Data Driven Conveyor System

A Baccalaureate thesis submitted to the
School of Dynamic Systems
College of Engineering and Applied Science
University of Cincinnati

in partial fulfillment of the
requirements for the degree of

Bachelor of Science

in Mechanical Engineering Technology

by

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April 2013

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ACKNOWLEDGEMENTS

Special thanks to R.A Jones and Company and their staff for giving us the opportunity to work on this project. Our hope is that the final design will be utilized within their machines and the benefits of learning DriveWorks can expand into other sub-assemblies within their lines of equipment.

ABSTRACT

DriveWorks, which is a subprogram of SolidWorks, was utilized to build off of a unique conveyor design for R.A Jones and Company. The purpose of using this process was to eliminate redundant design work for assemblies which require minor overall dimensional changes. A conveyor was chosen for this project due to its common use and requirement of modification within the company.

A master assembly was created for the conveyor to which the dimensions and features could be captured by DriveWorks to later create a new assembly including all parts and drawings. Variables were called out and rules were written into the program, based off of the captured dimensions which were then used to create custom conveyor sizes.

By utilizing DriveWorks, conveyor systems are now able to be created and verified by R.A Jones and Company engineers in as little as one hour. This has decreased engineering hours needed to create a conveyor assembly by a minimum of 25%, while allowing future possibilities to save the company even more.

With DriveWorks being implemented into the normal business operation of R.A Jones and Company, it will continue to expand into other design aspects of the organization, saving time and money while still delivering a quality product.
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INTRODUCTION

BACKGROUND

R.A Jones and Company is one of the North American leaders in food and consumer packaging machinery. They are consistently looking to increase productivity while delivering quality products to their customers. Within this company, master assemblies are modified to meet customer requirements while trying to deliver the machinery within the given deadlines. Often, assemblies need minor modification while maintaining the same overall design. This is accomplished, but often requiring numerous engineering hours to deliver the necessary product. R.A Jones and Company is looking to research DriveWorks, a subprogram for SolidWorks, to reduce engineering hours used to rework current designs for future projects. This software is used to aid in the design of mechanical components for their packaging and processing equipment. The focus of this project is to design a conveyor which can be built in house to meet their custom requirements. The main goal is that when a new conveyor is needed the engineer will need only to choose a configuration, length and belt width required by the customer and the parts and assembly will be created, including all drawings.

Paul Neal designed the driving mechanisms while Corey Campbell concentrated on the framing. The driving mechanisms include the motor type, drive type, pulley selection, idler assembly design and belt selection. The framing consists of material type, hole placement, mounting hardware, as well as height, width, and length of the overall design. Both team members are required to collaborate and combine the findings to ensure proper operation and design approval to meet R.A Jones and Company’s designing standards. Since DriveWorks needs the full assembly before it can complete what is asked of it, this project needed to be completed as a group, instead of individuals.

The team became proficient in DriveWorks so as to share their knowledge with other employees to increase productivity and eventually save the company hundreds of thousands of dollars by eliminating redundant design work. Parameters are designated within the software to ensure proper components are used for correct strength, speed, and size needed. The successful application of this program into the conveyor design has opened the door to using it elsewhere within R.A Jones and Company leading to even more savings.

Conveyor systems are generally used for product transportation and handling. At R.A Jones and Company, conveyor systems are typically used as product in-feed or reject conveyors. The company uses a wide range of conveyor systems including, flat belt conveyors, roller conveyors, and flex-link conveyors (1). The basis of this project is to focus on the design of a flat belt conveyor system that can be used within their machines. The end product will include a conveyor system which requires several inputs from the engineer including; configuration, length and belt width.
RESEARCH

Every conveyor company has their own unique style of product, which they prefer to produce, but the overall design is basically the same. Framing, belt pulleys, belts, drive motors, and overall dimensions make up the general components. Each part of the conveyor determines how the overall product will function as a whole and they are all intertwined with one another. Interviews, surveys, as well as competitor research was conducted to determine the best features of the most popular conveyor companies, which were then used to create a unique design.

After conducting these interviews, surveys and competitor research, the basic necessities were narrowed down based off of the faults of current methods. Engineering hours are being wasted due to redundant work (2). When a similar product is needed, engineering has to modify every part in the assembly individually, check for assembly errors, and document the changes manually.

With conveyors being built in house, all CAD models will be available and all specifications for commercial components used will be documented. Some of the companies used provide poor documentation (3), which can lead to design error.
CURRENT METHODS

COMMERCIALLY PURCHASED CONVEYOR SYSTEMS

Currently, R.A Jones and Company uses multiple vendors for their conveyor needs, with preference given to three companies; Conveyor Technologies (4), Dorner Manufacturing Corporation (5), and QC Industries (6). All three have their advantages and disadvantages. In most cases, R.A Jones and Company is forced to modify the purchased product to fit their customer’s needs. This post purchased fabrication causes rework of what should be a finished product, costing man hours, tooling, and added materials (7).

At R.A Jones and Company, Dorner Manufacturing Corporation is the most commonly used conveyor system. According to several R.A Jones and Company employees including engineers, assemblers and assembly managers, Dorner is the preferred conveyor for their packaging applications. Dorner was found to be beneficial due to their deliverability, quality and affordability (2). Recommendations for design improvement would be the elimination of the extrusion in the frame of the conveyor along with the ability to use smaller nose bars and or pulleys. Having the ability to use smaller nose bars or pulleys, it creates a smoother transition by reducing the gaps between conveyors (8). The removal of the extrusion from the conveyor frame would reduce problems caused in mounting and guarding the conveyors along with improving aesthetics (9). For applications in which sanitation must be taken into consideration such as pharmaceutical or the food industry, it is vital to eliminate additional features that would aid in contamination build up. An extrusion in the conveyor frame is one example of what needs to be eliminated or covered up before the conveyor can be mounted to the machine line Figure 1).

