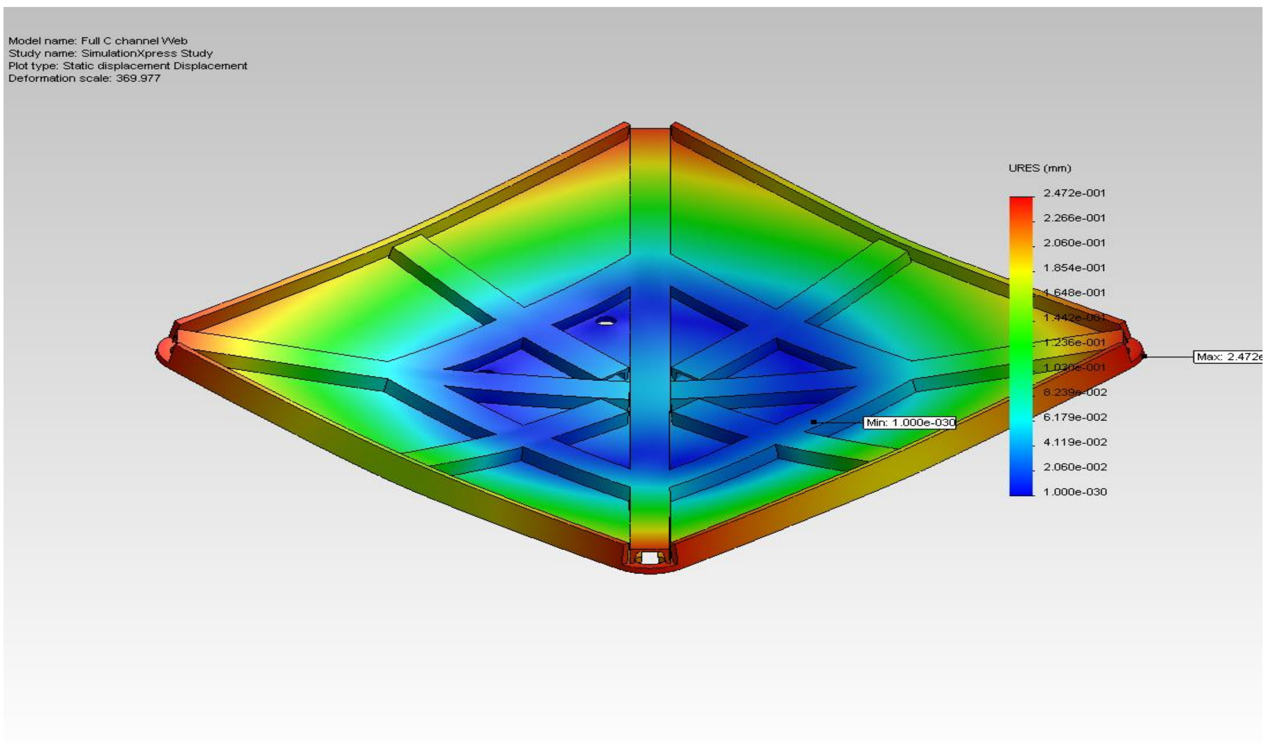


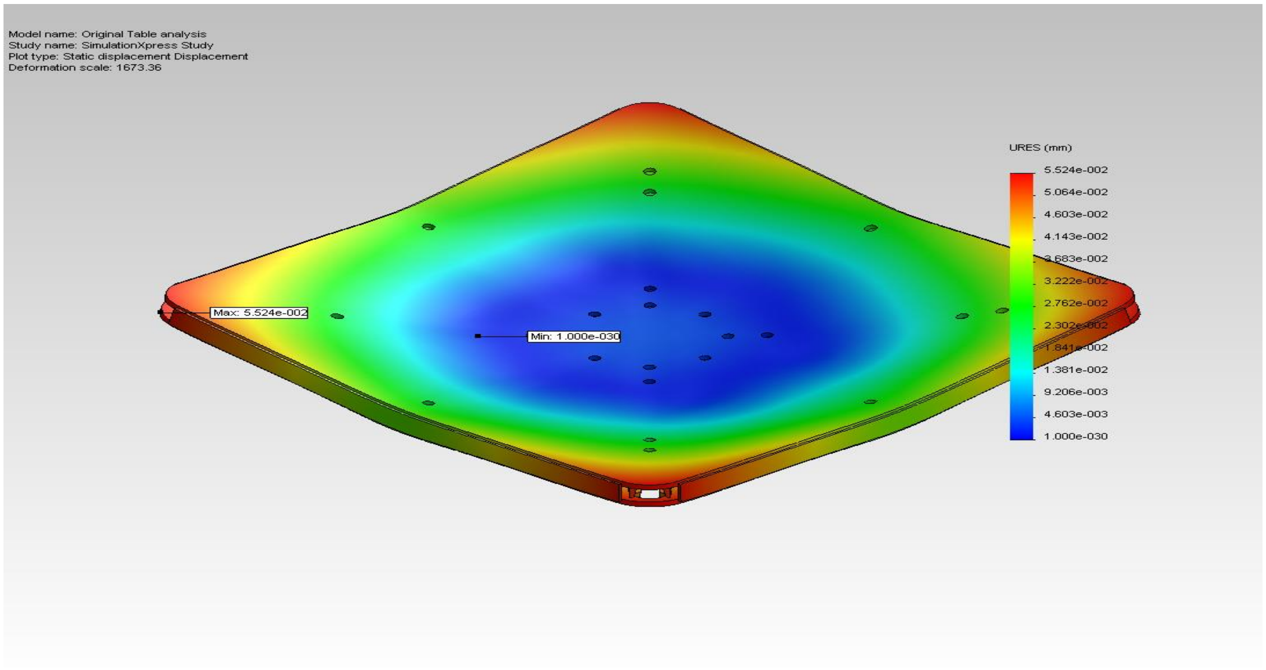
Design Chosen for Least Cost.

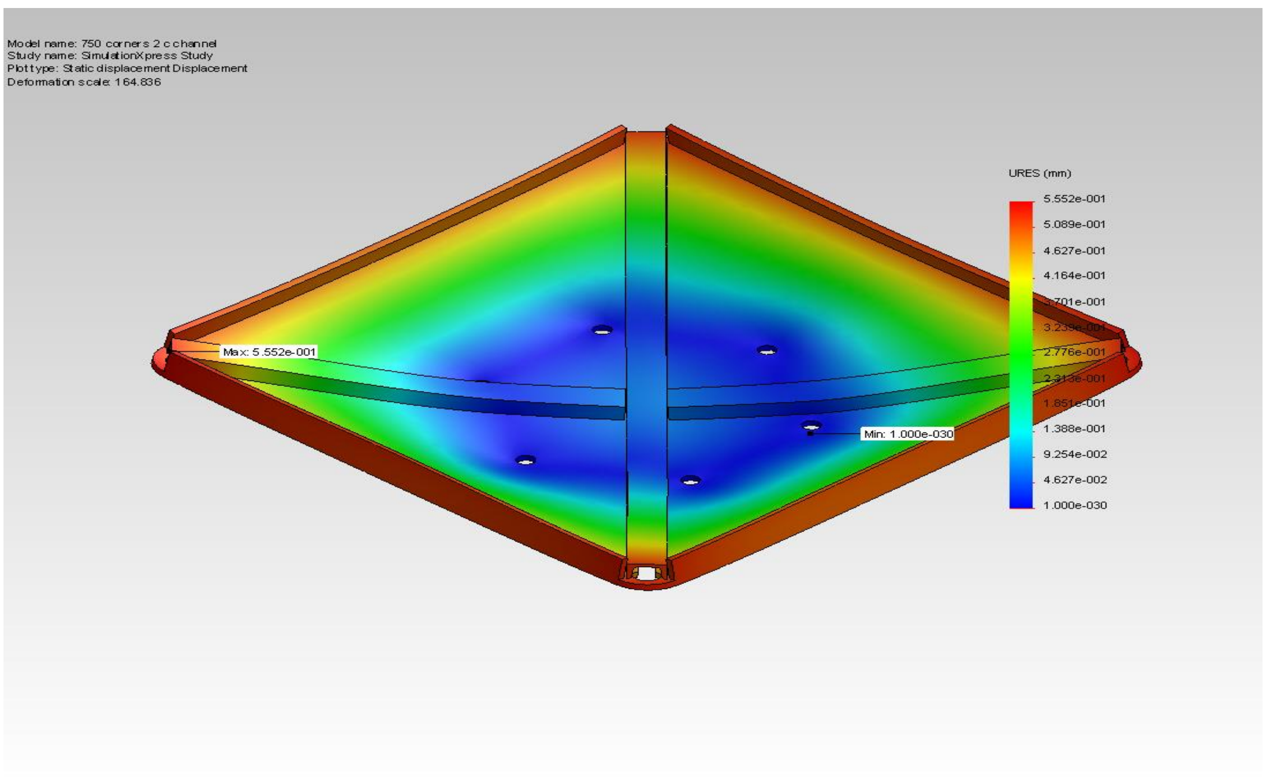


Design Recommended for Production.

As you can see from comparing the stress analysis of the three possible table designs below the new design is capable of withstanding loads within the rated load criteria of the machine while using fewest parts. The over-engineering of the original table can also be seen by the drastic difference in the safety factor and amount of deformation as compared to the “X” shape c-channel design.







All analysis shown is has a 3000lb load applied evenly to the vertical face at the six bolt holes without the inclusion of the rotation gear as additional support.

After thorough analysis of the different choices of table designs the final design chosen was the table top with the "X" shape c-channel. This design although is the least durable is the cheapest to build and assemble which was the main focus of the project design. However, even though the "X" shape was chosen we as a team do recommend the single table with full c-channel design for production due to its higher rigidity and safety factor at a limited cost increase.

Table Type	Max Deflection	Min Factor of Safety	Cost
Original Table	0.055 mm	10.1	264.94
Full C Channel Web 1 Plate	0.247 mm	4.1	139.11
X C Channel	0.555 mm	2.8	111.25

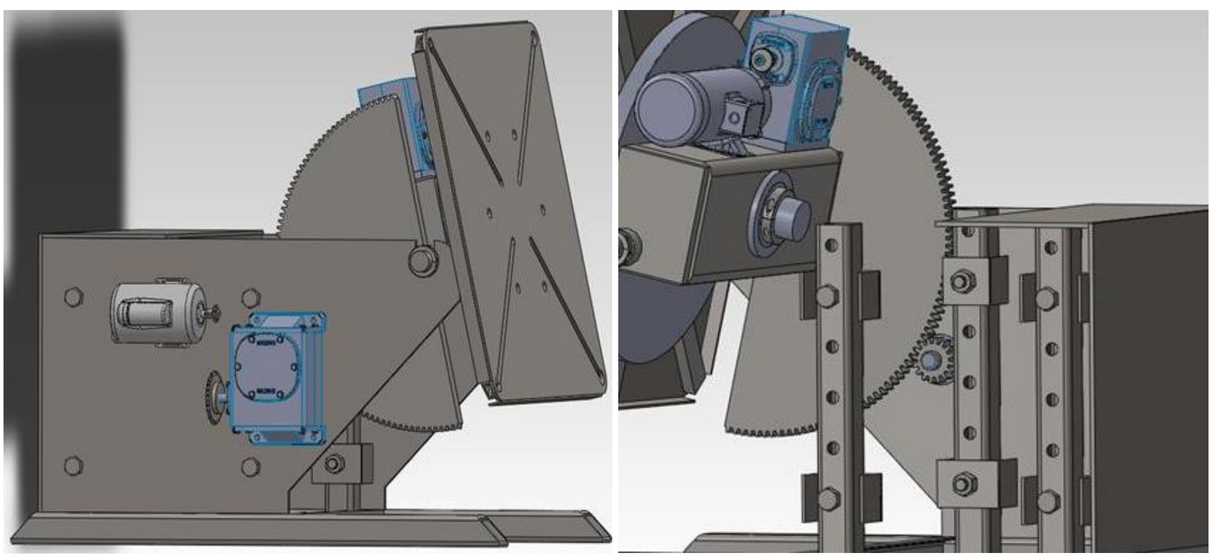
Cost Comparison Table

Power Transmission

When we looked at the original design we noticed that there were some definite changes that could be made to the existing power transmission system for tilting the positioner table. The existing design used an in house design and built worm drive gear box in conjunction with a 3/4hp AC brake motor that applied power through two, tooth gears on a shaft before finally making it to the larger segment gear that actually tilts the positioner table.

Original Power Transmission

The main way that we could see in eliminating cost out of this system was to simplify it and eliminate any unnecessary parts or any unnecessary man hours in putting it together. First we started by getting rid of the in house built gear box and going with an off the shelf product. This change will significantly decrease the cost of the tilt system because we no longer have to spend valuable labor hours on assembling a gear box. Next we looked at the internal gears on shafts that transferred power from the gear box and into the actual segment gear. We decided to eliminate this shaft and apply our power directly from our gear box to the rotating segment gear. By doing this we were able to mount our motor and our gear box to the outside of the machine. This change will not only save labor hours from instillation but it will also save on material cost by eliminating a shaft, two bearings, and two gears.



New Power Transmission Design

After making these changes we had to change up some gear sizes and gear box ratios to achieve our desired output torque. We moved the size of our gear box from 36:1 to 60:1 this is to accommodate for the reduction lost by eliminating the tooth gears on the cross shaft. We also increased the size of our pulleys between the motor and gear box and the size of our segment gear to further aid in achieving our desired reduction and torque. Below is a comparison table showing the altered reductions.

Tilt	**Reduction**	**Torque in-lbs**	**RPM**
Current Design			
Brake Motor		.25	1750
Pulley	2.28:1	.57	766
Worm Gear Box	36:1	20.56	21
Spur to Tooth	3.6:1	73.12	6
16 Tooth to 144 Segment	8:1	584.92	.7
Reduction	**Total: 2363**		
New Design			
Brake Motor		.25	1750
Pulley	3.57:1	.8925	490.19
Worm Gear Box	60:1	53.55	8.169
16 Tooth to 160 Segment	10:1	535.5	.8190
Reduction	**Total: 2142**		

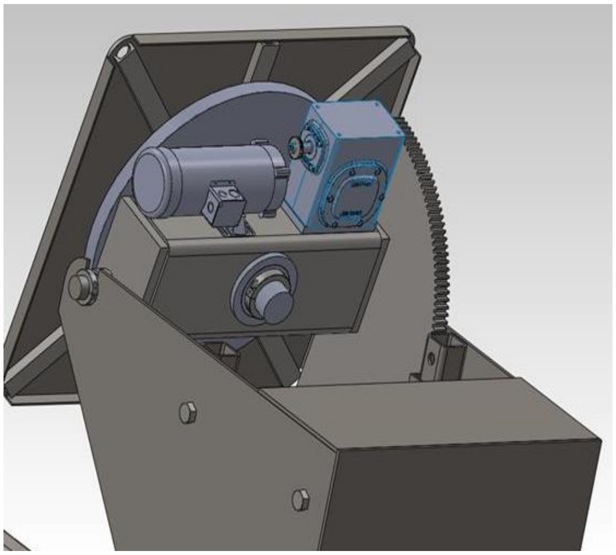
Tilt Ratio Comparison Table

Below is a comparison table of the specifications of the current model and the changes made for the new design.

Current Model		**New Design**	
Tilt Range	0 - 135°	Tilt Range	0 - 135°
Tilt Motor	¾ HP AC Break Motor	Tilt Motor	¾ HP AC Break Motor
Inherent PSI	36000	Inherent PSI	35745
Reduction	2363	Reduction	2142
Capacity 6in off face	5627lbs	Capacity 6in off face	4834lbs
Tilt Speed	135° In 11 ¼ sec [12°/sec]	Tilt Speed	135° in 27 ½ sec [4.9°/sec]

Specifications Table

The power transmission system for table rotation uses a 1Hp DC motor that applies power through a 50:1 gear box directly to a gear mounted underneath the table. We decided that the current rotation system currently being used on the PA-30 HD6 is the most efficient and cost effective and that no changes should be made to it on the new design. Below is a Table showing the current reduction setup.



Rotation Drive

Rotation Reduction	Reduction	Torque in-lbs	RPM
Dc Motor		.33	1750
Pulley	1.78:1	.59	984
Boston Reducer	50:1	29.3	20
Table Gear	6.67:1	195.6	3.0
	Total: 592.6		

Rotation Comparison Table

Unchanged Items: Inside Plates and Electrical

The new design of the inside plates does not vary much from the original design. A slightly narrower frame combined with outside mounting of the tilt system allowed us to shorten the top plate and remove their original inside plate. We replaced the inside plate with a basic square cut piece of 3/8 inch steel vertically attached to the top plate and the side plates. We did however remove the bottom plate at the request of Preston-Eastin's consumer's.

After examining the electrical components we have determined that the current setup is what we found to be the most cost efficient. We suggest that the current foot pedal that is a standard option on the current model be offered as an option this would result in a cost savings of 400 dollars.

Budget

Preston-Eastin sells their original PA-30 HD6 to dealers for $18,000. Then the dealers turn a profit of around $2,000 when they sell them to their customers. It cost Preston-Eastin approximately $12,700 to produce a PA-30 HD6 giving them a profit margin of approximately 30%. Our proposed goal was to get our labor and material cost around $9000 to reach a profit margin of 50%. After creating our new design and performing an in depth financial analysis we were able to exceed our goal and achieve an approximate profit margin of 59%.

Our recommendations for Preston-Eastin to increase revenue from PA-30 HD6 sales would be to sale the new design for approximately $15,000 and start selling directly to the customer eliminating the middle man. This plan will not only increase Preston-Eastin's profit margin but will also save the customer money. The table below shows a comparison of designs and proposed sale prices.