![Figure 1 Frame extrusion and customization to cover said extrusion](image)

Conveyor Technologies supplies another conveyor system commonly used within the machines at R.A Jones and Company. The frame for their conveyors is made from a single piece of 10 gauge steel (4). This is beneficial because it helps to reduce the amount of parts (9), which aids in the ease of assembly.
The down side to their design is that the sides of the frame is perforated with holes (Figure 2) which are intended to make the conveyor system modular with the mounting of guarding (4). These holes are not aesthetically pleasing to R.A Jones and Company’s customers and the frame is often replaced with a custom frame per application (Figure 3). The holes also cause a problem with sanitation, and require nut plates inside the frame in order to mount to the machine or the guarding. The supplied components for mounting the conveyors often rub against the belt causing the belt to become frayed as the tracking becomes misaligned. The feature most valued at R.A Jones and Company is the self-aligning driver bearings which avoid bearing failure caused by misalignment and pulley deflection (4).

QC Industries is the third most commonly used conveyor system within the company. Their feature of a tension release tail operated by push-button is desirable for maintainability (Figure 4). This provides ideal technology for both maintainability and sanitation, known as a “wash-down”. Their conveyors are available with both single-piece steel frame and aluminum extrusions.
With all three of these conveyor companies, the purchased product is then disassembled, modified, reassembled, and finally attached to the machine. New parts and fabricated and added to the purchased conveyor to ensure R.A Jones and Company’s design and safety specifications are met.

The positives and negatives of all three conveyor companies were taken as firsthand accounts by the R.A Jones and Company employees (APPENDIX A) who participated in the customer survey (APPENDIX B).
CUSTOMER SURVEY RESULTS AND ANALYSIS

PRODUCT FEATURE DEFINITION
After speaking to representatives from R.A Jones and Company, a list of product features was created. This list was then used to survey a broader sample from R.A Jones and Company to gage the importance of each feature. Definitions of each feature are described below.

- **Safety**: The need to minimize dangers to employees or those who might come in contact with the conveyor.
- **Customizability**: The ability for the conveyor to be designed and built to fit the machine it is to be used for.
- **Aesthetics**: The overall appearance of the final product.
- **Reliability**: Having the finished product do what it is expected to do.
- **Affordability**: The final cost of the finished product must be less than a commercially purchased one.
- **Adjustability**: This includes belt tracking, height, width, length, speed, and weight capacity.
- **Ease of Assembly**: How well the parts fit and the ease in which the assembly drawings can be followed.
- **Documentation**: This includes part and assembly drawings, purchased part paper work, and updating drawings for any and all changed made.
- **Maintainability**: The ease in which the finished product can be maintained, up to and including part replacement and general maintenance.
- **Lead Time**: How long it takes for the product to be ready for assembly.
- **Sanitation**: The ability for the design to be capable for “wash down” versions which are used in the pharmaceutical or food industry.
Survey Results

Fifteen customer surveys were received and used to determine the most important features that were desired for the final product. These surveys were completed by mechanical engineers, sales engineers, design engineers, assemblers, and supervisors (see APPENDIX B for full results). The survey included a wide range of product features arranged in categories of operation/function, maintenance, cost, and appearance. The first half of the survey focused on customer importance as they were asked to rate the importance of features on a scale from 1-5 with 5 being the most important. These results were then compiled to show the average importance of each feature (Table 1). It was determined that safety, reliability, and maintainability are the most important features which were focused on during for the final design.

The second half of the survey focused on satisfaction with the features of current commercially purchased conveyors as they were asked to rate the importance of features on a scale from 1-5 with 5 being the most important. These results were also compiled to show the average satisfaction of each feature (Table 2). The same three features topped the list showing that they are currently most satisfied with these features. This gave a goal to maintain or improve these features while improving the remaining eight to produce a far better product.

Table 1 Survey Results of Customer Importance

<table>
<thead>
<tr>
<th>Question Surveyed</th>
<th>Avg.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Safety</td>
<td>4.80</td>
</tr>
<tr>
<td>Reliability</td>
<td>4.67</td>
</tr>
<tr>
<td>Maintainability</td>
<td>4.27</td>
</tr>
<tr>
<td>Customizability</td>
<td>4.20</td>
</tr>
<tr>
<td>Affordability</td>
<td>4.13</td>
</tr>
<tr>
<td>Ease of Assembly</td>
<td>4.07</td>
</tr>
<tr>
<td>Lead Time</td>
<td>3.80</td>
</tr>
<tr>
<td>Adjustability</td>
<td>3.73</td>
</tr>
<tr>
<td>Documentation</td>
<td>3.60</td>
</tr>
<tr>
<td>Sanitation</td>
<td>3.60</td>
</tr>
<tr>
<td>Aesthetics</td>
<td>3.07</td>
</tr>
</tbody>
</table>

Table 2 Survey Results of Customer Satisfaction

<table>
<thead>
<tr>
<th>Question Surveyed</th>
<th>Avg.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reliability</td>
<td>3.60</td>
</tr>
<tr>
<td>Maintainability</td>
<td>3.40</td>
</tr>
<tr>
<td>Safety</td>
<td>3.40</td>
</tr>
<tr>
<td>Aesthetics</td>
<td>3.13</td>
</tr>
<tr>
<td>Lead Time</td>
<td>2.60</td>
</tr>
<tr>
<td>Adjustability</td>
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<tr>
<td>Customizability</td>
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</tr>
<tr>
<td>Sanitation</td>
<td>2.47</td>
</tr>
<tr>
<td>Ease of Assembly</td>
<td>2.40</td>
</tr>
<tr>
<td>Affordability</td>
<td>2.13</td>
</tr>
<tr>
<td>Documentation</td>
<td>2.00</td>
</tr>
</tbody>
</table>
PRODUCT FEATURES AND OBJECTIVES

The product features and objectives come directly from the customer survey results (APPENDIX B). Customer importance percentages were calculated from the survey results and arranged in order from highest to lowest. These results were then translated into product features necessary to meet the customer’s expectations for the final design (APPENDIX D). The top five objectives are described in more detail below:

**Safety** 10.9%
- Guarding is to be used to cover all moving parts to eliminate pinch points.
- Ensure that conveyor shuts off if emergency stop on machine on machine is engaged

**Reliability** 10.6%
- Refer to vendor component life/warranty
- System built to specifications

**Maintainability** 9.7%
- Ability to replace belt without disassembly of conveyor
- Accessibility to wear parts such as bearings in less than five steps

**Customizability** 9.5%
- Conveyor Speed will be determined using the correct motor, bearings, gears, and pulleys
- Height, width and length requirements determined by intended use
- Mounting holes will be kept to a minimal and custom per intended use
- Belt type will be determined by designer per intended use

**Affordability** 9.4%
- Reduce engineering hours by 20% or more
- Final design will require no additional customization for installation
- Manufacturing costs reduced compared to purchased conveyor systems due to conveyors being designed and built by R. A Jones
**ANALYSIS OF CUSTOMER INPUT**

Data collected from the customer survey was then used to construct a quality deployment function diagram (QFD). The QFD is a tool used to direct the product design to fit what is desired from the customer (APPENDIX C). In the QFD, correlation values are determined by the relationship of the customer features and the engineering characteristics (Table 3).

![Table 3 QFD](image)

For this QFD, a designer multiplier was used for affordability since this feature was the entire reason for the project creation (Table 4). If conveyors cannot be produced at R.A Jones and Company for less than purchasing them from an outside vendor, DriveWorks will not be utilized within the company and the project will be considered a failure.

![Table 4 Section of the QFD showing the designer’s multiplier to the affordability feature](image)
CONCEPT GENERATION AND SELECTION

When considering the type of conveyor to move forward with, three options were discussed. The end drive conveyor has the motor/gearbox mounted on the end of the conveyor directly or indirectly through a pulley/belt design. The Inner drive conveyor has the motor located inside the end shaft and has no extra attachments. Finally, the center drive conveyor has the motor/gearbox mounted to the underside of the conveyor in the center. It can be directly driven or indirectly through pulley/belt design.

All three have benefits, but after team meetings with the engineering group, a center drive concept was chosen for the R.A Jones and Company in-house conveyor due to its versatility with how it can be mounted and modified to fit left or right handed machines as well as its capability to push or pull the conveyor belt. This design also allows for the conveyor to be run in either direction without the loss of grip or power. It has a compact design since the motor is mounted under the conveyor, so shorter conveyor lengths can be accommodated. This also gives the flexibility of having the drive section of the conveyor relocated during the design phase if needed for clearance.

The final design was created in SolidWorks and approved by the engineering team (Figure 5).

This design accommodates the product feature definitions while utilizing a simple design. Using a timing belt drive system, desired speeds can be easily obtained with a proper gear ratio and a controller to fine tune the final conveyor belt speed.
ASSEMBLY DESIGN DETAILS

The most common problems with any conveyor are proper tensioning and tracking. The following figures provided by F.N. Sheppard & Co. (9) will demonstrate basic information on both tensioning and tracking a belt on a conveyor.

Proper tensioning must be taken into consideration during conveyor design. Belt tensioning specifications must come from the belt manufacturer/provider. Several types of rollers can be used to assist in proper tensioning. The center crown belt has been used to apply tension to the center of the belt but was found to cause too much stress on the belt, limiting belt life. Trapezoidal crowns have been found to be the better solution in applying proper tension to the conveyor belt (10). This design applies pressure to approximately 60% of the surface of the belt allowing the stress to be spread, prolonging belt life (Figure 6). Each belt has its own specification sheet identifying such things as proper tension, coefficient of friction, and operating temperature range.

![Proper Tension Diagram](image)

**Figure 6 Proper Tension**

The ability to track or center the belt on a conveyor is the most important factor in prolonging the life of the conveyor belt. Improper tracking of the belt will cause the belt to fray as it will rub on the guides, bearings, or inner walls of the conveyor bed. It also depends on a proper square splice/bond of the belt and symmetry of the conveyor system. There are several methods used in order to track a belt. The first method used is to have an adjustment on each side of the conveyor to control the slight angle of the roller. The belt will track to the side in which the belt contacts the roller first (Figure 7). Adjustments must be made while the conveyor is running, allowing three full belt rotations in order to see if further adjustment is necessary.
Another common method is using a self-tracking belt which has a V-guide bonded to the center of the underside of the conveyor belt itself. This method may also affect the design of the conveyor system, requiring clearance for the V-guide (Figure 8).

The conveyor assembly was designed to meet all of R.A Jones and Company standards for safety, operation, and appearance, while giving flexibility for use in their machine lines. Standard parts and sizes were chosen to reduce costs while ensuring proper operating limits were not exceeded.
PART DESCRIPTIONS AND FEATURES

The frame was chosen to be made from 11 gauge stainless steel (Figure 9). This is a standard material used in R.A Jones and Company’s applications and the appearance matches all of their machinery lines. Using a single plate with a double-bend increases strength while giving a clean appearance. This material is also thick enough to be drilled and tapped directly, eliminating the need for nuts or additional fastening needs. The bend on either end of the frame serve as a lead-in for the conveyor belt.