Budget	*Parts*	*Labor*	*Total*	*Sale Price*	*Profit Margin*
Initial	$7,503.398	$5,200	$12,703.398	$18,000	30%
Goal	$6,400	$2,600	$9,000	$18,000	50%
New Design	$4,941.92	$2,496.00	$7,437.92	$18,000	59%
New Design	$4,941.92	$2,496.00	$7,437.92	$15,000	50%

Budget Comparison Table

Conclusion

In the new model we eliminated 6 major components, 2 gears, cross shaft for the gears, 2 bearings, and the pillow blocks for the trunnion mounting. All of the precision machining was eliminated in place of burned holes with the use of mounting plate for the tilt drive system. With the elimination of the precision machining and having the flat steel burn out of one sheet the manufacturing time could be reduces as much as 50 percent. With the reduction of the material on the new model the ship weight was reduced by 40 percent. Making the overall product saving reach an estimated 2,300-3,300 dollars. All expanded tables including the specifications comparison table, cost analysis comparison of designs, complete stress analysis, and other project relative materials are located inside the appendices section.

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Project Schedule

Time Period

Date	Delivery Report (Class)	(Actual)
Sept 28, 2011	Mission Statement	Mission Statement
Oct 21, 2011	Competitive Analysis	-
Oct 28, 2011	Statement of Work	Statement of Work
Oct 31, 2011	Gantt Charts	Gantt Chart
Nov 4, 2011	Work Breakdown Structure	*Begin Product Analysis*
Nov 7, 2011	Task List	-
Nov 14, 2011	Engr Specs and Design Concepts due	-
Nov 18, 2011	1st Draft report	WBS/Competitive Analysis
Nov 21, 2011	Review report “draft”	1st Draft Report
Dec 2, 2011	Report “2nd draft version”	-
Dec 9, 2011	Final Report and Presentation	Final Fall Report/Presentation
Jan 13, 2012	Finalize Design	Continue Cost Analysis
Jan 16, 2012	Submit Final Design/Start building Prototype	Begin Complete Redesign
Mar 30, 2012	Pick up Prototype	Turn in Final Analysis
April 6, 2012	-	Met with Preston-Eastin
April 9, 2012	Second Draft Report Due	Second Draft
April 13-20, 2012	-	Design Changes and Modifications
April 26, 2012	Final report Due/Presentation	Presentation
May 4, 2012	-	Turn in Final Report/Design Notebooks

Fall Materials

Work Breakdown Schedule

Financial and Structural Analysis of PA-30 HD6

1. Initiation

   1.1 Initial Sponsor Evaluation

   1.2 Form Team Name Logo

   1.3 Initial Ag Econ Meeting

   1.4 Initial Sponsor Meeting

2. Planning

   2.1 Declare Initial Statements

   2.2 Research Competitors

   2.3 Find Applicable Patents

   2.4 Form Competitive Analysis

   2.5 Develop Business Plan

   2.6 Develop Engineering Solutions

      2.6.1 Identify Problems

      2.6.2 Determine Solutions on Current Positioner

      2.6.3 Make Changes and Convert to SolidWorks

   2.7 Form Team Website

   2.8 Submit Fall Design Report

   2.9 Fall Design Presentation

3. Execution

   3.1 Meet With Sponsor

   3.2 Finalize Design With Sponsor

   3.3 Prepare Material List for Prototype

   3.4 Prototype Fabrication (at Preston-Eastin)

   3.5 Final Reports

   3.6 Final Presentation

Gantt Chart Provided in Appendix

Task List

Listed below are the tasks needed to complete the project in conjunction with our business partners.

Engineering	Business
Solidworks Conversions	Initial Cost Analysis
Structural Analysis	Competitive Analysis
Determine Design Changes	Market Research
Implement design Changes	Patent Search
Finalize Design with Sponsor	Labor Cost Analysis
Oversee Prototype Construction	Budget Agreement with Sponsor

Task Table 5.0.1

Competitive Analysis

Preston-Eastin is a company based out of Tulsa, Ok one of their main products is an automated welding positioner. Preston-Eastin takes pride in manufacturing one of the highest quality welding positioners on the market. The following contains an industry, customer, competitor and technical analysis which will allow us to determine the best way to design, build and sell welding positioners more effectively in today's market.

Industry Analysis

Welding positioners come in many sizes, weight capacities, functions, and prices. Simple positioners are the typical stationary table, the manual indexing table, and the motor driven tilt and rotating tables. Preston-Eastin products are mainly specialized simple products that fit the need of very specific customers so being able to market a specialized product to a small range of buyers is essential in being a successful manufacturer. They design and build manual and motor driven styles of positioners. One of the biggest problems that Preston-Eastin faces in the positioner marketplace is the need to increase profit margin on their products. They build one of the highest quality positioners on the market but with that quality also comes cost. The industry only has a few main manufacturers of welding positioners mostly based in the U.S. In today's economic standing manufacturers in places such as China are starting to consume the marketplace with cheaper lower quality products. As far as growth in the industry marketresearch.com predicts that the market for welding equipment will grow 15% over the next 5 years from 4.7 billion dollars to 5.5 billion dollars, with the entire welding industry already surpassing 16 billion dollars. So in order to capitalize on this growth and to maintain a foothold on a large portion of the marketplace Preston-Eastin must design, build and market the most economically efficient positioner they can in comparison to their competitors.

Customer/Buyers

The primary source of purchasers of positioners and other welding equipment are either solely or partially in the manufacturing production and fabrication service industry. The buyers of such equipment vary from company to company. Both large and small companies alike have similar needs as far as equipment needed to complete their product. Preston-Eastin's line of positioners that includes the PA30 HD-6 is designed for a product capacity in the hundreds of parts per month depending on the need of the purchaser. Amounts larger than that are typically more easily fabricated and completed by robotic positioners for the ease of use for such a large quantity of product. The PA30 HD-6 is one the best positioners available for mid-sized manufacturing products. With its usage capacity being 3000 pounds and 18000 pounds at a 90° angle, the positioner is compatible for the addition of parts during the fabrication process. It's large enough to compete and preform in the mid-sized product market without being too large to take up space and having a small enough shipping weight to be easily moved with a typical 2000lbs load forklift.

Client Company/Agency and its Resources

Preston-Eastin designs and manufactures a complete line of manual, electric and robotic welding positioners and manipulators. Since 1972, Preston-Eastin has provided innovative solutions to positioning requirements in the welding industry. At their state-of-the-art engineering and manufacturing facility in Tulsa, Oklahoma, they design and manufacture positioners for precision operations, while affording as much safety as possible. Drive mechanisms and electrical controls are completely enclosed for the operator's protection. They are constructed to afford the customer many years of safe and dependable operation. Preston Eastin understands their customers' needs, and quickly responds with solutions and service for any positioning requirement. New products and enhancements to their product lines ensure continued customer satisfaction worldwide.[1]

Preston Eastin has an extensive product line ranging from Positioners, Head and Tailstock Positioners, Floor Turntables, Turning Rolls, Specialty Rolls, Manipulators, Travel Cars, Strip Heads Welding Cross Slides, Side Beam Carriages, Chucks, Grippers & Jaws Jack Stands. Their expertise is providing the best positioning equipment the welding industry has to offer. One of the main ways they get their name into the positioning market place is through their distributors such as Air Gas and through trade shows like FabTech which is North Americas largest metal forming, fabricating, welding and finishing event. Their key customers are companies in the manufacturing and fabrication industry and it is up to their Director of Engineering Kenneth Mui to make sure that their clients' needs are satisfied.

Competitor Analysis

After the completion of the competitive analysis, Wolf Pack Engineering has collected and produced a short list of primary competitors in the positioner marketplace to Preston-Eastin, an analysis of their products, and a comparison of their cost and specifications.

Preston-Eastin's competes in a relatively small market for positioners in the welding industry, so knowledge of their competition is a vital component to being successful in the marketplace.

1. Koike Aronson, Inc. is the largest of Preston-Eastin's competitors. Koike is an international supplier of mostly all welding service products, from gases to cutting machines, positioners, and welding carriages. They build standard, stock models, as well as customer specific models, meeting any customer needs.

   Koike manufactures their positioners from a base model positioner so their HD-25 model through the HD-100 model is all the same framework with adjustments for the different load capacities coming in the form of increasing the horsepower in the motors. So even though Koike positioners are higher in price, a buyer can purchase a positioner with a lot higher load capacity for not a lot of increase in extra cost due to the only cost increase coming from an upgrade in motor sizes and an increase in the size of the sandwich table.

Specifications for Koike Aronson Positioners listed in Appendix

http://www.google.com/imgres?q=koike+positioner+hd+25&um=1&hl=en&biw=1600&bih=815&tbm=isch&tbnid=0_fBIn3BV-05-M:&imgrefurl=http://pdf.directindustry.com/pdf/koike-aronson/positioners/19388-178374-

_18.html&docid=u3Wx2nwObjAZkM&itg=1&imgurl=http://img.directindustry.com/pdf/repository_di/19388/positioners-178374_18b.jpg&w=772&h=1000&ei=aUrZTvWBDqjq0gHIornEDQ&zoom=1&iact=rc&dur=299&sig=117519645916129924265&page=1&tbnh=151&tbnw=116&start=0&ndsp=33&ved=1t:429,r:6,s:0&tx=54&ty=85

2. Pandjiris, Inc. the self-proclaimed leader in fixed welding automation is also an international company that provides a similar service to their customers as Preston-Eastin. Pandjiris based in St. Louis, Missouri has a 46,000 square foot facility that they create products to be sold throughout North America and multiple countries worldwide. They offer customer unique products as well as stock products. Pandjiris' sixty plus years of experience in the welding industry make them a large competitive force in the marketplace. The model 30-6 welding positioner is the Preston-Eastin PA30 HD-6's closet competition. This particular model in a made to stock product. Pandjiris has been able to hold prices on stock items since 1993 despite labor and materials cost increases through improved productivity.[2] Other cost savings come in the options they offer. Their product comes in a completely base model with multiple options including the foot switch, digital tachometer, dial weld, tach feedback, welding grounds, and grippers.

http://www.weldplus.com/product_details.asp?id=981&qs=

Company	Load Capacity at 6in (lbs)	Tilt Range (degrees)	Torque Tilt (in lbs)	Torque Rotation (in lbs)	Shipping Weight (lbs)	Price USD
Koike	3000	0-135	31,875	15,000	2100	22,175
Pandjiris	3000	0-135	35,250	18,000	1,750	13,190
Preston-Eastin	3000	0-135	36,000	18,000	2,100	18,000

Competitive Table 10.2.1

Patent Search

There were no relevant patents found during our product analysis that are still in effect to sway our opinions in any direction.

Customer Requirements

The typical customer of Preston-Eastin expects what has been produced since the company began, a high quality product. Preston-Eastin prides itself in a quality of work second to none. An average customer will have encountered a manufacturing problem that is need of a safe and reliable welding operation. Preston-Eastin offers a wide range of products to customers as well as an extensive list of additional add-on options to meet any customers situation, typical or unique. Made-to-order products are always in demand when customers' needs change on a regular basis. Consequently, Preston-Eastin can adapt standard equipment, or design and custom-build equipment to fit the customer's specific needs. This flexibility has allowed Preston-Eastin to become one of the industry's leading suppliers of custom positioning products.

Engineering Specifications

Capacity:

- Weight: 3000 pounds
- Offset of C.G. from table: 6 inches
- Eccentricity of C.G. from axis: 6 inches

Rotation:

- Motor: Variable speed DC, 1 horsepower

- Speed range: 0.1 to 2.0 rpm
- Speed accuracy: 2% of set speed

Tilt:

- Motor: AC brakemotor, 3/4 horsepower
- Range: 135 degrees forward tilt
- Inherent Overhang: 6 inches

Elevation:

- Adjustment: Manual
- Range: 33" to 53" in 4" increments (to top of table)

Table:

- Diameter: 36 inch square, with four radial T-slots
- Mounting bolt size: 3/4 inch
- Bearings: Timken tapered roller bearings
- Ground: 600 amp spring-loaded mechanical ground

Controls:

- Pendant: Remote pendant 115V, with 30' cable
- Rotation speed: One-turn potentiometer
- Rotation mode: Two-position selector switch, WELD/RAPID

- Rotation direction: Three-position selector switch, FWD/OFF/REV
- Rotation control: START and STOP pushbuttons
- Tilt control: Three-position momentary switch, UP/OFF/DOWN
- Power: 460/230V, 10/20A, three phase, 60 hertz.
- Overload protection: Fused disconnect
- Foot switch: Optional

Weight:

Shipping weight: 2100 pounds

Costed Bill of Materials Report				Preston-Eastin, Inc.	
Component	Description	U/M	QTY	Std Cost	Cost of Bill
2020704	MA PA-30 HD6 NE NT	EA	1	5,299.068	5299.068
8080192	FSC 1/2-13 X 2-1/2" LONG	EA	8	0.460	3.680
8080197	FSC 3/4-13 X 2-1/2" LONG	EA	1	1.940	1.940
9090001	NAMEPLATE PE LARGE	EA	1	10.600	10.600
9090366	PLATE, DATA POSITIONER	EA	1	3.000	3.000
9090247	NAMEPLATE WARNING	EA	1	3.550	3.550
6060140	ENCLOSURE	EA	1	164.000	164.000
6060150	PANEL A20P20 HOFFMAN	EA	1	17.000	17.000
6060545	DRIVE DC PM1 MPA-04342	EA	1	225.800	225.800
6060546	CONTACTOR REVERSING PM-1	EA	1	118.560	118.560
6061462	SWITCH DSCONECT 194R NC030P3	EA	1	161.290	161.290

6061489	HANDLE DISCONNECT 194R-HS1	EA	1	21.400	21.400
6061490	SHAFT DISCONNECT 194R-R1	EA	1	13.310	13.310
6061498	REVERSE STARTER AE56DNOA	EA	1	249.500	249.500
6061697	HEATER PACK H2005-3	EA	1	17.400	17.400
6060046	HOLDER FUSE BUSS 4405	EA	1	3.620	3.620
6060047	FUSE 1/8 AMP AGC SERIES, BUSSM	EA	1	0.950	0.950
6060063	STRIP TERMINAL 14CNTCT 214SP	EA	1	7.730	7.730
6060019	TRNSFRMR 2 KVA 411-0091-000	EA	1	219.230	219.230
6060137	SWITCH LIMIT E50 NN1	EA	1	168.250	168.250
6060138	LEVER LIMIT SWITCH E50KL581	EA	1	19.350	19.350
6061749	CABLE 14-5 SEOOW	FEET	8	1.260	10.080
6063705	CABLE, 18-5/C STR, PVC, 300V	FEET	12	0.580	6.960
6060106	CABLE 14-4 SEOOW BLACK 600V	FEET	9	0.950	8.550
6060081	CABLE 14-3 SJO	FEET	14	0.400	5.600
6060020	TRANS CONTROL .05KVA C0050E2A	EA	1	55.600	55.600
6061463	FUSE FNQ-R-20-20AMP	EA	3	11.390	34.170
6060670	SA PENDANT POS/MANIP NEW	EA	1	230.050	230.050
6061052	SWITCH TOGGLE SPST 90-0001	EA	1	5.270	5.270
6060147	FOOTSWITCH RFS-20 1025C2SP-S	EA	1	354.000	354.000
6060262	BASE RELAY AMF P/B 27E123	EA	1	3.590	3.590
6060261	RELAY C/H D3PF3AA	EA	1	12.350	12.350
6060065	STRIP TERMINAL 5 CONTACT	EA	1	4.180	4.180
6063501	GRIP CORD CG90-6275	EA	1	9.430	9.430
6063503	GRIP CORD CG90-5075	EA	1	9.430	9.430
6063502	GRIP CORD 1/2" CG50A35090	EA	1	5.540	5.540
6063525	CORD GRIP CG90-3750	EA	1	7.220	7.220
6063121	CORD GRIP 3/4" RANGE .512	EA	3	1.650	4.950
6063120	CORD GRIP 1/2" RANGE .197-47	EA	2	1.270	2.540
6060050	FUSE FNM 1/2 AMP	EA	1	4.660	4.660
	TOTAL				7503.398

Costed Bill of Materials 15.0.1

Conceptual Changes and Plans

Throughout this semester we have been involved in the engineering and financial analysis of the PA30 HD-6 rotational positioner from Preston-Eastin. We began converting several of the main components into SolidWorks designs to get an idea of how are product is being manufactured. While doing so we began to see a couple primary areas of interest. Our areas of interest to primarily focus upon were the time spent machining and producing the product, and the cost of parts to manufacture the product.

Goals

During analysis our initial goals were to reduce labor cost, from machine time and man hours spent on completion of the product, as well as part cost. Preston-Eastin spends on average of one hundred man hours at a typical cost of $51.60 per employee hour, that dollar amount including overhead cost, bringing a total labor cost to be $5,160. Knowing the current price of producing the PA30 HD-6 is $12,658 our goal is to reduce this cost to $9,000 on a best case scenario.

We as a team plan to reduce cost in any way possible to achieve our goal 50% profit margin. Once achieving this, or as close as we can get, we will propose to Preston-Eastin the design and product differentiations as we have found them.

Product Cost

As a team we made the decision to limit our product analyze the high dollar items then work our way down in order of price. We began with motor analysis. The motors currently used on the positioner are the Boston 1HP DC drive motor for the rotational drive and the Leeson 3/4HP AC drive motor for the tilt drive. Looking at the motors led us directly to the gears used for rotational and tilt drive reductions to fit required torque specifications. Preston-Eastin uses a purchased gear box reduction system for the rotation. They purchase the matching Boston Reducer to go with the Boston motor used to drive the table. However, the tilt reducing gear system is manufactured in-house. Below is a table listing the current prices of motors and gearboxes used in the PA30 HD-6.

Motors

Current Motors and Speed Reducers	Price
Boston 50:1 Worm Gear Reducer for rotation	$746.86
1hp DC Motor for rotation	$341.79
36:1 Worm Gearbox for Tilt	$450-$650 (Estimation)
¾hp AC Motor for Tilt	$409.84

Motors and Speed Reducers 1

The first step we took in evaluating the cost of the motors and gearboxes was to look at the market and see if the currently used products on the PA30 HD-6 were the most cost efficient products to be using. We started our search primarily within American made, trusted, motor and gear box manufacturers to see if we were in fact using the most economical and highest quality products available. Although it turns out, products comparable to the ones currently used are relatively within the same price range and even in some instances more expensive as you can see listed in the table below.

Motors and Speed Reducers (Current Set-up, American made)	Price
50:1 Gear Reducer for rotation	$700.00-800.00
1hp DC Motor for rotation	$400-$1000.00
40:1 Worm Gearbox for Tilt	$400.00-$550.00
¾hp AC Motor for Tilt	$700.00-$900.00

Motors and Speed Reducers 2

Next, we decided to look into getting rid of the belt and pulley system between the motor and speed reducer in switching to NEMA 56C face motors and speed reducers to see if we could save any cost. As before we searched only within notable quality American made products. The main problem we faced when searching for a 56C face motor and speed reducer that met the reduction requirements from removing the belt and pulley for the PA30-HD6 was that both the speed reducers had to be moved up to an 80:1 ratio. As you can see from the table below the cost of using the 56C face motors and reducers is relatively close to the current cost of the current setup. Even though switching to this system doesn't necessarily save on initial cost, it does have the potential to save some on installation time.

Aftermarket (American)	Price
80:1 Worm Gear Reducer 56C for rotation	$450.00-$1200.00
1hp DC 56C Motor for rotation	$450.00-$1000.00
80:1 Worm Gearbox 56C for Tilt	$450.00-1200.00
¾hp AC 56C Motor for Tilt	$500.00-$1000.00

Motors and Speed Reducers 3

The last thing we searched for was cheap foreign made motors and speed reducers. All the motors and speed reducers we were able to find were all 56C face in design. We weren't able to find any cheap 80:1 foreign speed reducers so listed below is a table with 60:1 speed reducers which could be a cheap alternative to the 80:1 speed reducers and with some alterations in the driven gear sizes, could achieve the same total reductions.

Aftermarket (Foreign)	Price
60:1Worm Gear Reducer 56C for rotation	$238.00
1hp DC 56C Motor for rotation	$214.00
60:1 Worm Gear reducer 56C for Tilt	$238.00
¾hp AC 56C Motor for Tilt	$100.00-$300.00

Motors and Speed Reducers 4Structure

Wt. in Lb.	3/8"	5/16"	1/4"	3/16"	1/16" decrease	1/8" decrease
Side Plate	121.32	101.04	80.85		17%	33%
Bottom Plate			65.06	48.81	25%	
Front Plate	50.99	42.47	33.35		17%	35%
Table	137.88	114.84	91.89		17%	33%
Top Plate			66.64	49.99	25%	
Avg. Wt. Reduction					20%	34%

Following the motor and gearbox analysis we began looking into the structural members that make up the positioner. Cost and weight analysis was done on the metal plate parts that make up the assembly of the entire PA30 HD-6 machine. The parts that were chosen were done so for the fact that they are both structural and non-structural part. The price and weight reduction are shown in percentage form to show the average savings. Also shown are the potential savings by reduction of the sizes of the metals, in the following tables.

Size Reduction Table 15.5.1

Part	3/8"	5/16"	1/4"	3/16"	1/16" decrease	1/8" decrease
Side Plate	155.58	131.25	107.02		16%	31%
Bottom Plate			88.08	68.53	22%	
Front Plate	71.18	60.96	50.78		14%	29%
Table	175.46	147.81	120.27		16%	31%
Top Plate			89.97	69.99	22%	
Avg. Savings					18%	30%

From the table above an average of 18 percent of metal cost can be achieved by decreasing metal sizes by 1/16 of an inch. Also shown is a 30 percent metal cost savings by a reduction in the size of the steel by 1/8 of an inch. Assuming changes in steel sizes a max deflection calculation was done, under worst case scenario upon the original pieces and the 1/8 inch reduced pieces, which yielded 20 percent more deflection when reducing the metal thickness from 3/8 to 5/16 of an inch. This loss of some deflection strength also brings a reduction in cost and weight of the machine.

Weight Reduction Table 15.5.2

This table above shows the potential weight reduction to the PA30 by decreasing metal sizes by 1/16 and 1/8 of an inch. By decreasing the metal 1/16 of an inch there will be approximately a 20 percent weight reduction. We continued the analysis by dropping steel by another 1/8 of an inch. This reduction will gain an approximate 34 percent to the total raw metal weight of the PA30. These two tables show the potential benefits to decreasing the metal thicknesses on the PA30. Savings on the overall cost to produce it and the weight reduction will reduce shipping costs. The negative aspect to lowering the metal thickness is the decrease in metal strength and integrity.

<u>Electrical</u>

Next we examined the electrical aspect of controlling the PA30 HD-6. The electronic controls of the PA30 HD-6 are very basic and straight forward. After examining the individual components with an electrician in the Biosystems Department on campus, it has been concluded that the current electrical setup being used is the simplest, cheapest way to control the two electrical motors onboard the PA30-HD. The only way we found we could reduce cost of the electrical aspect is to possibly condense the components down into a smaller control box.

Fall 2011 Conclusion

After evaluating the cost aspects of the PA30 HD-6 we have determined that there is not a significant amount of cost that can be cut out of the machine but we have listed above a few options that should be taken into consideration. During the spring semester we will continue to look at new aspects to find cost savings. We have found several savings options when looking at using thinner plate metal, foreign made electric motors and gear boxes, as well as an extensive look at labor.

Spring 2012 Plans

Goals

In the spring semester of 2012 we plan on further continuing our cost analysis of purchased parts along with an extensive look and a detailed labor and production cost evaluation. As stated in our conclusion, cutting the cost of the PA30-HD solely through reducing the bill of materials is not going to be a sufficient enough way to significantly reduce the cost of the machine. We plan on taking a further look into the production of the PA30-HD in perspective of the labor side of things and determining the most cost efficient way to produce a PA30-HD from the ground up. We also plan on looking into designing an economy model, basically the same specifications of the current machine but made with some thinner materials in certain areas, inexpensive motors and speed reducers, comparatively, and without any extra options like foot controls, different table shapes, as well as several more items.

Labor Cost

A major cost in the production of the PA30-HD comes in the form of labor. Labor cost make up 40% of the total cost of producing a PA30-HD. We plan on taking an in depth look at the processes that go into the manufacture of a PA30-HD and determining the most cost friendly and efficient way to manufacture a machine. Whether that be building them to stock with an assembly line fashion or simply examining some of the practices that are currently used and changing them to be faster and more efficient.

Model Changes

The design of an economy model could be a good opportunity for Preston-Eastin to maintain the current high quality positioner that they already produce while also offering a cheaper version to customers who don't necessarily need as much rigidity and durability with their product. It could also be more cost efficient to mass produce and build to stock an economy model due to the fact of it being more basic without any extra options or customer specifications that could slow down production.

WOLFPACK Engineering

Members:

- Dalton Hamilton
- Levi Edens
- Brice Abbott

Sponsor:

- Preston-Eastin
- Kenneth Mui

Mission Statement

- Wolf Pack Engineering strives to provide our customer with innovative solutions. We take a cost effective idea or methodology to produce a successful product.

Preston-Eastin

- Company began in 1972
- Design and Manufacture
- Based in Tulsa, Ok
- Large Product Line
- High Quality
  - Safe
  - Reliable
  - Long Lasting

PRESTON-EASTIN

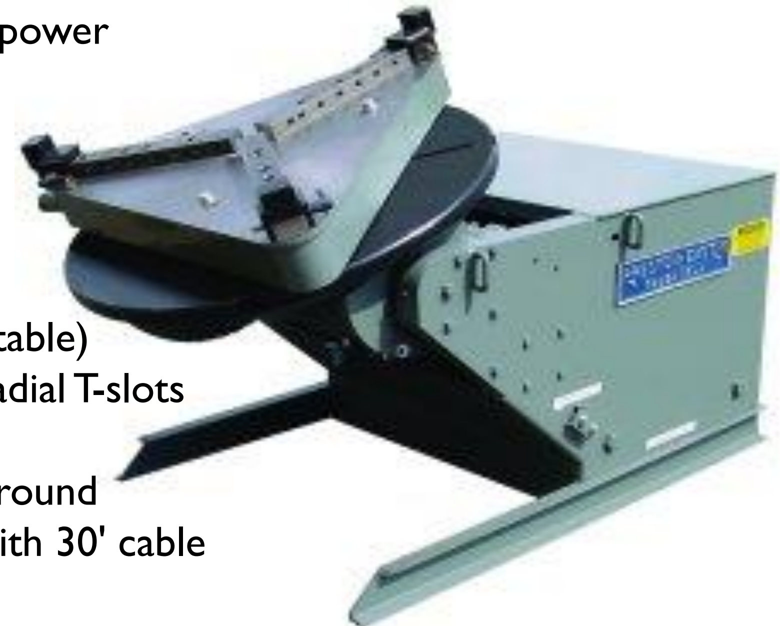
Motion control and positioning
for welding and manufacturing since 1972

Problem Statement

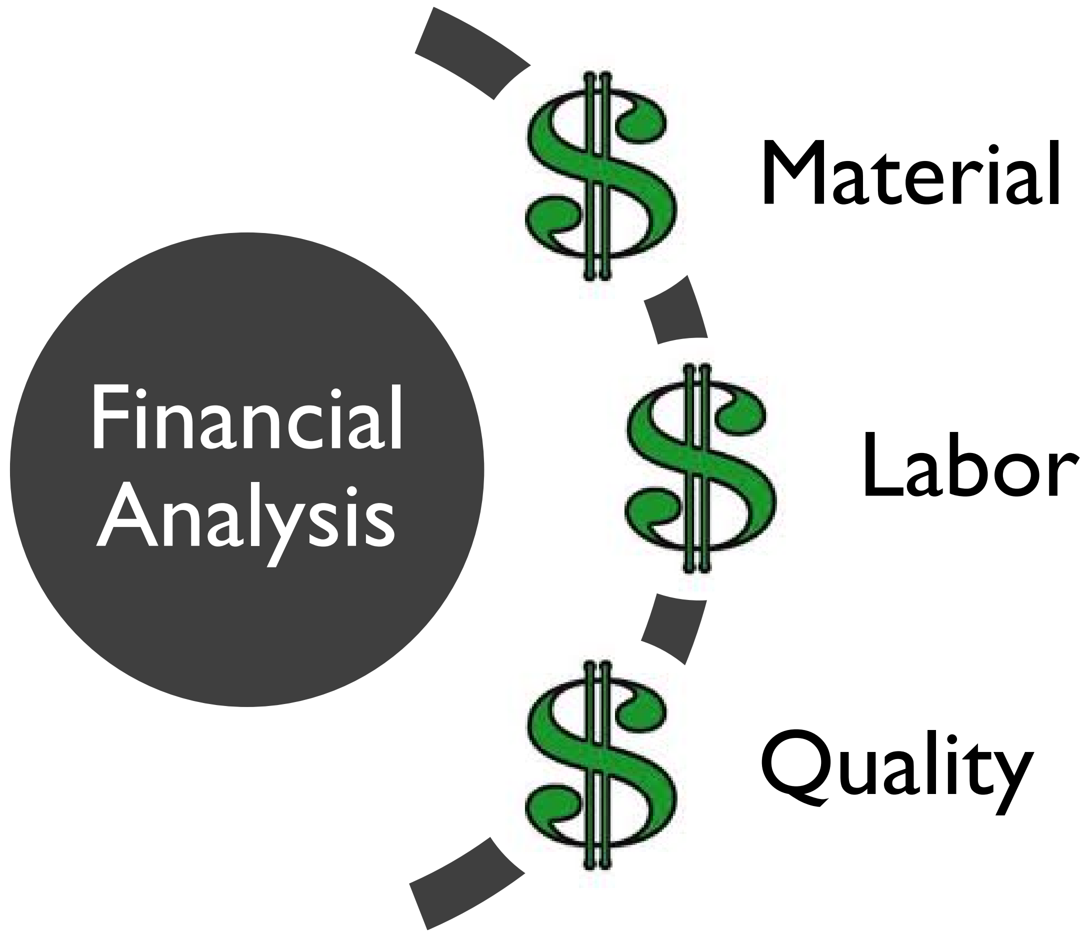
- PA30 HD-6 Welding Positioner
- Increase Profit Margin
- Increasing Competition
- Maintain Quality
- Create Best Possible Solution

Current Product

Capacity Weight: 3000 pounds
Offset of C.G. from table: 6 inches
Eccentricity of C.G. from axis: 6 inches
Rotation Motor: Variable speed DC, 1 horsepower
Speed range: 0.1 to 2.0 rpm
Tilt Motor: AC brakemotor, 3/4 horsepower
Range: 135 degrees forward tilt
Inherent Overhang: 6 inches
Elevation Adjustment: Manual
Range: 33" to 53" in 4" increments (to top of table)
Table Diameter: 36 inch square, with four radial T-slots
Bearings: Timken tapered roller bearings
Ground: 600 amp spring-loaded mechanical ground
Controls Pendant: Remote pendant 115V, with 30' cable
Rotation speed: One-turn potentiometer
Rotation mode: Two-position selector switch, WELD/RAPID
Rotation direction: Three-position selector switch
Rotation control: START and STOP pushbuttons
Tilt control: Three-position momentary switch,



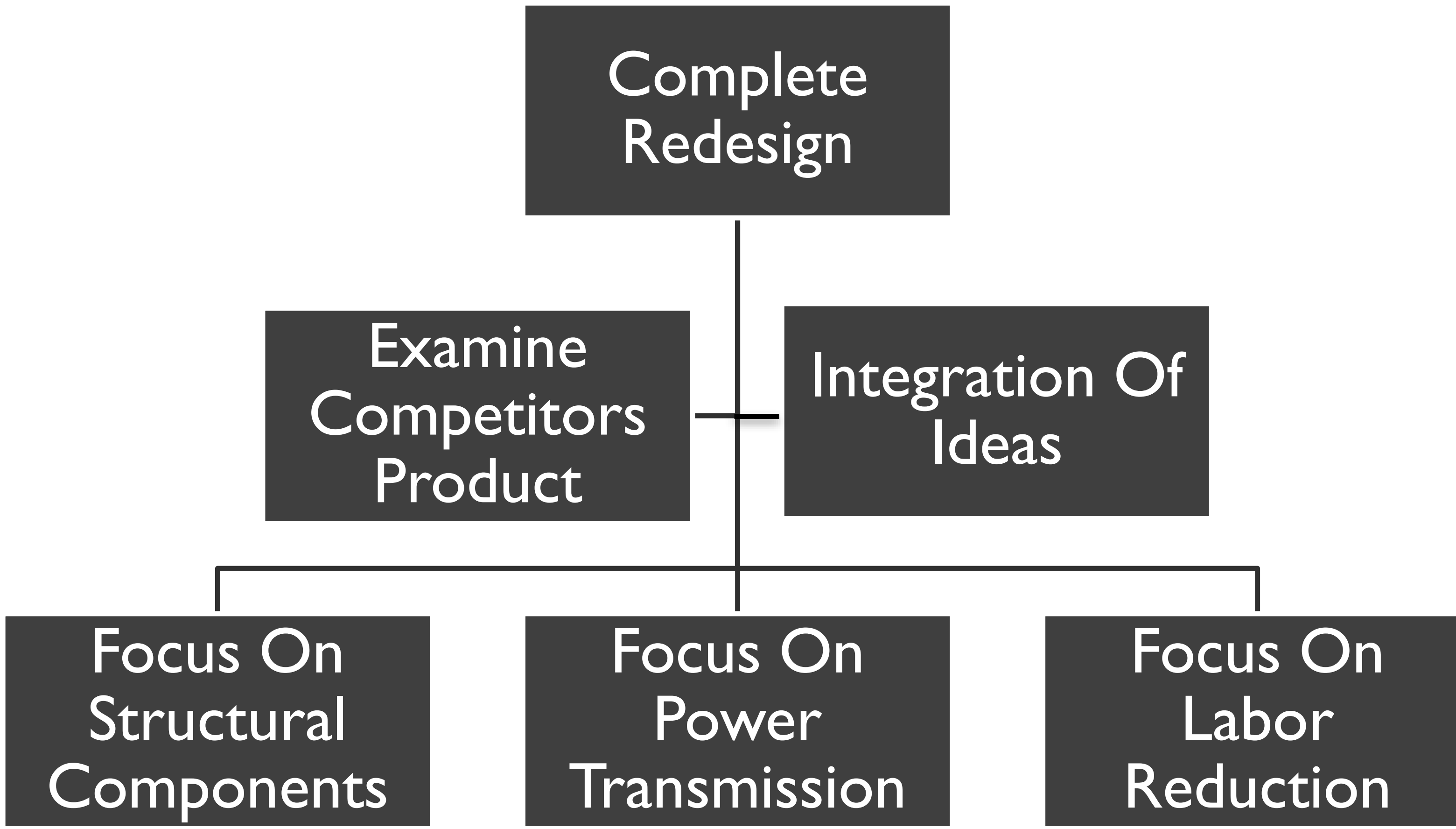
Fall 2011



Fall 2011

- Financial Analysis
- Unable To Find Substantial Savings
- Decided To Redesign Machine From The Ground Up