A modification was made to current designs to improve belt tracking and tensioning while allowing for conveyors to be lined up end to end. The belt tracking/tensioning plate took current methods, and improved the design while decreasing the cost of the overall assembly (Figure 10). The large cutout on the plate gives clearance for a wrench to adjust the tensioning bolt from within the conveyor footprint. The design is also low profile to fit the contours of the conveyor frame, which decreases sediment build up for cleaner operation.

The idler box was designed for safety and ease of access. The front and rear mounting plates allow for routine maintenance to be performed without the need to completely disassemble the enclosure (Figure 11 and 12). The vertical slots allow for the drive pulley to be removed from the bottom after the bearings have been removed. The slots around the perimeter are designed in such a way to allow the guarding to be mounted or removed in a hinged fashion. The bearing mounting holes are utilizing a new technology called a Flow drill. This process drills a hole without removing material, and in turn, allows for larger holes to be tapped in thin material without sacrificing strength.
The large cutouts in the rear mounting plate (Figure 12), allow for the inner idlers to be removed for replacement or maintenance by removing only the mounting plate (Figure 13).

The mounting plate cutouts are placed so that the stepped surface of the shaft once installed will be facing downward. The cut out prevents rotation of the shaft and the orientation prevents the buildup of contamination on the shaft.

The guarding utilizes a single piece design to eliminate pinch points to within R.A Jones and Company’s standards while providing structural support to the idler box assembly (Figure 14). The holes are tapped to eliminate the need for nuts or additional fastening methods. The extended flange was designed to meet safety standards as it prevents someone from being able to reach any moving components.

All sheet metal parts are laser cut to ensure proper tolerances are met.
The roller was designed using 50.8 mm (2.0”) stock aluminum (Figure 15). The ends are machined to create a seat for the bearing to be pressed into. Once machined, the idler is sent out for plating which helps to prevent wear on the aluminum from the conveyor belt. It is a lightweight, symmetric design that can be used in both the center and end idler assemblies. The length of the roller will be determined in relation to the belt width demanded per application.

The idler shafts were both designed from a 20 mm diameter stock stainless steel material (Figure 16). This is a standard size shaft diameter for similar applications within R.A Jones and Company. The stainless steel provides increased strength which is needed due to the torsional stress applied to the shaft. Grooves are cut into the shaft to properly locate and secure the set screw on the bearing used in the idler assembly. The M6 tapped hole located at each end allows the assembler to properly tension and track the conveyor belt. The design of the end idler shaft is symmetrical to ensure proper assembly.

The center idler shaft consists of a single flat on one end to prevent rotation once installed. The round end is placed in the conveyor first while the stepped end fits into the access panel on the back side of the conveyor (Figure 17). It is not symmetrical due to the center drive enclosure which contains an access plate on the rear side of the enclosure for maintenance. Both shafts have grooves cut into them according to R.A Jones and Company standards in order to hold bearings in place with set screws located in the extended sleeve to lock the inner race.
The drive shaft (Figure 18) is machined from a 63.5mm (2.50") diameter stainless steel rod. The outer diameter is larger than the 50.8mm (2.00") diameter idler pulley roller in order to increase the contact surface with the conveyor belt by increasing the angle of wrap. The drive shaft is non-symmetrical and can therefore only be installed one way for proper function. Both sides of the drive shaft are machined to 20 mm diameter to match the idler shafts as well as fit the proper flange bearing used in the design per R.A Jones and Company standards. A keyway is located on the drive side as designed per R.A Jones and Company standards for a 20 mm diameter shaft with a keyway. The keyway will allow the tapered bushing and the pulley to lock in place on the shaft, which will then be driven by the motor through a timing belt pulley system.

The motor adjustment block is a simple piece laser-cut from 9.525mm stainless steel (Figure 19). The block also acts as a spacer to properly align the pulleys on both the motor and the drive shaft. The block has four M8 holes tapped into it, two countersunk holes are for mounting to the frame, the other two are for mounting to the motor mounting plate. The bolts will come outward from under the frame and thread into the block keeping it stationary. The other set of holes is to allow proper tensioning of the drive belt.

The motor mounting plate is a simple stainless steel plate with a hole pattern located according to the drawings received for the particular motor in the design (Figure 20). The large diameter cut out is to ensure clearance for the motor shaft and the slots on the top of the plate are where the plate will mount to the block previously mentioned. This simple slot design allows for the mounting bolts to be loosened allowing the entire motor and plate to slide along the frame tension or remove the drive belt.
The idler assembly (Figure 21) utilizes the same components excluding the shaft for both the end and center idler pulley assemblies. The roller bearings are pushed into place in both ends of the roller with the shaft going through the center. When positioned properly, the set screws are tightened as they fit over the groove cut in the shaft to keep the roller centered. This design will allow for easy maintenance when needed for the assembly to switch out the bearings.
The center drive assembly houses the drive shaft and the two inner idlers (Figure 22 and 23). The front and rear assembly plates are mounted directly to the frame and make up the overall housing. The slots around the perimeter serve two purposes: mounting of the center covers, and ease of access to the drive components. The slots are angled in such a way to allow the installer to hang the covers on the top slots while being able to pivot the covers out for access or in for final assembly. The flange bearing is mounted to the assembly plates directly with bolts, without the need for nuts by making the mounting holes with a flowdrill. This process creates a hole without removing material by actually melting and shaping the extra material into a tube shape which can then be tapped. The removable plate gives access to the inner idler assemblies without the need for a complete disassembly. This way the belt can be quickly replaced with minimal downtime. The vertical slots on the assembly plates allow for removal of the drive shaft assembly by only having to remove the flange bearing bolts.
The tensioning/tracking adjustment (Figure 24) has been modified from current methods by simply reversing the way in which it is adjusted. Typically, the head of the adjustment bolt is facing the outside of the conveyor. This causes problems when multiple conveyors are in line and adjustment is needed as there is no way to get to the bolt head. By reversing the bolt and using a relief on the adjustment plate, a wrench can reach the head and make adjustments without the worry of clearance. Also, the low profile design reduces buildup of dirt or product by eliminating crevasses along the frame itself. The cutout itself now horizontally aligns the end idlers which eliminates the need for flats on the idler shafts.