Spring 2012 Design Plan

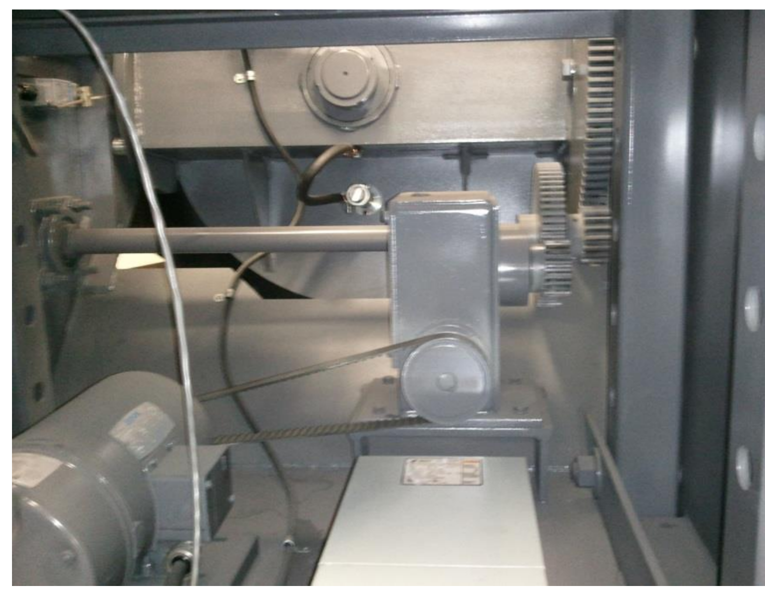


Structural Components

- Machine Time Reduction
- Manufacture Simplification
- Reduction Of Unnecessary Components

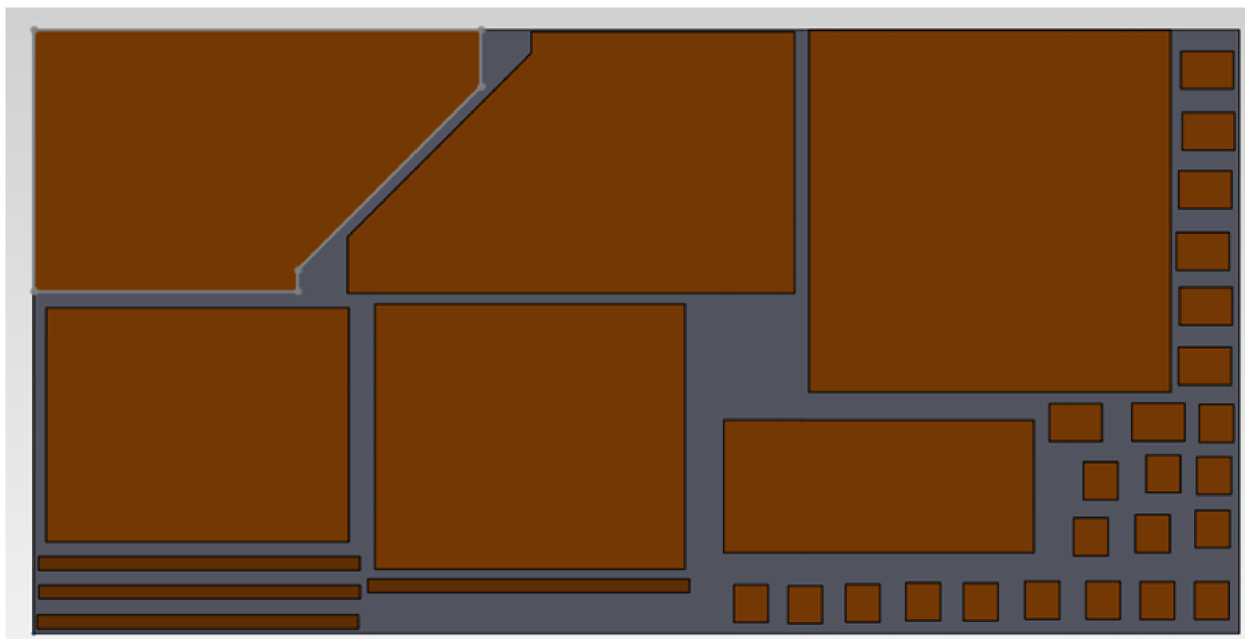
Design Changes-Outer Plates

- Single Sheet Design
- Simplify Trunnion Mounting
- Remove Unnecessary Plates
- Decrease Machine Time



Design Changes-Single Sheet

- 5’x10’-3/8” Steel Sheet
- Steel Arrives Pre-cut



Design Changes-Original Side Plates

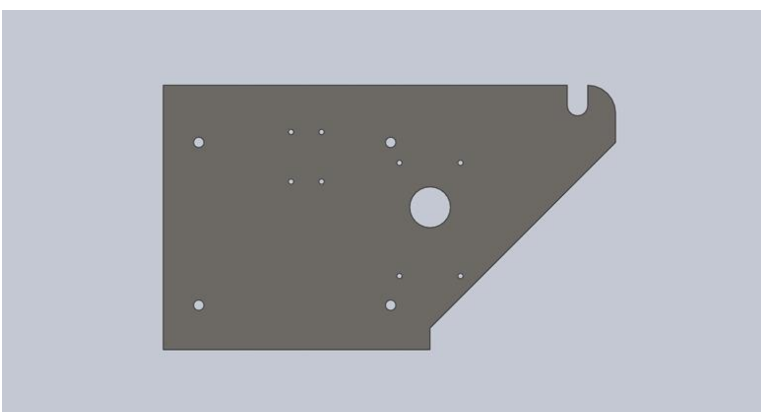
- Right Side Plate
- 20 Machined Holes
- Precision Machined For Trunnion Box

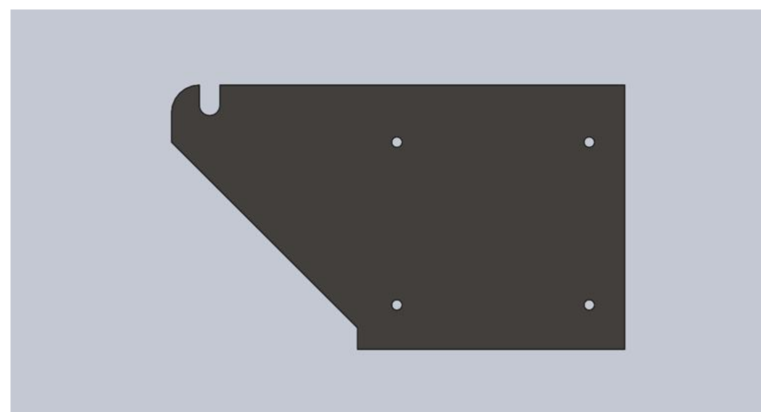
- Left Side Plate
- 20 Machined Holes

Design Changes-Side Plates

- Right Side Plate
- 13 Burnt Holes
- Notch Design
- Less Machine Time
- Easier Trunnion Mounting

- Left Side Plate
- 4 Burnt Holes



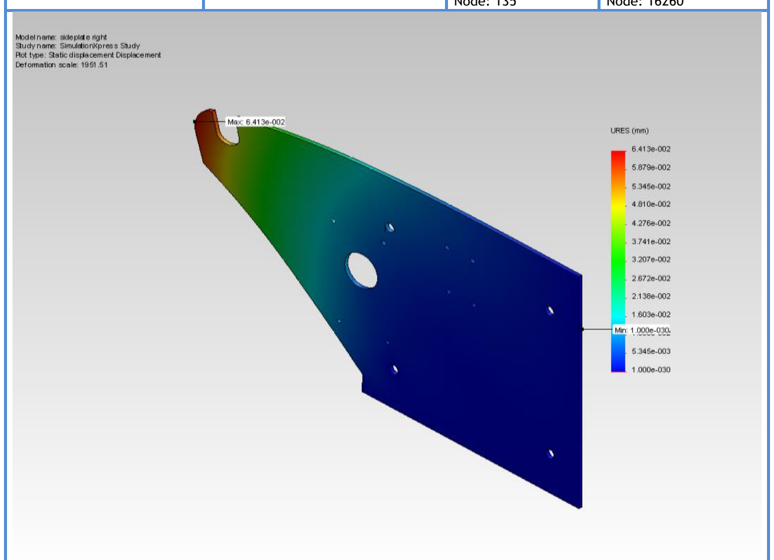


Stress Analysis-Outer Plates

- 3000lb Load Applied
- Maximum Deformation .002 Inches
- Factor of Safety 6

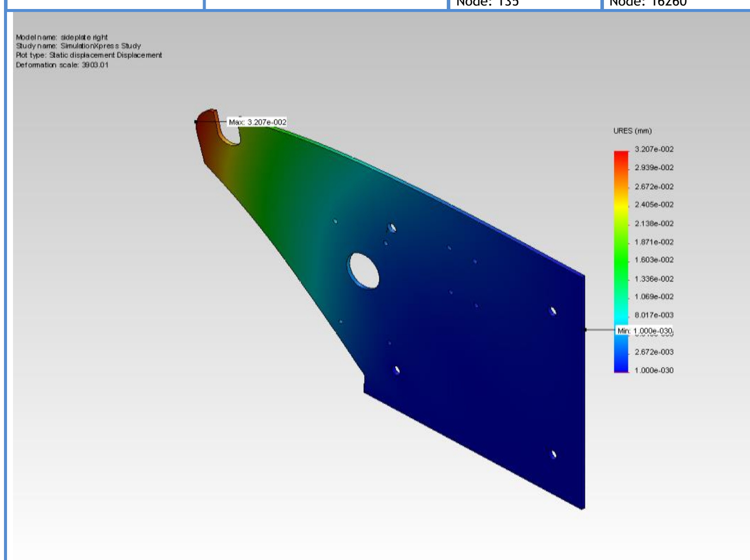
- 1500lb Load Applied
- Maximum Deformation .001 Inches
- Factor of Safety 11

Name	Type	Min	Max
Displacement	URES: Resultant Displacement	0 mm Node: 135	0.0641343 mm Node: 16260



sideplate right-SimulationXpress Study-Displacement-Displacement

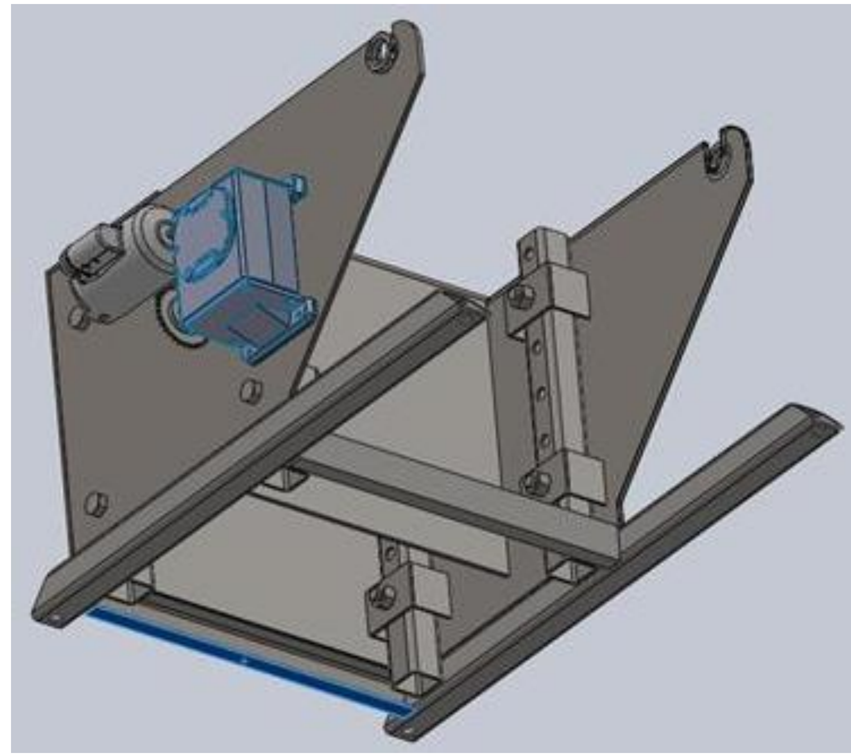
Name	Type	Min	Max
Displacement	URES: Resultant Displacement	0 mm Node: 135	0.0320671 mm Node: 16260



sideplate right-SimulationXpress Study-Displacement-Displacement

Design Changes-Inside Plates

- Removed Bottom Plate
- Removed Front Angled Plate
- Shortened Top Plate
- Added New Front Plate



Cost Savings

Part	Original Cost	Part	New Cost	Savings
Side Plate 45" X 25 7/8" X 3/8" (2)	193.29	Side Plate 44 1/2" X 26" X 3/8" (2)	141.15	52.14
Front Plate 35 1/2" X 13 1/2" X 3/8"	38.34	Front Plate 30 1/8" X 23 1/2" X 3/8"	43.18	-4.84
Back Door 11 GA X 25" X 33 1/4"^	18.83	Back Plate 33 7/8" X 26 3/8" x 3/8"	54.5	-35.67
Bottom Plate 35 1/8" X 26 1/8" X 1/4"	60.56	Bottom Plate (N/A)	0	60.56
Top Plate 26 7/8" x 36" X 1/4"	63.86	Top Plate 13 3/16" X 30 7/8" X 3/8"	24.84	39.02
Manufacturing Time Hrs(20)	1040	Manufacturing Time Hrs(15)	780	260
Total	1,414.88	Total	1,043.67	371.21

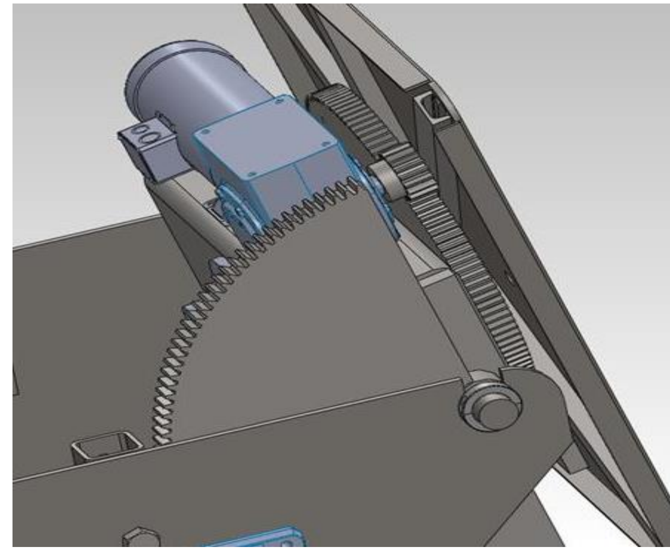
Design Changes-Trunnion

- Machined to Large Tilt Gear
- Has to be Precision Machined for Alignment
- Bearings Mounted on to Side Plate

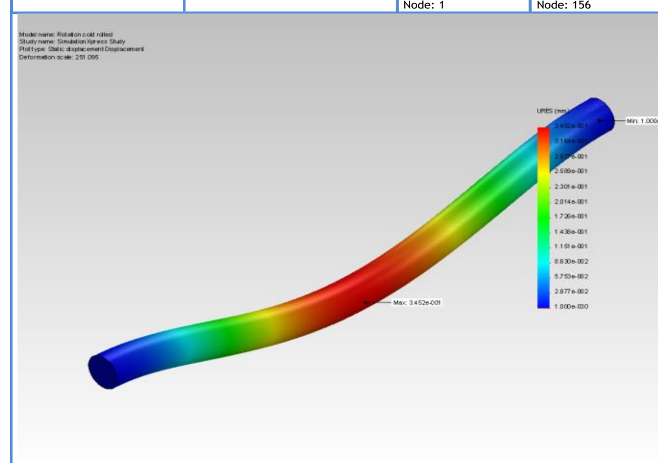
Design Changes-Trunnion

- Attached to Tilt Gear
- Through shaft
- Shaft Mounted into Notches Side Plates

- Shaft Analysis:
- Min Displacement-0in
  Max Displacement-.01in
- SF-5



Name	Type	Min	Max
Displacement	URES: Resultant Displacement	0 mm Node: 1	0.345198 mm Node: 156



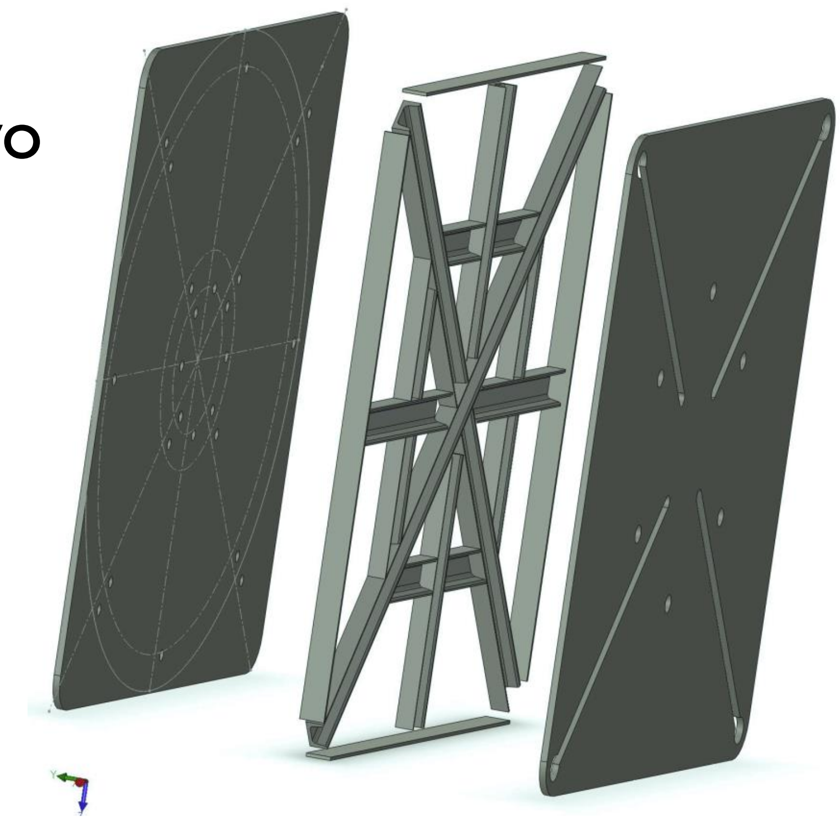
Rotation cold rolled-SimulationXpress Study-Displacement-Displacement