The conveyor was designed to be easily maintained. The flange bearings on the outside of the drive box used on the drive shaft contain grease fittings easily accessible for lubrication. The idler bearings are sealed and will therefore need to be replaced when damaged or worn. The center drive box was designed for easy access to these bearings. The back plate is removed and the full idler assembly can be pulled out, rebuilt and placed back into the drive box after belt tension is relieved (Figure 25).
In order to remove the drive shaft, the M10 bolts used to fasten the flange bearings must be removed. Once removed, the M6 bolts holdings the center drive covers are loosened and the covers can simply be rotated out of the way so that the drive shaft can be removed from the bottom of the drive box without requiring full disassembly (Figure 26).
All of the manufactured components were laser cut, bent and machined in the warehouse at R.A Jones and Company. The drive shaft was machined outside the company due to limitations on stock material. In the future, this part could be redesigned so that it could be done in-house and be more cost effective. The pulley cover is a 3-D plastic print done on location. The conveyor was easy to assemble and will be easy to maintain when needed. The motor, belts, and idlers can all be removed and replaced within just a few steps. The final center drive- belt driven conveyor system can be seen below (Figure 27).
The conveyor belt tensioning and tracking feature (Figure 28) and the access plate for the center idler assemblies (Figure 29) can be seen below. Both features make the maintenance and adjustments needed on the conveyor easy on the operator. The entire assembly can be assembled adjusted in less than one hour.
PURCHASED COMPONENTS

The motor (Figure 30) is supplied from Bodine Electric Company. It is a three-phase, parallel shaft gear motor. This motor was selected primarily due to availability within the company. The output speed of the motor is 170 RPM which can be fine-tuned using a controller in order to get a precise output speed of the conveyor belt. The motor specifications show that it is more than adequate for initial needs (Table 5).

![Motor Image](image)

**Figure 30 Motor**

<table>
<thead>
<tr>
<th>Table 5 Motor Specifications</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Model Number</strong></td>
</tr>
<tr>
<td><strong>Category</strong></td>
</tr>
<tr>
<td><strong>Speed (RPM)</strong></td>
</tr>
<tr>
<td><strong>Torque (lb-in)</strong></td>
</tr>
<tr>
<td><strong>Motor Output Power (Hp)</strong></td>
</tr>
<tr>
<td><strong>Voltage (AC)</strong></td>
</tr>
<tr>
<td><strong>Current (amps)</strong></td>
</tr>
<tr>
<td><strong>Rated Frequency (Hz)</strong></td>
</tr>
<tr>
<td><strong>Gear Ratio</strong></td>
</tr>
<tr>
<td><strong>Length XH (inches)</strong></td>
</tr>
<tr>
<td><strong>Weight (lbs)</strong></td>
</tr>
<tr>
<td><strong>Motor Type</strong></td>
</tr>
</tbody>
</table>
The deep groove roller bearing with set screw shaft sleeve is supplied from Misumi (Figure 31). It is to be used in the idler pulley assemblies and is very cost effective. The ability to seat the bearing inside the roller pulley simplified the design. The dimensions fit R. A Jones standard sizes for shafts and loads (Table 6). The sleeve with set screw allows the inner race to be secured properly to the shaft to prevent slippage which would cause damage to both the bearing and the shaft.

![Deep Groove Roller Bearing](image)

**Figure 31 Deep Groove Roller Bearing**

<table>
<thead>
<tr>
<th>Table 6 Roller Bearing Specifications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inner Diameter (mm)</td>
</tr>
<tr>
<td>Outer Diameter (mm)</td>
</tr>
<tr>
<td>Width (mm)</td>
</tr>
<tr>
<td><strong>Load Ratings</strong></td>
</tr>
<tr>
<td>Dynamic (kN)</td>
</tr>
<tr>
<td>Static (kN)</td>
</tr>
<tr>
<td>Fatigue Load (kN)</td>
</tr>
<tr>
<td>Speed Ratings (RPM)</td>
</tr>
<tr>
<td>Mass (kg)</td>
</tr>
</tbody>
</table>

The two hole flange bearing is supplied by Seal Master (Figure 32). It is used for the drive shaft and is mounted directly to the center drive enclosure. The bearing contains a clamp collar which secures to the drive shaft. The housing contains a grease fitting for lubrication making it easy to maintain.

![Two Hole Flange Bearing](image)

**Figure 32 Two Hole Flange Bearing**
**CALCULATIONS**

A goal of 250 ft/min was set for the initial design of the conveyor system. Based off of this, as well as the output speed of the motor used, certain calculations were necessary.

**DRIVE SPEED CALCULATION**

*Input Speed* = 170 RPM

*Number of Teeth (Driver) Pulley* = 30 teeth

*Number of Teeth (Driven) Pulley* = 22 teeth

\[
\text{Pulley Ratio} = \frac{30 \text{ teeth}}{22 \text{ teeth}} = 1.36
\]

*Output Speed* = 170 RPM * 1.36 = 231.2 RPM ≈ 231 RPM

**CONVEYOR BELT SPEED CALCULATION**

*Drive Shaft Outer Diameter* = 2.5 in * \( \frac{1 \text{ ft}}{12 \text{ in}} \) = .2083 ft

*Actual Conveyor Belt Speed* = 0.2083 ft/2 * \( \pi \) * 231 RPM = 302 ft/min

*Desired Conveyor Belt Speed* = 250 ft/min

\[
\text{Percent Error (Before Controller Adjustment)} = \left(\frac{302 - 250}{250}\right) \times 100 = 20.8\%
\]

*Final Adjustment of speed can be done with the controller.*

Due to component availability, the speed is increased from the driver to the driven pulley. This is uncommon among belt drive designs. Typically the motor output speed is higher than the required speed and it is therefore stepped down by going from a small pulley to a larger pulley.
STANDARDS

R. A Jones chooses shaft sizes based on industry standards (Figure 33). This helps keep costs down while utilizing proven dimensions. This helps the company save money through time by eliminating the need to constantly calculate minimum sizes unless it is for a special application.