Cost Savings

Part	Original Cost	Part	New Cost	Savings
Box MC8-22.8# channel 27 1/2" (2)	100.13	Box Square tube 10" X 8" X 25" X 1"^	180.00	-79.87
End Plates 1" THK X 13 1/4" dia.	76.76	End Plates 9 7/16" X 7 7/16" X 1"^	46.50	30.26
Tilt Rod 11" X 2 1/2" DIA HR1020*	24.76	Tilt Rod 34 1/8" X 2" DIA CR1020*	37.54	-12.78
Mounting Plates 18 13/16" X 8" X 2"	56.91	-	-	56.91
Manufacturing Time Hrs(32)	1664	Manufacturing Time Hrs(10)	520	1144
Total	1,922.56	Total	794.04	1,128.52

Design Changes-Sandwich Table

- Original Sandwich Table
- Full Channel Mesh Welded Between Two 3/8" Steel Plates

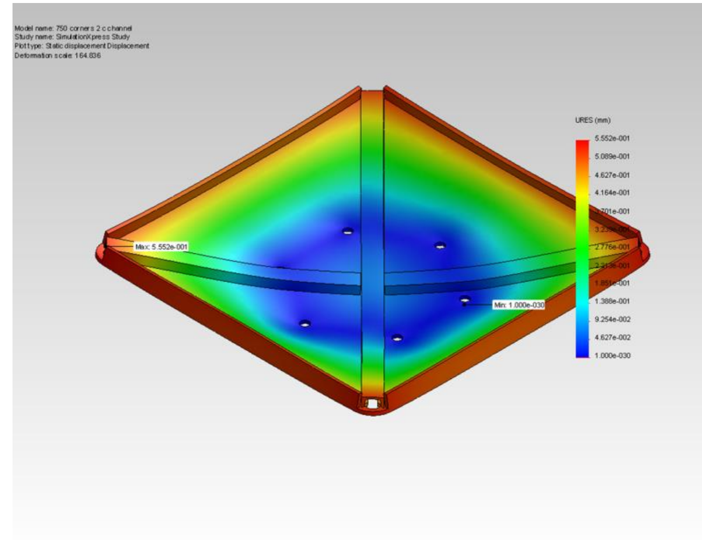


Design Changes-Table

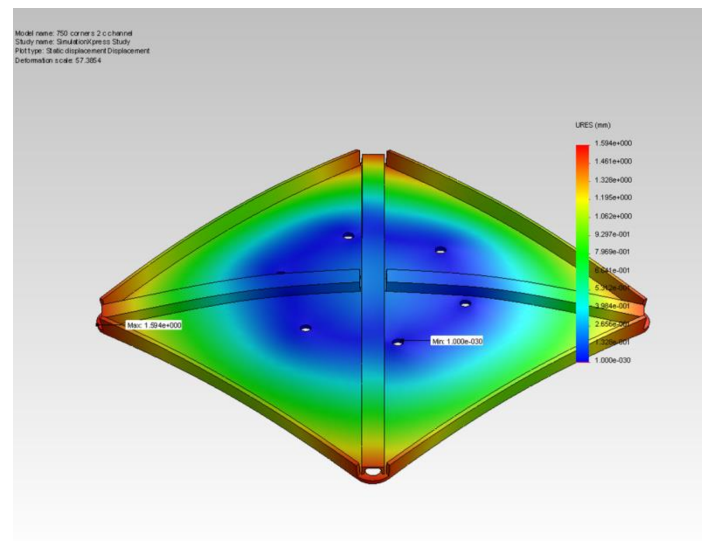
- Removed Back Plate
- Removed Most C Channel Web

Stress Analysis-Sandwich Table

- 3000lbs Load Displaced Over Face
- Max Displacement-.02in
- Factor of Safety – 2.83



- 750lbs Load in Each Corner
- Max Displacement-.06in
- Factor of Safety – 1.24



Cost Savings

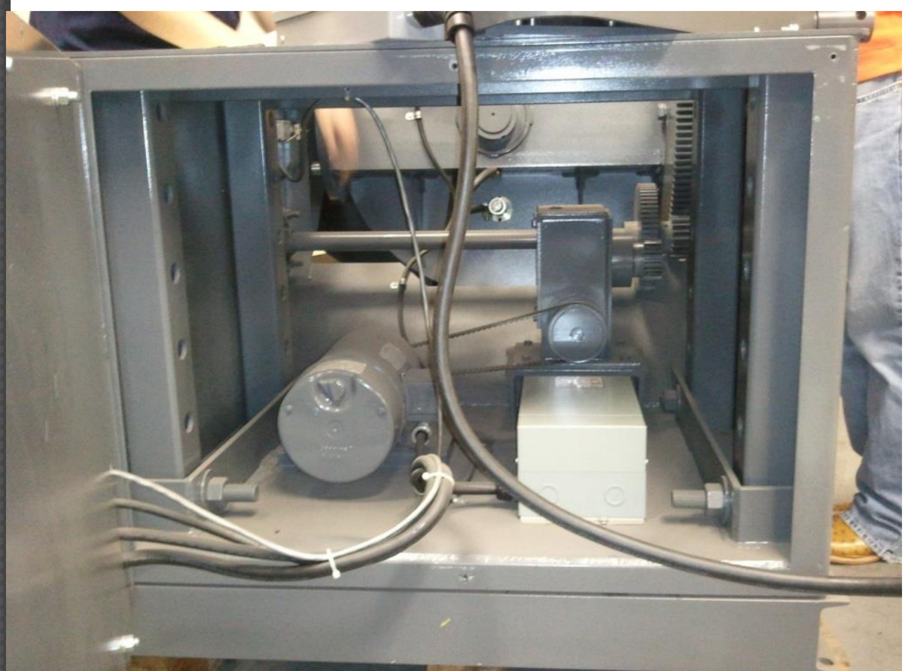
Part	Original Cost	Part	New Cost	Savings
Table 36" X 36" X 3/8" (2)	207.36	Table 36" X 36" X 3/8"	79.06	128.30
C channel 2" X 1" X 3/16" X 214 3/8"	49.31	C channel 2" X 1" X 3/16" X 93 1/4"	21.45	27.86
Table gard 3/16" X 128" X 1 3/8"	8.27	Table gard 3/16" X 128" X 1 3/8"	10.74	-2.47
Manufacturing Time Hrs(10)	520	Manufacturing Time Hrs(5)	260	260
Total	784.94	Total	371.25	413.69

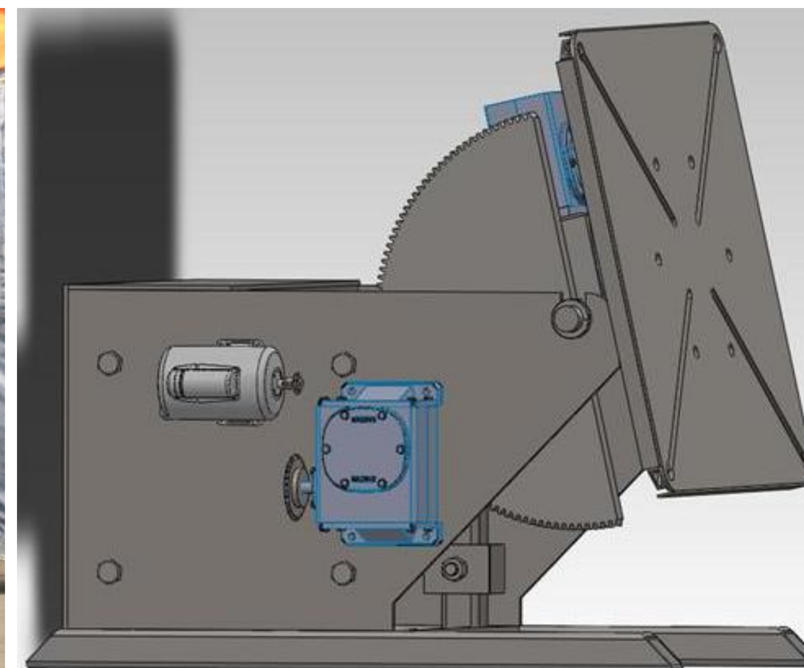
Design Changes-Power Transmission

- Power Transmission
  - Tilt System
    - Gear Boxes
    - Gears
    - Mounting
  - Rotation System

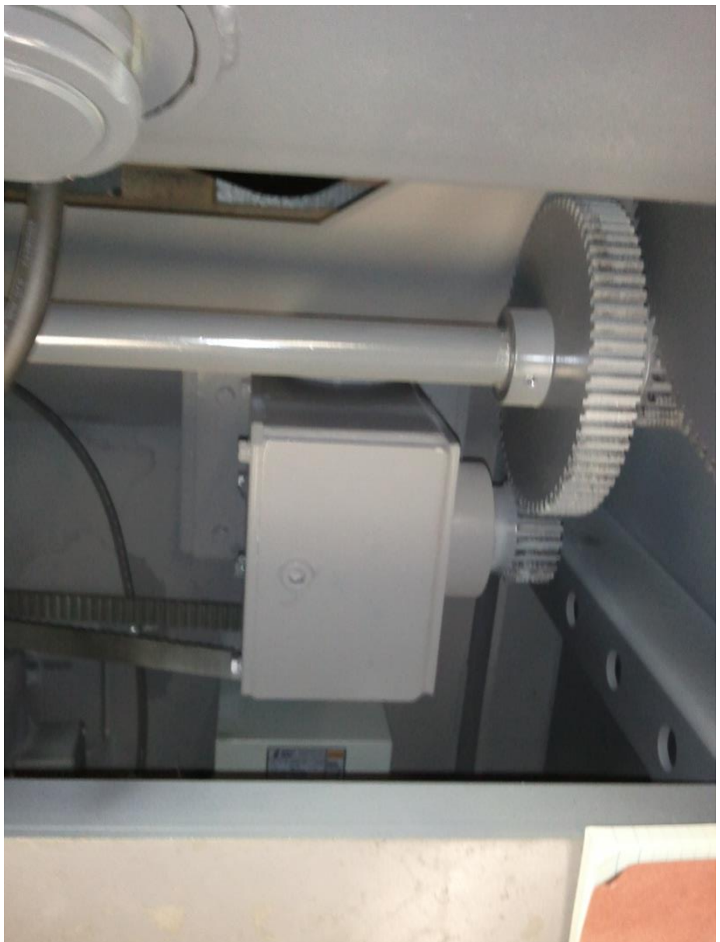
Design Changes-Tilt System

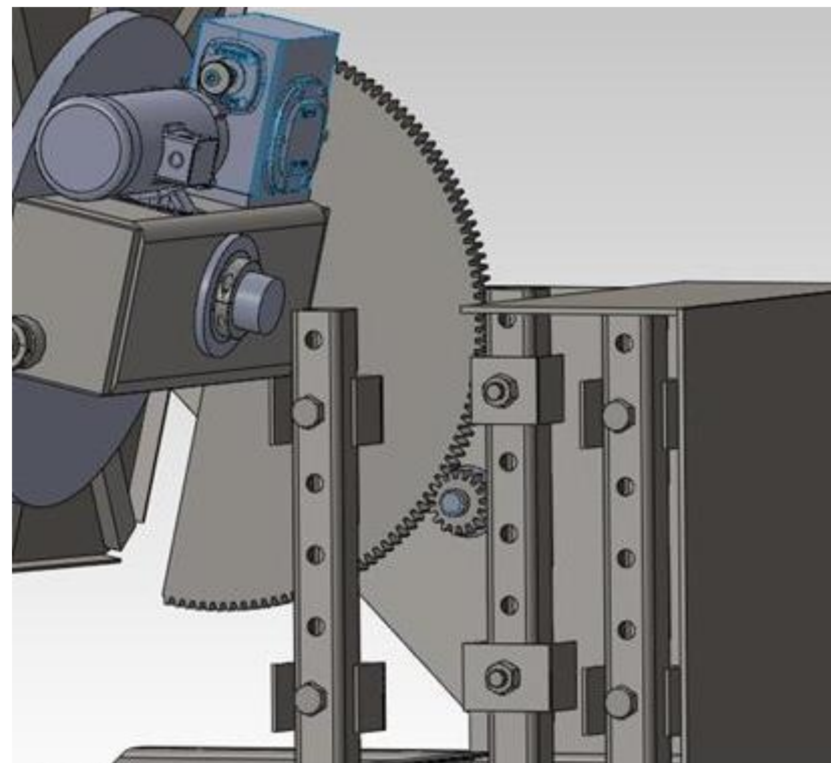
- Replace Custom Gear Box
- Remove Unnecessary Gears
- Outside Mounting
- Direct Drive To Segment Gear



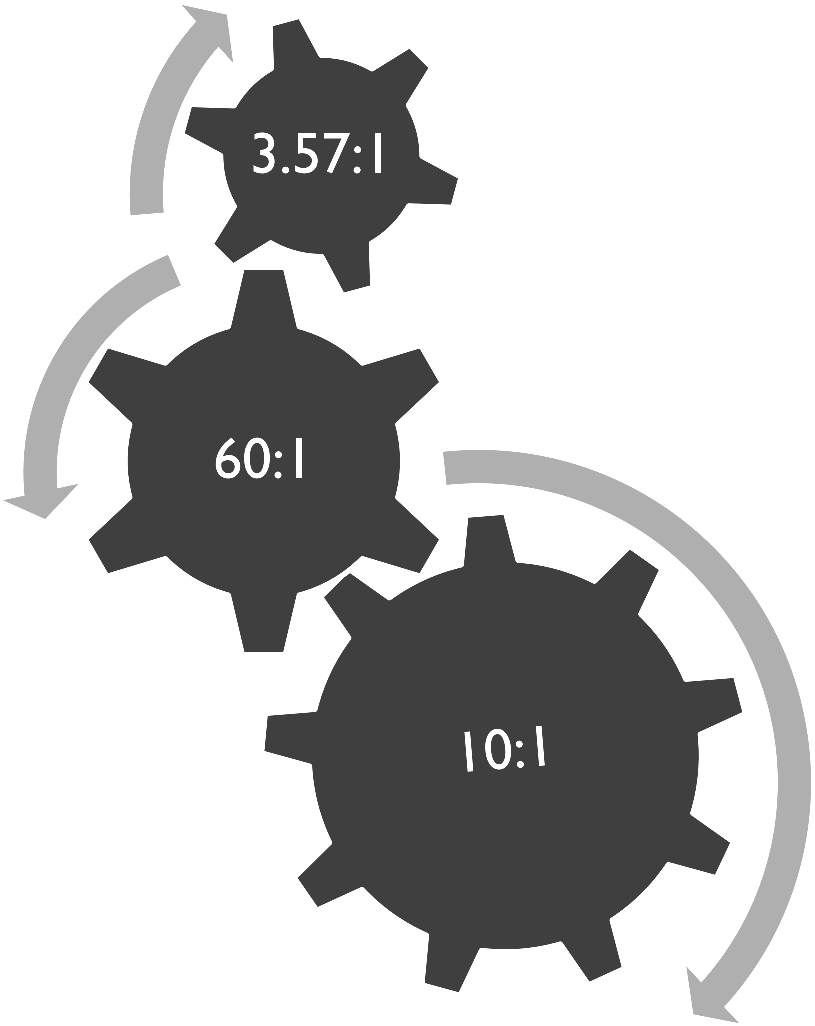


Design Changes- Tilt System





Design Changes-Tilt System



Reduction	Torque	RPM
	.25	1750
3.57:1	.8925	490.19
60:1	53.55	8.169
10:1	535.5	.8190
Total Reduction	2142	

Original vs. New Design Specs

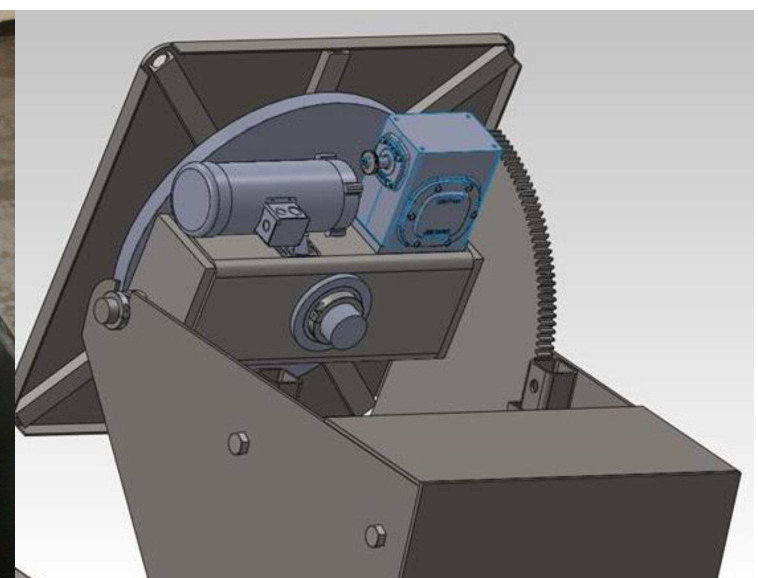
Original Design		New Design	
Tilt Range	0 - 135°	Tilt Range	0 - 135°
Tilt Motor	¾ HP AC Break Motor	Tilt Motor	¾ HP AC Break Motor
Inherent PSI	36000	Inherent PSI	35745
Reduction	2363	Reduction	2142
Capacity 6in off face	5627lbs	Capacity 6in off face	4834lbs
Tilt Speed	135° In 11 ¼ sec [12°/sec]	Tilt Speed	135° in 27 ½ sec [4.9°/sec]