![Figure 33 Shaft Standards](image)

Once the correct pulley ratio is calculated, the correct parts are chosen from a list of R. A Jones standard parts (Table 7). This saves time with the need to track down proper parts from vendors directly by being able to choose what is needed directly from a list.

<table>
<thead>
<tr>
<th>Jones Part Number</th>
<th>Number of Teeth</th>
<th>Pitch Diameter</th>
<th>Width (mm)</th>
<th>Bushing Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>334806</td>
<td>22</td>
<td>55</td>
<td>20</td>
<td>1108</td>
</tr>
<tr>
<td>330800</td>
<td>30</td>
<td>76</td>
<td>20</td>
<td>1210</td>
</tr>
</tbody>
</table>

Proper bearing selection is also chosen with standard parts. Once acceptable dimensions are determined (Figure 34), based mainly off of shaft diameter, the standard part is selected from the standard parts book (Table 8).
Standard components were chosen for this design out of the engineering standard parts list provided by R.A Jones and Company. The previous figures and tables demonstrate some of the information available through the Jones Intranet.

<table>
<thead>
<tr>
<th>Jones Part Number</th>
<th>Commercial Part Number</th>
<th>A</th>
<th>B (Max)</th>
<th>C</th>
</tr>
</thead>
<tbody>
<tr>
<td>303670</td>
<td>SFT-204TMC</td>
<td>20</td>
<td>113</td>
<td>90</td>
</tr>
</tbody>
</table>
Upon completion of the base conveyor design, the next step was to use DriveWorks in order to customize the assembly based on user inputs. DriveWorks is a software add-on for SolidWorks, which has the ability to create parts, assemblies, and drawings, from user input to generate completely new components. Utilizing this software, the engineer can simply enter the desired parameters for the conveyor, and DriveWorks will do all the design work in a fraction of the time it would take the engineer. Once the parts and drawings are created, all the engineer has to do is approve the final design and send it through for processing.

With the base conveyor created and approved, each part and drawing that would need to be remodeled for different conveyor sizes can be captured by the program. These captured dimensions are saved within a workgroup in the software so rules can be written to change them. Once the rules are written and the program is completed, the engineer can choose desired sizes from the user input page which was determined during the DriveWorks design setup phase. This allows the engineer to enter specific sizes, or pick them from a drop-down box, and have DriveWorks do the rest.

The first step taken was to open an assembly that can be captured by DriveWorks; here it was the base conveyor assembly. Within the captured assembly, certain components are chosen which must be captured in order to become variable components (Figure 35). Variable components are the components that will change according to the engineering input. Once
the components have been captured, they are opened individually and the dimensions that will need to change to create the desired parts and assemblies can be captured and labeled such as width, length or diameter. The SolidWorks model must be carefully designed to ensure that the component will properly change as the captured dimensions are driven by user inputs.

After all of the necessary components and dimensions were captured, rules were written within DriveWorks (Figure 36). These rules set the constants, variables, and their relations to one another. The inputs are set as constants, which in this case was conveyor length and belt width. Each input was given a minimum and maximum dimension along with certain increments. The width of the conveyor varies from 2 to 24 inches in 0.5 inch increments. The length has a minimum of 24 inches and a maximum of 120 inches due to manufacturing limitations. This input can be any dimension that falls within the minimum and maximum constraints. As can be seen, the value for Frame Length is undetermined. This is because it depends directly on the input for conveyor length on the Design Information screen.

![Figure 36 Variables](image)

The engineer will be able to start a new project within DriveWorks driven by the base assembly. The user interface is displayed when the operator begins new conveyor specifications using DriveWorks. The interface displays options for four different conveyor configurations available including center drive- belt driven (both left hand and right hand configurations), center drive- direct driven and end drive- direct driven. Once the operator has chosen the configuration, they type in the required length within the minimum and maximum values and choose a belt width which is given to them in a range from 2 inches to 24 inches using 0.5 inch increments (Figure 37). After the required dimensions are selected, the program is executed developing new components and creating the new assembly. As new components are developed, the drawings are also created including a new assembly drawing which will have been pre-approved through manufacturing engineering because they are all based off of initial drawings. This will reduce the engineering hours needed and therefore reduce cost.
These parts all drive off of one another once the rules were written to give the end user a full assembly including parts and drawings. By changing the inputs, an endless array of conveyor sized could be modeled within DriveWorks and virtually eliminate the need for engineering to exhaust resources by having to draw and model each component individually.
DriveWorks creates new parts from the base assembly. Here, a four inch long idler becomes eight inch (Figure 38 and 39) based on user input.
The specification flow displayed in (Figure 40) fully defines the process a specification goes through and which users will have access to the specifications at any given time. The flow process can be customized to follow internal company processes.

**PROJECT PLANNING AND MANAGEMENT**

*SCHEDULE*

The project schedule began October 14, 2012 and was concluded on April 23, 2013 (Figure 41). Throughout this timeline, different aspects of the project were scheduled for completion and approval to ensure the project remained on course (APPENDIX E). The schedule involved two parts, concept and design, and fabrication and assembly.
The total preliminary budget for this project was determined by assessing the current methods of design at R.A Jones and Company and justifying the costs versus benefits. The initial cost came out to be approximately $9,725.00. This includes the DriveWorks license, parts, and material for the initial design and build. This initial cost will be offset by engineering hour savings as more conveyors are produced by R.A Jones and Company. These figures were projected by the team, and approved by R.A Jones and Company management to allow this project to continue (Table 9).

<table>
<thead>
<tr>
<th>Description</th>
<th>Estimated Cost</th>
<th>Actual Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>DriveWorks Pro 9.0 License</td>
<td>$9,375.00</td>
<td>$9,375.00</td>
</tr>
<tr>
<td>Vendor Components</td>
<td>$200.00</td>
<td>$429.02</td>
</tr>
<tr>
<td>Manufactured Components</td>
<td>$350.00</td>
<td>$1,004.89</td>
</tr>
<tr>
<td>Total</td>
<td>$9,725.00</td>
<td>$10,808.91</td>
</tr>
</tbody>
</table>

Once approval was given, software packages were purchased so training could begin. As can be seen from the table, the actual cost was about $1000.00 over the estimated cost. This was due in part by the drive shaft having to be outsourced. Different materials for the higher cost components will be explored to try and lower to final cost to a point closer to that which was estimated.

**SUPPORT LETTER**

A contract was requested and received from R.A Jones and Company, which ensures that the project cannot be canceled (APPENDIX F). This is a precautionary step for the protection of the group members working on the project. All part and assembly drawings have been left excluded from the report per company policy.
WORKS CITED

### APPENDIX A: RESEARCH

<table>
<thead>
<tr>
<th>Interview with Product Engineer: Tony Salvato of R.A Jones and Company. 2701 Crescent Springs Rd. Covington, KY 41017 09-06-2012</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tony has twelve years of mechanical and electrical design of custom machinery with seven years of mechanical design of packaging machinery.</td>
</tr>
<tr>
<td>He prefers to use Dorner for their conveyor needs due to their delivery, quality and cost. An issue about the tracking system was brought up and he would like to see this improved, as well as eliminating their extra mounting holes and slots on their extrusion. He also would like to see the ability to use smaller nose bars/pulleys then are generally available. “Wash down” versions are tending to be used more often and he would like to have this ability.</td>
</tr>
<tr>
<td>He believes that if the engineering was reduced to no more than that required to purchase a conveyor, an internally designed and manufactured conveyor would save money as well as better suite their needs.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Interview with Product Design Engineer: Paul Frederick of R.A Jones and Company. 2701 Crescent Springs Rd. Covington, KY 41017 09-06-2012</th>
</tr>
</thead>
<tbody>
<tr>
<td>Paul has eight years of mechanical design experience in the packaging machinery industry.</td>
</tr>
<tr>
<td>He prefers to use Dorner for their conveyor needs due to their clean design and low cost. He would like to keep their clean design and ease of getting CAD models while removing the extrusion which causes mounting problems.</td>
</tr>
<tr>
<td>The most important characteristics to him as an engineer are: it works, cost, ease of assembly, and lowest amount of parts.</td>
</tr>
<tr>
<td>The most common issues found are tailoring the purchased conveyors to work in their machinery, as well as safety.</td>
</tr>
<tr>
<td>He sees a large benefit to designing/assembling in house conveyors since they would be designed to fit their machinery as well as eliminating the middle man.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Interview with Application Engineer: Matt Lukes of R.A Jones and Company. 2701 Crescent Springs Rd. Covington, KY 41017 09-06-2012</th>
</tr>
</thead>
<tbody>
<tr>
<td>Matt has fourteen years of experience at R.A Jones and Company and three at Multifold. He specifies equipment, design, and mechanical costs for sales quotes.</td>
</tr>
<tr>
<td>He chooses conveyors based on what customers ask for.</td>
</tr>
<tr>
<td>The most important characteristics to him as an engineer are: accurate CAD models, bearing life and speed specs.</td>
</tr>
<tr>
<td>He has found issues with companies not staying consistent with their designs and poor documentation.</td>
</tr>
<tr>
<td>He sees a large benefit to designing/assembling conveyors in house since all modifications would be better documented while using less effort than buying and modifying purchased components.</td>
</tr>
</tbody>
</table>
Interview with Assembly Manager: James L Blom of R.A Jones and Company.  2701 Crescent Springs Rd. Covington, KY 41017 09-06-2012
James has 35 years building, and testing packaging machinery. He manages day shift assemblers and electricians.
He prefers Dorner and QC conveyors because they are an internal company preference. He would like to keep smaller diameter pulleys because they tend to transfer product from one conveyor to another easier.
He is more concerned with using smaller pulley systems so product cannot build up as easy and with custom designs that can utilize safety guarding more efficiently while ensuring proper strength of overall design.
He believes R.A Jones and Company should design and build their own conveyors to match the products that are packaged. This skill set will save not only time, but money from having to modify commercially purchased conveyor systems.

Interview with Senior Assembler/Development Lab Coordinator: Dave Daniels of R.A Jones and Company. 2701 Crescent Springs Rd. Covington, KY 41017 09-06-2012
Dave has 33 years of experience in the engineering field. He schedules and runs Development Engineering projects for sales.
He prefers QC, Conveyor Technologies, and Dorner due to their price and deliverability. He would like to keep the large replaceable bearings, their tracking capability, small diameter pulleys, easy belt change features, and the easy side guide adjustment, while removing the “tiny” needle bearings non-trackable fixed-tail pulley. He would also like to add a “drum motor” style drive which eliminates the larger size AC motor/gear reducer/belt drive combination.
The most important characteristics to him are: compact design, durability, belt tracking precision, and ability to meet speed requirements.
The most common issues he has found are the designs not being able to meet speed requirements, having poor tracking, and only light duty.
He says the R.A Jones and Company has built robust conveyor systems in the past that have cost more than a commercially purchased one and the challenge will be cost.
Conveyor Technologies Ltd. offers a wide range of conveyor types including: Modular Plastic, Accuvision Internal Backlit, Wire Mesh, Dual Belt, Cleated Belt, Low Profile, end and center drive conveyors systems. The Low Profile End Drive Conveyor Type A Series "S" Represents the foundation of Conveyor Technologies' line, and provides outstanding performance.