Cost Savings

Part	Original Cost	Part	New Cost	Savings
In House Gear Box est. cost	1500	Boston 730D-60-J Gearbox	1000	500
Tilt Pinion Gear 18 teeth 6 pitch	65	16 tooth Gear 5 pitch	200	-135
Tilt Drive Gear 64 teeth 8 pitch	65	-	-	65
Tilt Gearbox Gear 22 teeth 8 pitch	45	-	-	45
Tilt Gear 1/2 144 teeth gear 6 pitch	163	Tilt Gear 1/2 160 teeth 5 pitch	750	-587
Flange Bearing SF 1 1/2 (2)	30	-	-	30
Cross Shaft 35" X 1 1/2" HR1020*	21.14	-	-	21.14
Manufaturing Time Hrs(30)	1560	Manufaturing Time Hrs(10)	520	1040
Total	3,449.14	Total	2,470	979.14

Rotation System

Rotation Reduction	Reduction	Torque in-lbs	RPM
Dc Motor		.33	1750
Pulley	1.78:1	.59	984
Boston Reducer	50:1	29.3	20
Table Gear	6.67:1	195.6	3.0
	Total: 592.6		



Electrical

- After examining the electrical components we have determined that the current setup is what we found to be the most cost efficient.
- Foot pedal operation is now only a additional option at approximately $400

Savings

Current Model		New Design		Savings
Parts	Cost	Parts	Cost	
Flat Steel				
Side Plate 45" X 25 7/8" X 3/8" (2)	193.29	Side Plate 44 1/2" X 26" X 3/8" (2)	141.15	52.14
Front Plate 35 1/2" X 13 1/2" X 3/8"	38.34	Front Plate 30 1/8" X 23 1/2" X 3/8"	43.18	-4.84
Back Door 11 GA X 25" X 33 1/4"^	18.83	Back Plate 33 7/8" X 26 3/8" x 3/8"	54.5	-35.67
Bottom Plate 35 1/8" X 26 1/8" X 1/4"	60.56	Bottom Plate (N/A)	0	60.56
Top Plate 26 7/8" x 36" X 1/4"	63.86	Top Plate 13 3/16" X 30 7/8" X 3/8"	24.84	39.02
Base				
C channel C 4 X 7.25# X 52" (2)	51.13	C channel C 4 X 7.25# X 52" (2)	51.13	0.00
C channel C 4 X 7.25# X 34 3/4" (2)	34.17	C channel C 4 X 7.25# X 29 3/4" (2)	21.45	12.72
3" X 3" X 1/4" Sq. Tube 28 3/8" (4)	76.05	3" X 3" X 1/4" Sq. Tube 28 3/8" (4)	76.05	0.00

Savings

Current Model		New Design		Savings
Sandwich Table				
Table 36" X 36" X 3/8" (2)	207.36	Table 36" X 36" X 3/8"	79.06	128.30
C channel 2" X 1" X 3/16" X 214 3/8"	49.31	C channel 2" X 1" X 3/16" X 93 1/4"	21.45	27.86
Table gard 3/16" X 128" X 1 3/8"	8.27	Table gard 3/16" X 128" X 1 3/8"	10.74	-2.47
Tilt System				
In House Gear Box est. cost	1500	Boston 730D-60-J Gearbox	1000	500
Tilt Pinion Gear 18 teeth 6 pitch	65	16 tooth Gear 6 pitch		-135
Tilt Drive Gear 64 teeth 8 pitch	65	Tilt Gear 1/2 160 teeth 6 pitch		65
Tilt Gearbox Gear 22 teeth 8 pitch	45			45
Tilt Gear 1/2 144 teeth gear 6 pitch	325			-587
Flange Bearing SF 1 1/2 (2)	30			30
Cross Shaft 35" X 1 1/2" HR1020*	21.14			21.14

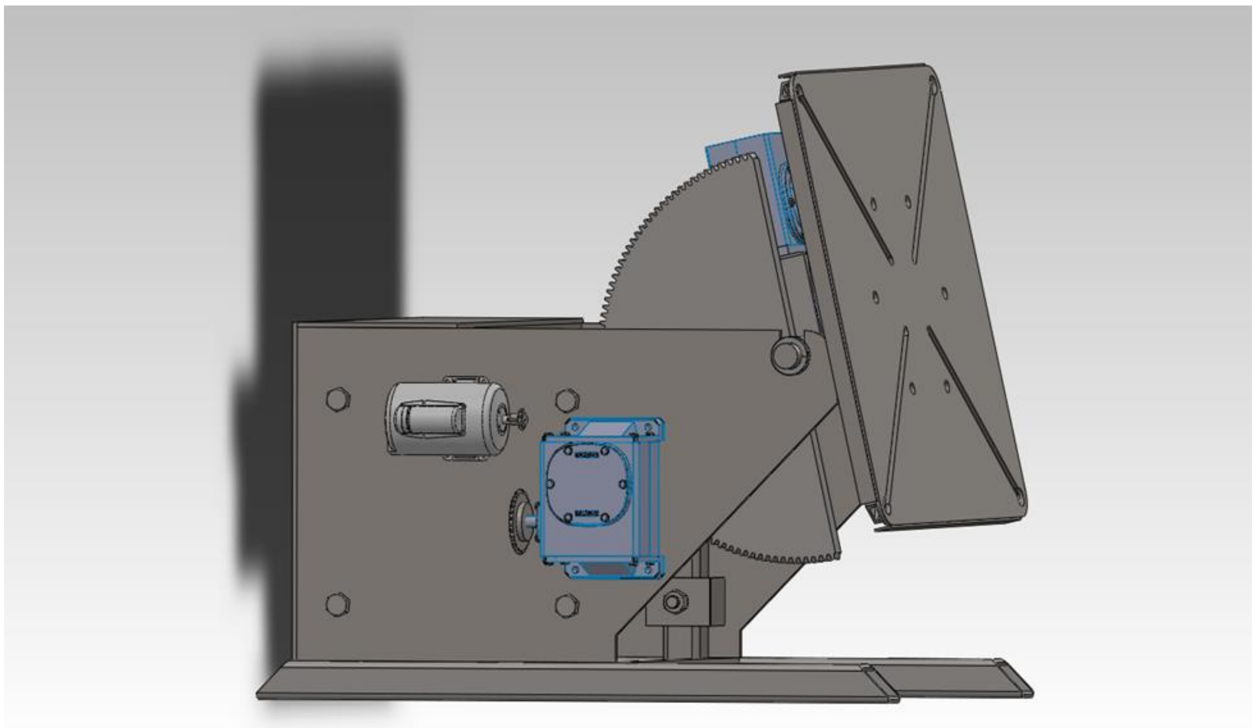
Savings

Current Model		New Design		Savings
Trunion Box/Mounting				
Box MC8-22.8# channel 27 1/2" (2)	100.13	Box Square tube 10" X 8" X 25" X 1"^	180	-79.87
End Plates 1" THK X 13 1/4" dia.	76.76	End Plates 9 7/16" X 7 7/16" X 1"^	46.5	30.26
Tilt Rod 11" X 2 1/2" DIA HR1020*	24.76	Tilt Rod 34 1/8" X 2" DIA CR1020*	37.54	-12.78
Mounting Plates 18 13/16" X 8" X 2"	56.91	-	-	56.91
Materials	2948.87	Materials	2737.59	211.28
Labor 100hrs @ $52/hr	5,200	Labor 40-60hrs @ $52/hr	2,080-3,120	2,080-3,120
Misc.	2,204.33	Misc.	2,204.33	-
Total	10353.20	Total	7021.92-8061.92	2,300-3,300

Conclusion

- 6 Major Components Eliminated
- Precision Machining was Eliminated
- Reduced Manufacturing Time by ~ 50%
- Reduced Ship Weight by ~ 40%

Questions??



Comparison of Table Specs

	Pan 30-6	PA-30 HD6	WP-3000
Overall Dim			
footprint	30" x 48 1/2"	38 3/16" X 52"	35 3/4" X 52"
Feet	6 x 2 Channel	4 x 2 Channel	4 X 2 Channel*
Overall Width	39 1/4"	38	43 1/4"
Rotation Offset	4"	6"	6"
C.G offset from table	4"	6"	6"
Overall Length	58 1/4"	71 1/8"	71 1/8"
Inherent Overhang	5 3/4"	6"	6"
Tilt Axis Height	27 1/4"	27"	27"
Load Capacity (lbs)	3000	3000	3000
Trunnion box	Rectangle Tube	C Channels weld together	Rectangular Tube
Trunnion size	8 X 10 X 22 1/2"	7 X 8 X 27 1/2"	8 X 10 X 25"
Side walls	1/2"	3/8"	1/2"
Machined hole on the side plates	16	40	17
Weld	skip weld mostly	mostly full welds	mostly full welds
Trunnion seems to be made standard and used for multiple assemblies			
Table			
Table layers	3 [plate, skirt & stiffener]	4 [2 plates, side plates, stiffeners, gear guard]	3 [Plate, skirt, & stiffener]
Length of stiffeners	5.33 feet	16.27 feet	7.77 feet
Stiffener size	1/2" x 3/4"	2" x 1" x 3/16"	2" x 1" x 3/16"
Number of Table Stiffnrs	4	16	3
Gear guard attachment	Trunnion	Table	
Table shape	Rectangular	Rectangular/Round	Square
Table Size	30" sq.	36" sq. [Round] 36"sq. [Rectangular]	36" X 36"
"T" Slot Quantity	4	4	4
ANSI Std "T" Nut Size	5/8"	3/4"	3/4"
Table height adjustment	No/ fixed	Manual	Manual
Table Height	32 5/8"	33"-53"	32" - 52"

Rotation			
Rotation motor size	1 HP	1 HP	1 HP
Max Rot speed	1.4 RPM	2.0 RPM	2.0 RPM
Min Rot speed	0.07	0.1 RPM	0.1 RPM
Speed Acc.		2%	2%
Rot torque	18000	18000	18000
Rotation reducer	60:1	50:1	50:1
Motors			
Voltage	230/460 V	230/460 V	230/460 V
Phases	three phase	three phase	three phase
Input power	60 hz	60 hz	60 hz
Amp	14.8 @ 230 V	20/10	20/10
Transmition of power			
Tilt	chain	Belt	Chain
Rotation	Belt	Belt	Belt
Tilt motor location	Outside of frame	In frame	Outside frame
Rot motor location	attached to trunnion	In Frame	In Frame
Motor guards	no	no	no
Tilt			
Tilt Range	0-135°	0-135°	0-135°
Tilt Motor	3/4 H.P. AC Break Motor	3/4 HP AC Break Motor	3/4 HP AC Break Motor
Tilt Speed	135° in 36 sec [3.75°/sec]	135° in 11 1/4 sec [12°/sec]	135° in 27 ½ sec [4.9°/sec]
Tilt Torque	32250 psi inherent	36000	36000
Tilt Gear			
Radius	16"	12.165"	16"
Teeth	80	72	80
width	1.385"	1 1/2"	1.385"
Pitch	5	6	5
Attach method	Bolted	welded/Bolted	Bolted
Tilt Axis turn attachment	bushing	Cross Shaft	Bushing/Shaft
Tilt Reductor	60:1	36:1	60:1
Misc.			
Ship Weight	1750 lb.	2100 lb.	~1350 lb.
Pendant cable length	25	30	30
Controls	Speed,Rapid, FWD, Rev, Stop, Tilt	Speed, Rot mode, FWD, REV, Tilt, Stop	Speed, Rot mode, FWD, REV, Tilt, Stop
pendant control	all except for Tilt	All	All
Optional Pedal	No	yes	Yes
Pendant material	Mold Plastic	Metal	Metal
Appearance	Simple minimal	Robust, Big, high safety factor	Simple
	minimal machining		Cost Efficient
	Bolt instead of weld		Effective

Fall 2011 Design Proposal Report

Team Members:

Dalton Hamilton

Brice Abbott

Levi Edens

Client Sponsor:

Preston-Eastin, Inc.

Kenneth Mui

Table of Contents

Mission Statement

Wolf Pack Engineering strives to provide our customer with innovative solutions. We take the problem of our customer and mold it into a competitive and cost effective idea or methodology to produce a successful product.

Problem Statement

Preston-Eastin has challenged us with analyzing their PA-30 HD6 welding positioner to produce a solution to their need for increased profit margins on their products. With increasing economic hardships to manufacturing businesses, profit margins are the number one priority, our team goal is to create a solution to their financial question, while maintaining the high quality they are accustom to providing.

Statement of Work

Company Background

Preston-Eastin is a leading supplier of positioning solutions for the industrial manufacturing and construction industries. Located in Tulsa, Oklahoma they design and build their own complete line of manual and robotic positioners to solve and complete all aspects of welding, fabrication, and thermal spray application successfully and efficiently.

Product

The PA-30 HD6 gear driven rotational positioner has been produced and sold by Preston-Eastin for numerous years with little to no design changes outside of electronic upgrades. Changes have not been a necessity due to the fact that the product is simple, effective, and boasts the high lifetime quality that comes standard with the Preston-Eastin name.

Scope of Work

To accomplish the goals set forth, the three engineers of Wolf Pack Engineering reviewed the designs and cost incorporated with the creation of the PA-30 HD6 rotational positioner. We developed the reduction of labor to be the major area of interest associated with the cost analysis breakdown to potentially reduce cost and increase profit margin. The areas associated with labor cost reduction include but are not limited to the in-house machining and production of gear boxes and other parts, and the workload associated with the wiring and electrical set-up of the final product.

Location of Work

All analysis of cost and designs take place on OSU's campus while any and all production of the product will be handled by Preston-Eastin upon their approval. All design changes will be created and communicated through the SolidWorks program while cost breakdown changes will be relayed via excel spreadsheets with comparisons to existing costs.

Time Period

Date	Delivery Report (Class)	(Actual)
Sept 28, 2011	Mission Statement	Mission Statement
Oct 21, 2011	Competitive Analysis	-
Oct 28, 2011	Statement of Work	Statement of Work
Oct 31, 2011	Gantt Charts	Gantt Chart
Nov 4, 2011	Work Breakdown Structure	*Begin Product Analysis*
Nov 7, 2011	Task List	-
Nov 14, 2011	Engr Specs and Design Concepts due	-
Nov 18, 2011	1^{st} Draft report	WBS/Competitive Analysis
Nov 21, 2011	Review report "draft"	1^{st} Draft Report
Dec 2, 2011	Report "2^{nd} draft version"	-
Dec 9, 2011	Final Report and Presentation	Final Fall Report/Presentation
Jan 13, 2011	Finalize Design	Continue Cost Analysis
Jan 16, 2011	Submit Final Design/Start building Prototype	-
Mar 30, 2011	Pick up Prototype	Turn in Final Analysis

April , 2011	Final report/Presentation	Final Report/Presentation

Delivery Table 3.5.1

Budget

The current budget of the product for Preston-Eastin is $12,658. Of this cost $7,503.398 comes from purchased parts, and $5,155 comes from in-house labor costs. This product generally sales at a cost of $18,000 showing a profit margin of roughly 30%. In collaboration with Preston-Eastin we have set a goal to reduce the cost of the machine to $10,000 to produce a profit margin of 44%. Both parties feel as if this high goal for cost reduction on this particular product.

Budget	*Parts*	*Labor*	*Total*	*Profit Margin*
Initial	$7,503.398	$5,155	$12,658	29%
Goal	$	$	$	%

Budget Table 3.6.1

Work Breakdown Schedule

Financial and Structural Analysis of PA-30 HD6

1. Initiation

   1.1 Initial Sponsor Evaluation

   1.2 Form Team Name Logo

   1.3 Initial Ag Econ Meeting

   1.4 Initial Sponsor Meeting

2. Planning

   2.1 Declare Initial Statements

2.2 Research Competitors

2.3 Find Applicable Patents

2.4 Form Competitive Analysis

2.5 Develop Business Plan

2.6 Develop Engineering Solutions

2.6.1 Identify Problems

2.6.2 Determine Solutions on Current Positioner

2.6.3 Make Changes and Convert to SolidWorks

2.7 Form Team Website

2.8 Submit Fall Design Report

2.9 Fall Design Presentation

3. Execution

3.1 Meet With Sponsor

3.2 Finalize Design With Sponsor

3.3 Prepare Material List for Prototype

3.4 Prototype Fabrication (at Preston-Eastin)

3.5 Final Reports

3.6 Final Presentation

Gantt Chart Provided in Appendix

Task List

Listed below are the tasks needed to complete the project in conjunction with our business partners.

Engineering	Business
Solidworks Conversions	Initial Cost Analysis

Structural Analysis	Competitive Analysis
Determine Design Changes	Market Research
Implement design Changes	Patent Search
Finalize Design with Sponsor	Labor Cost Analysis
Oversee Prototype Construction	Budget Agreement with Sponsor

Task Table 5.0.1

Competitive Analysis

Preston-Eastin is a company based out of Tulsa, Ok one of their main products is an automated welding positioner. Preston-Eastin takes pride in manufacturing one of the highest quality welding positioners on the market. The following contains an industry, customer, competitor and technical analysis which will allow us to determine the best way to design, build and sell welding positioners more effectively in today's market.

Industry Analysis

Welding positioners come in many sizes, weight capacities, functions, and prices. Simple positioners are the typical stationary table, the manual indexing table, and the motor driven tilt and rotating tables. Preston-Eastin products are mainly specialized simple products that fit the need of very specific customers so being able to market a specialized product to a small range of buyers is essential in being a successful manufacturer. They design and build manual and motor driven styles of positioners. One of the biggest problems that Preston-Eastin faces in the positioner marketplace is the need to increase profit margin on their products. They build one of the highest quality positioners on the market but with that quality also comes cost. The industry only has a few main manufacturers of welding positioners mostly based in the U.S. In today's economic standing manufacturers in places such as China are starting to consume the marketplace with cheaper lower quality products. As far as growth in the industry marketresearch.com predicts that the market for welding equipment will grow 15% over the next 5 years from 4.7 billion dollars to 5.5 billion dollars, with the entire welding industry already surpassing 16 billion dollars. So in order to capitalize on this growth and to maintain a foothold on a large portion of the marketplace Preston-Eastin must design, build and market the most economically efficient positioner they can in comparison to their competitors.

Customer/Buyers

The primary source of purchasers of positioners and other welding equipment are either solely or partially in the manufacturing production and fabrication service industry. The buyers of such equipment vary from company to company. Both large and small companies alike have similar needs as far as equipment needed to complete their product. Preston-Eastin's line of positioners that includes the PA30 HD-6 is designed for a product capacity in the hundreds of parts per month depending on the need of the purchaser. Amounts larger than that are typically more easily fabricated and completed by robotic positioners for the ease of use for such a large quantity of product. The PA30 HD-6 is one the best positioners available for mid-sized manufacturing products. With its usage capacity being 3000 pounds and 18000 pounds at a 90° angle, the positioner is compatible for the addition of parts during the fabrication process. It's large enough to compete and preform in the mid-sized product market without being too large to take up space and having a small enough shipping weight to be easily moved with a typical 2000lbs load forklift.

Client Company/Agency and its Resources

Preston-Eastin designs and manufactures a complete line of manual, electric and robotic welding positioners and manipulators. Since 1972, Preston-Eastin has provided innovative solutions to positioning requirements in the welding industry. At their state-of-the-art engineering and manufacturing facility in Tulsa, Oklahoma, they design and manufacture positioners for precision operations, while affording as much safety as possible. Drive mechanisms and electrical controls are completely enclosed for the operator's protection. They are constructed to afford the customer many years of safe and dependable operation. Preston Eastin understands their customers' needs, and quickly responds with solutions and service for any positioning requirement. New products and enhancements to their product lines ensure continued customer satisfaction worldwide.[1]

Preston Eastin has an extensive product line ranging from Positioners, Head and Tailstock Positioners, Floor Turntables, Turning Rolls, Specialty Rolls, Manipulators, Travel Cars, Strip Heads Welding Cross Slides, Side Beam Carriages, Chucks, Grippers & Jaws Jack Stands. Their expertise is providing the best positioning equipment the welding industry has to offer. One of the main ways they get their name into the positioning market place is through their distributors such as Air Gas and through trade shows like FabTech which is North Americas largest metal forming, fabricating, welding and finishing event. Their key customers are companies in the manufacturing and fabrication industry and it is up to their Director of Engineering Kenneth Mui to make sure that their clients' needs are satisfied.

Competitor Analysis

After the completion of the competitive analysis, Wolf Pack Engineering has collected and produced a short list of primary competitors in the positioner marketplace to Preston-Eastin, an analysis of their products, and a comparison of their cost and specifications.

Preston-Eastin's competes in a relatively small market for positioners in the welding industry, so knowledge of their competition is a vital component to being successful in the marketplace.

1. Koike Aronson, Inc. is the largest of Preston-Eastin's competitors. Koike is an international supplier of mostly all welding service products, from gases to cutting machines, positioners, and welding carriages. They build standard, stock models, as well as customer specific models, meeting any customer needs.

   Koike manufactures their positioners from a base model positioner so their HD-25 model through the HD-100 model is all the same framework with adjustments for the different load capacities coming in the form of increasing the horsepower in the motors. So even though Koike positioners are higher in price, a buyer can purchase a positioner with a lot higher load capacity for not a lot of increase in extra cost due to the only cost increase coming from an upgrade in motor sizes and an increase in the size of the sandwich table.

   Specifications for Koike Aronson Positioners listed in Appendix

http://www.google.com/imgres?q=koike+positioner+hd+25&um=1&hl=en&biw=1600&bih=815&tbm=isch&tbnid=0_fBIn3BV-05-M:&imgrefurl=http://pdf.directindustry.com/pdf/koike-aronson/positioners/19388-178374-_18.html&docid=u3Wx2nwObjAZkM&itg=1&imgurl=http://img.directindustry.com/pdf/repository_di/19388/positioners-178374_18b.jpg&w=772&h=1000&ei=aUrZTvWBDqjq0gHIornEDQ&zoom=1&iact=rc&dur=299&sig=117519645916129924265&page=1&tbnh=151&tbnw=116&start=0&ndsp=33&ved=1t:429,r:6,s:0&tx=54&ty=85

2. Pandjiris, Inc. the self-proclaimed leader in fixed welding automation is also an international company that provides a similar service to their customers as Preston-Eastin. Pandjiris based in St. Louis, Missouri has a 46,000 square foot facility that they create products to be sold throughout North America and multiple countries worldwide. They offer customer unique products as well as stock products. Pandjiris’ sixty plus

years of experience in the welding industry make them a large competitive force in the marketplace. The model 30-6 welding positioner is the Preston-Eastin PA30 HD-6's closet competition. This particular model in a made to stock product. Pandjiris has been able to hold prices on stock items since 1993 despite labor and materials cost increases through improved productivity.[2] Other cost savings come in the options they offer. Their product comes in a completely base model with multiple options including the foot switch, digital tachometer, dial weld, tach feedback, welding grounds, and grippers.

http://www.weldplus.com/product_details.asp?id=981&qs=

Company	Load Capacity at 6in (lbs)	Tilt Range (degrees)	Torque Tilt (in lbs)	Torque Rotation (in lbs)	Shipping Weight (lbs)	Price USD
Koike	3000	0-135	31,875	15,000	2100	22,175
Pandjiris	3000	0-135	35,250	18,000	1,750	13,190
Preston-Eastin	3000	0-135	36,000	18,000	2,100	18,000

Competitive Table 10.2.1

Patent Search

There were no relevant patents found during our product analysis that are still in effect to sway our opinions in any direction.

Customer Requirements

The typical customer of Preston-Eastin expects what has been produced since the company began, a high quality product. Preston-Eastin prides itself in a quality of work second to none. An average customer will have encountered a manufacturing problem that is need of a safe and reliable welding operation. Preston-Eastin offers a wide range of products to customers as well as an extensive list of additional add-on options to meet any customers situation, typical or unique.   Made-to-order products are always in demand when customers' needs change on a regular basis. Consequently, Preston-Eastin can adapt standard equipment, or design and custom-build equipment to fit the customer's specific needs. This flexibility has allowed Preston-Eastin to become one of the industry's leading suppliers of custom positioning products.

Engineering Specifications

Capacity:

- Weight: 3000 pounds
- Offset of C.G. from table: 6 inches
- Eccentricity of C.G. from axis: 6 inches

Rotation:

- Motor: Variable speed DC, 1 horsepower
- Speed range: 0.1 to 2.0 rpm
- Speed accuracy: 2% of set speed

Tilt:

- Motor: AC brakemotor, 3/4 horsepower
- Range: 135 degrees forward tilt
- Inherent Overhang: 6 inches

Elevation:

- Adjustment: Manual
- Range: 33" to 53" in 4" increments (to top of table)

Table:

- Diameter: 36 inch square, with four radial T-slots
- Mounting bolt size: 3/4 inch
- Bearings: Timken tapered roller bearings
- Ground: 600 amp spring-loaded mechanical ground

Controls:

- Pendant: Remote pendant 115V, with 30' cable
- Rotation speed: One-turn potentiometer
- Rotation mode: Two-position selector switch, WELD/RAPID
- Rotation direction: Three-position selector switch, FWD/OFF/REV
- Rotation control: START and STOP pushbuttons
- Tilt control: Three-position momentary switch, UP/OFF/DOWN
- Power: 460/230V, 10/20A, three phase, 60 hertz.
- Overload protection: Fused disconnect
- Foot switch: Optional

Weight:

Shipping weight: 2100 pounds

Costed Bill of Materials Report				Preston-Eastin, Inc.	
Component	Description	U/M	QTY	Std Cost	Cost of Bill
2020704	MA PA-30 HD6 NE NT	EA	1	5,299.068	5299.068
8080192	FSC 1/2-13 X 2-1/2" LONG	EA	8	0.460	3.680
8080197	FSC 3/4-13 X 2-1/2" LONG	EA	1	1.940	1.940
9090001	NAMEPLATE PE LARGE	EA	1	10.600	10.600
9090366	PLATE, DATA POSITIONER	EA	1	3.000	3.000
9090247	NAMEPLATE WARNING	EA	1	3.550	3.550
6060140	ENCLOSURE	EA	1	164.000	164.000
6060150	PANEL A20P20 HOFFMAN	EA	1	17.000	17.000
6060545	DRIVE DC PM1 MPA-04342	EA	1	225.800	225.800
6060546	CONTACTOR REVERSING PM-1	EA	1	118.560	118.560
6061462	SWITCH DSCONECT 194R NC030P3	EA	1	161.290	161.290
6061489	HANDLE DISCONNECT 194R-HS1	EA	1	21.400	21.400
6061490	SHAFT DISCONNECT 194R-R1	EA	1	13.310	13.310
6061498	REVERSE STARTER AE56DNOA	EA	1	249.500	249.500
6061697	HEATER PACK H2005-3	EA	1	17.400	17.400
6060046	HOLDER FUSE BUSS 4405	EA	1	3.620	3.620
6060047	FUSE 1/8 AMP AGC SERIES, BUSSM	EA	1	0.950	0.950
6060063	STRIP TERMINAL 14CNTCT 214SP	EA	1	7.730	7.730
6060019	TRNSFRMR 2 KVA 411-0091-000	EA	1	219.230	219.230
6060137	SWITCH LIMIT E50 NN1	EA	1	168.250	168.250
6060138	LEVER LIMIT SWITCH E50KL581	EA	1	19.350	19.350
6061749	CABLE 14-5 SEOOW	FEET	8	1.260	10.080
6063705	CABLE, 18-5/C STR, PVC, 300V	FEET	12	0.580	6.960
6060106	CABLE 14-4 SEOOW BLACK 600V	FEET	9	0.950	8.550
6060081	CABLE 14-3 SJO	FEET	14	0.400	5.600
6060020	TRANS CONTROL .05KVA C0050E2A	EA	1	55.600	55.600
6061463	FUSE FNQ-R-20-20AMP	EA	3	11.390	34.170
6060670	SA PENDANT POS/MANIP NEW	EA	1	230.050	230.050
6061052	SWITCH TOGGLE SPST 90-0001	EA	1	5.270	5.270
6060147	FOOTSWITCH RFS-20 1025C2SP-S	EA	1	354.000	354.000
6060262	BASE RELAY AMF P/B 27E123	EA	1	3.590	3.590
6060261	RELAY C/H D3PF3AA	EA	1	12.350	12.350
6060065	STRIP TERMINAL 5 CONTACT	EA	1	4.180	4.180

6063501	GRIP CORD CG90-6275	EA	1	9.430	9.430
6063503	GRIP CORD CG90-5075	EA	1	9.430	9.430
6063502	GRIP CORD 1/2" CG50A35090	EA	1	5.540	5.540
6063525	CORD GRIP CG90-3750	EA	1	7.220	7.220
6063121	CORD GRIP 3/4" RANGE .512	EA	3	1.650	4.950
6063120	CORD GRIP 1/2" RANGE .197-47	EA	2	1.270	2.540
6060050	FUSE FNM 1/2 AMP	EA	1	4.660	4.660
	TOTAL				7503.398

Costed Bill of Materials 15.0.1

Conceptual Changes and Plans

Throughout this semester we have been involved in the engineering and financial analysis of the PA30 HD-6 rotational positioner from Preston-Eastin. We began converting several of the main components into SolidWorks designs to get an idea of how are product is being manufactured. While doing so we began to see a couple primary areas of interest. Our areas of interest to primarily focus upon were the time spent machining and producing the product, and the cost of parts to manufacture the product.

Goals

During analysis our initial goals were to reduce labor cost, from machine time and man hours spent on completion of the product, as well as part cost. Preston-Eastin spends on average of one hundred man hours at a typical cost of $51.60 per employee hour, that dollar amount including overhead cost, bringing a total labor cost to be $5,160. Knowing the current price of producing the PA30 HD-6 is $12,658 our goal is to reduce this cost to $9,000 on a best case scenario.

We as a team plan to reduce cost in any way possible to achieve our goal 50% profit margin. Once achieving this, or as close as we can get, we will propose to Preston-Eastin the design and product differentiations as we have found them.

Product Cost

As a team we made the decision to limit our product analyze the high dollar items then work our way down in order of price. We began with motor analysis. The motors currently used on the positioner are the Boston 1HP DC drive motor for the rotational drive and the Leeson 3/4HP AC drive motor for the tilt drive. Looking at the motors led us directly to the gears used for rotational and tilt drive reductions to fit required torque specifications. Preston-Eastin uses a purchased gear box reduction system for the rotation. They purchase the matching Boston Reducer to go with the Boston motor used to drive the table. However, the tilt reducing gear system is manufactured in-house. Below is a table listing the current prices of motors and gearboxes used in the PA30 HD-6.

Motors

Current Motors and Speed Reducers	Price
Boston 50:1 Worm Gear Reducer for rotation	$746.86
1hp DC Motor for rotation	$341.79
36:1 Worm Gearbox for Tilt	$450-$650 (Estimation)
¾hp AC Motor for Tilt	$409.84

Motors and Speed Reducers 1

The first step we took in evaluating the cost of the motors and gearboxes was to look at the market and see if the currently used products on the PA30 HD-6 were the most cost efficient products to be using. We started our search primarily within American made, trusted, motor and gear box manufacturers to see if we were in fact using the most economical and highest quality products available. Although it turns out, products comparable to the ones currently used are relatively within the same price range and even in some instances more expensive as you can see listed in the table below.

Motors and Speed Reducers (Current Set-up, American made)	Price
50:1 Gear Reducer for rotation	$700.00-800.00
1hp DC Motor for rotation	$400-$1000.00
40:1 Worm Gearbox for Tilt	$400.00-$550.00
¾hp AC Motor for Tilt	$700.00-$900.00

Motors and Speed Reducers 2

Next, we decided to look into getting rid of the belt and pulley system between the motor and speed reducer in switching to NEMA 56C face motors and speed reducers to see if we could save any cost. As before we searched only within notable quality American made products. The main problem we faced when searching for a 56C face motor and speed reducer that met the reduction requirements from removing the belt and pulley for the PA30-HD6 was that both the speed reducers had to be moved up to an 80:1 ratio. As you can see from the table below the cost of using the 56C face motors and reducers is relatively close to the current cost of the current setup. Even though switching to this system doesn't necessarily save on initial cost, it does have the potential to save some on installation time.

Aftermarket (American)	Price
80:1 Worm Gear Reducer 56C for rotation	$450.00-$1200.00
1hp DC 56C Motor for rotation	$450.00-$1000.00
80:1 Worm Gearbox 56C for Tilt	$450.00-1200.00
¾hp AC 56C Motor for Tilt	$500.00-$1000.00

Motors and Speed Reducers 3

The last thing we searched for was cheap foreign made motors and speed reducers. All the motors and speed reducers we were able to find were all 56C face in design. We weren't able to find any cheap 80:1 foreign speed reducers so listed below is a table with 60:1 speed reducers which could be a cheap alternative to the 80:1 speed reducers and with some alterations in the driven gear sizes, could achieve the same total reductions.

Aftermarket (Foreign)	Price
60:1Worm Gear Reducer 56C for rotation	$238.00
1hp DC 56C Motor for rotation	$214.00
60:1 Worm Gear reducer 56C for Tilt	$238.00
¾hp AC 56C Motor for Tilt	$100.00-$300.00

Motors and Speed Reducers 4

<u>Structure</u>

Following the motor and gearbox analysis we began looking into the structural members that make up the positioner. Cost and weight analysis was done on the metal plate parts that make

Part	3/8"	5/16"	1/4"	3/16"	1/16" decrease	1/8" decrease
Side Plate	155.58	131.25	107.02		16%	31%
Bottom Plate			88.08	68.53	22%	
Front Plate	71.18	60.96	50.78		14%	29%
Table	175.46	147.81	120.27		16%	31%
Top Plate			89.97	69.99	22%	
Avg. Savings					18%	30%

up the assembly of the entire PA30 HD-6 machine. The parts that were chosen were done so for the fact that they are both structural and non-structural part. The price and weight reduction are shown in percentage form to show the average savings. Also shown are the potential savings by reduction of the sizes of the metals, in the following tables.

Size Reduction Table 15.5.1

From the table above an average of 18 percent of metal cost can be achieved by decreasing metal sizes by 1/16 of an inch. Also shown is a 30 percent metal cost savings by a reduction in the size of the steel by 1/8 of an inch. Assuming changes in steel sizes a max deflection calculation was done, under worst case scenario upon the original pieces and the 1/8 inch

Wt. in Lb.	**3/8"**	**5/16"**	**1/4"**	**3/16"**	**1/16" decrease**	**1/8" decrease**
Side Plate	121.32	101.04	80.85		17%	33%
Bottom Plate			65.06	48.81	25%	
Front Plate	50.99	42.47	33.35		17%	35%
Table	137.88	114.84	91.89		17%	33%
Top Plate			66.64	49.99	25%	
Avg. Wt. Reduction					20%	34%

reduced pieces, which yielded 20 percent more deflection when reducing the metal thickness from 3/8 to 5/16 of an inch. This loss of some deflection strength also brings a reduction in cost and weight of the machine.

Weight Reduction Table 15.5.2

This table above shows the potential weight reduction to the PA30 by decreasing metal sizes by 1/16 and 1/8 of an inch. By decreasing the metal 1/16 of an inch there will be approximately a

20 percent weight reduction. We continued the analysis by dropping steel by another 1/8 of an inch. This reduction will gain an approximate 34 percent to the total raw metal weight of the PA30. These two tables show the potential benefits to decreasing the metal thicknesses on the PA30. Savings on the overall cost to produce it and the weight reduction will reduce shipping costs. The negative aspect to lowering the metal thickness is the decrease in metal strength and integrity.

Electrical

Next we examined the electrical aspect of controlling the PA30 HD-6. The electronic controls of the PA30 HD-6 are very basic and straight forward. After examining the individual components with an electrician in the Biosystems Department on campus, it has been concluded that the current electrical setup being used is the simplest, cheapest way to control the two electrical motors onboard the PA30-HD. The only way we found we could reduce cost of the electrical aspect is to possibly condense the components down into a smaller control box.

Fall 2011 Conclusion

After evaluating the cost aspects of the PA30 HD-6 we have determined that there is not a significant amount of cost that can be cut out of the machine but we have listed above a few options that should be taken into consideration. During the spring semester we will continue to look at new aspects to find cost savings. We have found several savings options when looking at using thinner plate metal, foreign made electric motors and gear boxes, as well as an extensive look at labor.

Spring 2012 Plans

Goals

In the spring semester of 2012 we plan on further continuing our cost analysis of purchased parts along with an extensive look and a detailed labor and production cost evaluation. As stated in our conclusion, cutting the cost of the PA30-HD solely through reducing the bill of materials is not going to be a sufficient enough way to significantly reduce the cost of the machine. We plan on taking a further look into the production of the PA30-HD in perspective of the labor side of things and determining the most cost efficient way to produce a PA30-HD from the ground up. We also plan on looking into designing an economy model, basically the same specifications of the current machine but made with some thinner materials in certain areas, inexpensive motors and speed reducers, comparatively, and without any extra options like foot controls, different table shapes, as well as several more items.

Labor Cost

A major cost in the production of the PA30-HD comes in the form of labor. Labor cost make up 40% of the total cost of producing a PA30-HD. We plan on taking an in depth look at the processes that go into the manufacture of a PA30-HD and determining the most cost friendly and efficient way to manufacture a machine. Whether that be building them to stock with an assembly line fashion or simply examining some of the practices that are currently used and changing them to be faster and more efficient.

Model Changes

The design of an economy model could be a good opportunity for Preston-Eastin to maintain the current high quality positioner that they already produce while also offering a cheaper version to customers who don't necessarily need as much rigidity and durability with their product. It could also be more cost efficient to mass produce and build to stock an economy model due to the fact of it being more basic without any extra options or customer specifications that could slow down production.

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WOLFPACK Engineering

Members:

Dalton Hamilton

Levi Edens

Brice Abbott

Sponsor:

Preston-Eastin

Kenneth Mui

Mission Statement

- Wolf Pack Engineering strives to provide our customer with innovative solutions. We take the problem of our customer and mold it into a competitive and cost effective idea or methodology to produce a successful product.

Preston-Eastin

- Company began in 1972
- Design and Manufacture
- Based in Tulsa, Ok
- Large Product Line
- High Quality
  - Safe
  - Reliable
  - Long Lasting

PRESTON-EASTIN

Motion control and positioning for welding and manufacturing since 1972

Problem Statement

- PA30 HD-6 Welding Positioner
- Increase Profit Margin
- Increasing Economic Hardships
- Maintain High Quality
- Create Best Possible Solution

Scope of Work

- Labor
  - Reduction
  - In-House Machining
  - In-House Production

- Parts
  - Motor Cost
  - Gear Cost
  - Misc Part Cost

Location of Work

- Product analysis
  - Biosystems Lab

- Product Production
  - Preston-Eastin

Schedule of Work

Date	Delivery Report (Class)	Delivery Report (Actual)
Sept 28, 2011	Mission Statement	Mission Statement
Oct 21, 2011	Competitive Analysis	-
Oct 28, 2011	Statement of Work	Statement of Work
Oct 31, 2011	Gantt Charts	Gantt Chart
Nov 4, 2011	Work Breakdown Structure	*Begin Product Analysis*
Nov 7, 2011	Task List	-
Nov 14, 2011	Engr Specs and Design Concepts due	-
Nov 18, 2011	1st Draft report	WBS/Competitive Analysis
Nov 21, 2011	Review report "draft"	1st Draft Report
Dec 2, 2011	Report "2nd draft version"	-
Dec 9, 2011	Final Report and Presentation	Final Fall Report/Presentation
Jan 13, 2011	Finalize Design	Continue Cost Analysis
Jan 16, 2011	Submit Final Design/Start building Prototype	-
Mar 30, 2011	Pick up Prototype	Turn in Final Analysis
April , 2011	Final report/Presentation	Final Report/Presentation

Work Breakdown

Initiation

- Initial Sponsor Evaluation
- Form Team Name Logo
- Initial Ag Econ Meeting
- Initial Sponsor Meeting

Planning

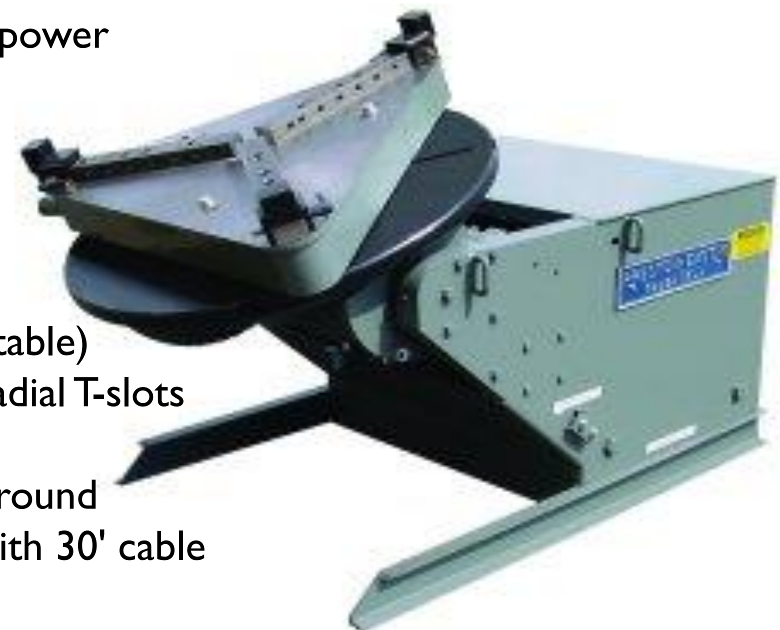
- Declare Initial Statements
- Research Competitors
- Find Applicable Patents
- Form Competitive Analysis
- Develop Business Plan
- Develop Engineering Solutions
    - Identify Problems
    - Determine Solutions on Current Positioner
    - Make Changes and Convert to SolidWorks
- Form Team Website
- Submit Fall Design Report
- Fall Design Presentation

Execution

- Meet With Sponsor
- Finalize Design With Sponsor
- Prepare Material List for Prototype
- Prototype Fabrication (at Preston-Eastin)
- Final Reports
- Final Presentation

Current Product

Capacity Weight: 3000 pounds
Offset of C.G. from table: 6 inches
Eccentricity of C.G. from axis: 6 inches
Rotation Motor: Variable speed DC, 1 horsepower
Speed range: 0.1 to 2.0 rpm
Tilt Motor: AC brakemotor, 3/4 horsepower
Range: 135 degrees forward tilt
Inherent Overhang: 6 inches
Elevation Adjustment: Manual
Range: 33" to 53" in 4" increments (to top of table)
Table Diameter: 36 inch square, with four radial T-slots
Bearings: Timken tapered roller bearings
Ground: 600 amp spring-loaded mechanical ground
Controls Pendant: Remote pendant 115V, with 30' cable
Rotation speed: One-turn potentiometer
Rotation mode: Two-position selector switch, WELD/RAPID
Rotation direction: Three-position selector switch
Rotation control: START and STOP pushbuttons
Tilt control: Three-position momentary switch,



Competitors

Koike Aronson, Inc.

RANSOME

PANDJIRIS®

#1 in Fixed Welding Automation

Koike Aronson, Inc.

- Largest competitor
- International Supplier
- Any Welding Service Product
  - Gases
  - Cutting Machines
  - Positioners
- Models
  - Stock
  - Customer Specific

Koike Aronson, Inc

http://www.google.com/imgres?q=koike+positioner+hd+25&um=1&hl=en&biw=1600&bih=815&tbm=isch&tbnid=0_fBIn3BV-05-M:&imgrefurl=http://pdf.directindustry.com/pdf/koike-aronson/positioners/19388-178374-_18.html&docid=u3Wx2nwObjAZkM&itg=1&imgurl=http://img.directindustry.com/pdf/repository_di/19388/positioners-178374_18b.jpg&w=772&h=1000&ei=aUrZTvWBDqjq0gHIornEDQ&zoom=1&iact=rc&dur=299&sig=117519645916129924265&page=1&tbnh=151&tbnw=116&start=0&ndsp=33&ved=1t:429,r:6,s:0&tx=54&ty=85

Pandjiris, Inc.

- Pandjiris, Inc. the self-proclaimed leader in fixed welding automation
- Multi National company
- Most similar to Preston-Eastin
- Based in St. Louis, Mo.
- Model 30-6 most similar
  - Made to stock

Pandjiris, Inc.

http://www.weldplus.com/product_details.asp?id=981&qs=

Competitor Analysis

Company	Load Capacity at 6in (lbs)	Tilt Range (degrees)	Torque Tilt (in lbs)	Torque Rotation (in lbs)	Shipping Weight (lbs)	Price USD
Koike	2500 3000 4500	0-135 0-135 0-135	31,875 36,000 54,000	15,000 56,250 84,375	1,500 2,100 2,200	22,175 25,935 26,780
Pandjiris	3000	0-135	35,250	18,000	1,750	13,190
Preston Eastin	3000	0-135	36,000	18,000	2,100	18,000 (20,000)

Budget

Budget	Parts	Labor	Total	Profit Margin
Initial	$7,503.398	$5,155	$12,658	29%
Goal	$	$	$9,000	50%

Design Changes/Plans

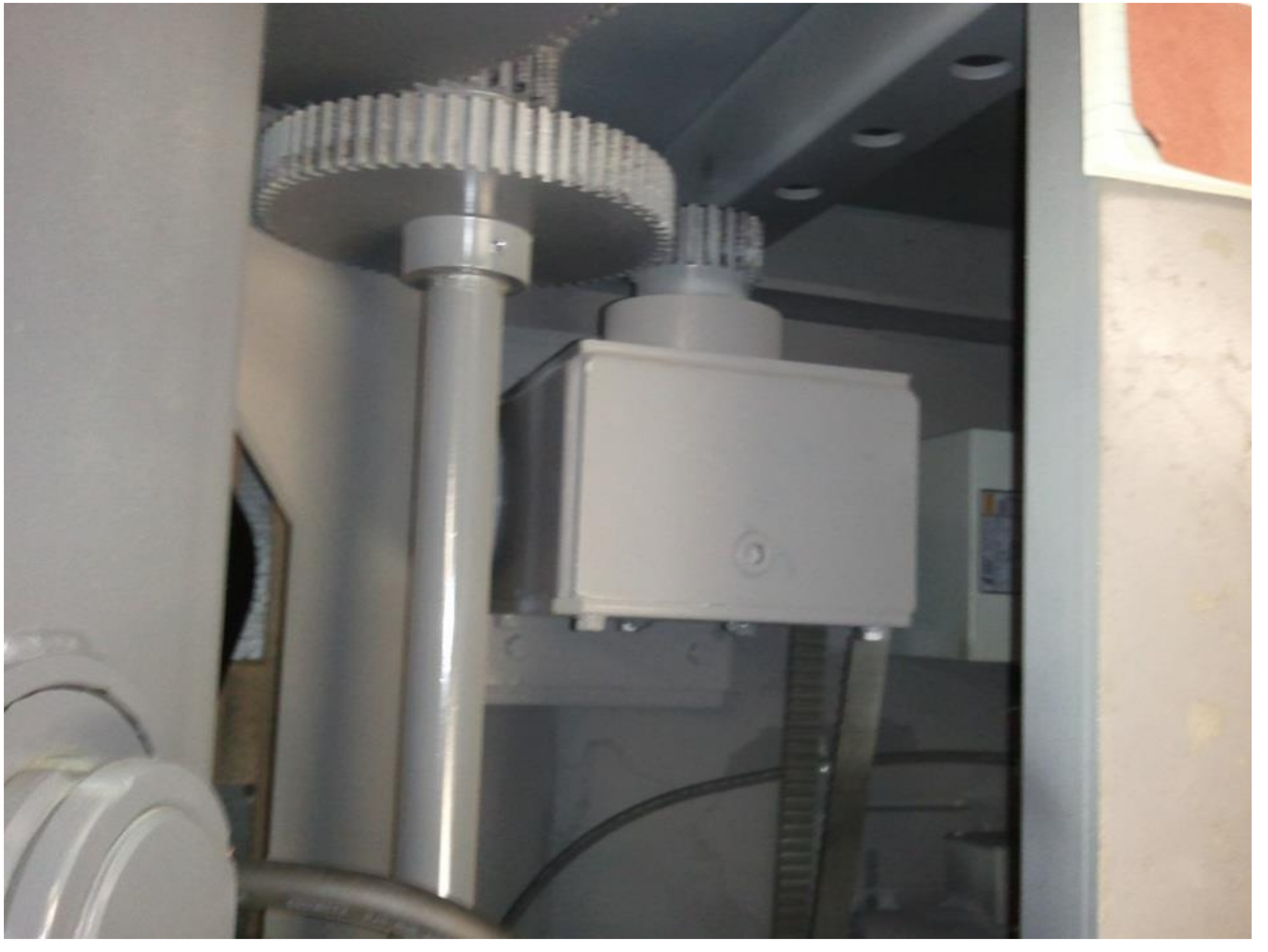
- Gear Box
- Structural Changes
- Electrical
- Labor Costs
- Economy Model

Design Changes

- Boston Gear Box and Motor

Design Changes

- Tilt Gear Box and Motor



Current Component Cost

Current Motors and Speed Reducers	Price
Boston 50:1 Worm Gear Reducer for rotation	$746.86
1hp DC Motor for rotation	$341.79
36:1 Worm Gearbox for Tilt	$450-$650 (Estimation)
¾hp AC Motor for Tilt	$409.84

Current Components other Manufacturers

Motors and Speed Reducers (Current Set-up, American made)	Price
50:1 Gear Reducer for rotation	$700.00-800.00
1hp DC Motor for rotation	$400-$1000.00
40:1 Worm Gearbox for Tilt	$400.00-$550.00
¾hp AC Motor for Tilt	$700.00-$900.00

56C Face American Made

American Made	Price
80:1 Worm Gear Reducer 56C for rotation	$450.00-$1200.00
1hp DC 56C Motor for rotation	$450.00-$1000.00
80:1 Worm Gearbox 56C for Tilt	$450.00-1200.00
¾hp AC 56C Motor for Tilt	$500.00-$1000.00

56C Face Foreign Made

Aftermarket (Foreign)	Price
60:1 Worm Gear Reducer 56C for rotation	$238.00
1hp DC 56C Motor for rotation	$214.00
60:1 Worm Gear reducer 56C for Tilt	$238.00
¾ hp AC 56C Motor for Tilt	$100.00-$300.00

Comparison

	Current	Other Manufacturers	56C Face American Made	56C Face Foreign Made
	Price	Price	Price	Price
50:1 Speed Reducer for Rotation	$746.86	$700.00-800.00	$450.00-$1200.00	$238.00
1 Hp DC Motor for Rotation	$341.79	$400-$1000.00	$450.00-$1000.00	$214.00
36:1 Speed Reducer for Tilt	$450-$650 (Estimation)	$400.00-$550.00	$450.00-1200.00	$238.00
¾ Hp AC Brake Motor for Tilt	$409.84	$700.00-$900.00	$500.00-$1000.00	$100.00-$300.00

Design Changes/Structural

- Smaller Gauge Steels
- All Similar Size
  - Kit Style
- Ordering Pre-Cut Squares
  - Cheaper
  - Machine notches, cuts, and tap holes in house

Cost Reduction

Part	3/8"	5/16"	1/4"	3/16"	1/16" decrease	1/8" decrease
Side Plate	155.58	131.25	107.02		16%	31%
Bottom Plate			88.08	68.53	22%	
Front Plate	71.18	60.96	50.78		14%	29%
Table	175.46	147.81	120.27		16%	31%
Top Plate			89.97	69.99	22%	
Avg. Savings					18%	30%

Weight Reduction

Wt. in Lb.	3/8"	5/16"	1/4"	3/16"	1/16" decrease	1/8" decrease
Side Plate	121.32	101.04	80.85		17%	33%
Bottom Plate			65.06	48.81	25%	
Front Plate	50.99	42.47	33.35		17%	35%
Table	137.88	114.84	91.89		17%	33%
Top Plate			66.64	49.99	25%	
Avg. Wt. Reduction					20%	34%

Electrical

- After examining the electrical components we have determined that the current setup is what we found to be the most cost efficient.
- Possibly outsourcing
- Condensing to smaller box

Spring Semester

- Goals
  - Labor Reduction
  - Economy Model

Labor Reduction

- Examination
  - Production Process
  - Machining Process
- Optimization
  - Techniques
  - Lean manufacturing
- Economy Model
  - Build to stock

Economy Model

- Economy Model
  - Replace all no structural metal with thinner sheet metal
  - Replace bearing with shorter life bearings
  - Use cheaper gear boxes and electric motors
  - Offer no extra options or add-ons