- Higher load capacity allows expanded reversing, accumulating, and incline ability.
- Self-aligning driver bearings avoid bearing failure caused by misalignment and pulley deflection.
- Eliminates slipping and tracking problems induced by contamination of knurled pulleys.
- No further lubrication of conveyor or drive.
- No lubricant contamination of belt or product.
- Bearings and reducers included in 2 year warranty.
- Precision crowning provides automatic wear resistant tracking.
- Quickest belt replacement, tensioning and tracking.
- Belt calibrator enhances belt life and reduces maintenance costs.
- Pulley size improves belt life and permits a broader belt selection.
- Single piece 10ga. steel frame with F.D.A. accepted white baked epoxy finish provides greater rigidity.
- Modular systems offer broadest selection of side rails.

<table>
<thead>
<tr>
<th>Order Width</th>
<th>Belt Width</th>
<th>Nominal Conveyor Length</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>In. (mm)</td>
<td>Feet (Mm)</td>
</tr>
<tr>
<td>02</td>
<td>2.5 (63)</td>
<td></td>
</tr>
<tr>
<td>03</td>
<td>3.25 (83)</td>
<td>2 (610)</td>
</tr>
<tr>
<td>04</td>
<td>4.5 (114)</td>
<td>3 (914)</td>
</tr>
<tr>
<td>06</td>
<td>6.0 (152)</td>
<td>4 (1219)</td>
</tr>
<tr>
<td>07</td>
<td>7.5 (190)</td>
<td>5 (1524)</td>
</tr>
<tr>
<td>10</td>
<td>10 (250)</td>
<td>6 (1829)</td>
</tr>
<tr>
<td>12</td>
<td>12 (305)</td>
<td>10 (3048)</td>
</tr>
<tr>
<td>18</td>
<td>18 (457)</td>
<td>Optional Lengths</td>
</tr>
<tr>
<td>24</td>
<td>24 (610)</td>
<td>Available</td>
</tr>
</tbody>
</table>

Conveyors from Conveyor Technologies Ltd. are often used as in-feed or reject conveyors within the machines at R.A. Jones and Company. The holes located on the frame of each conveyor often cause problems with contamination and are not aesthetically pleasing to their customers. R.A. Jones and Company often customizes their frame increasing costs. The standard mounting blocks offered often rub against the belt causing them to fray, providing an opportunity for a better design. The tracking/tensioning system is also bulky whereas their customers would prefer a simplistic and yet efficient system.

Cost varies depending on the required application.
Dorner offers a variety of conveyors systems including; Cleated Belt, Magnetic Belt, Plastic Chain, Portable Chain, Vacuum, Z-Frame and Low profile conveyor systems. Dorner is the originator of the low profile conveyor and still holds several patents for low profile designs. The low profile conveyor allows the conveyor to fit into tight spaces, under equipment, in equipment or under conveying systems to move parts and scrap. Low profile generally refers to the distance from the bottom of the low profile conveyor frame to the top of the belt. The other critical dimension is the distance between the edge of the belt and edge of the frame as this provides the maximum belt width in the smallest frame.

- Quick five-minute belt change.
- Rack and pinion belt tensioning for fast, accurate single-point belt tensioning.
- Aluminum die cast head plates eliminate painted surfaces.
- V-groove bed plate with guided belt provides positive belt tracking, even under demanding side load applications.
- Non V-guided belts use our patented belt tracking cams, offering you the widest belt selection possible.
- Strong, box-like construction resists damaging frame twist.
- 50% more belt take-up extends conveyor belt life.
- T-slots make mounting accessories simple with no drilling or special tools.
- Stand mounting brackets are easily re-positioned along the T-slot.
- Motion sensor switch ready.
- Sealed ball bearings.

Although Dorner conveyors are efficient and often used within the company, R.A Jones and Company, they must customize their designs due to the extrusion in the frame of the conveyor. Due to the unique need for each machine, they must customize parts for mounting and guarding. Dorner offers a rack and pinion design to apply tension to the belt and individual jack screws on each side for tracking, but the customer would like to introduce a new and improved design.

Cost varies depending on the required application.
QC Industries

Figure 3A

QC Industries has specialized in creating low profile conveyors for over 30 years. Most of their products are less than 2” tall. This makes them ideal for applications in a variety of machines. They offer a variety of conveyor systems including: Angled frame, Plastic chain belt, Inner-drive, Indexing, Heavy-duty and both aluminum and steel frame low profile conveyor systems. Potential applications include automation, assembly, packaging, pharmaceutical/medical, automotive & many more.

- Rigid aluminum frames (or aluminum/steel frames for conveyors 18” and wider).
- Large 35mm sealed ball bearings that are built to last.
- High Speed Capability — up to 400 fpm.
- Push-button Tension Release tails for easy under belt cleaning and belt changes.
- Support for optional V-Guide belts without changing any conveyor parts.
- Crowned drive pulleys to ensure proper belt tracking.
- More than 50 belt styles available — including cleated belts.
- Our 5 Year Warranty.

Widths: 2”, 3”, 4”, 5”, 6”, 8”, 10”, 12”, 18”, 21”, 24”
Lengths: 18” to 20’
Speeds: up to 400 FPM*
Profile: 1.95” High
Loads:

<table>
<thead>
<tr>
<th>Width</th>
<th>2”</th>
<th>3”</th>
<th>4”</th>
<th>5”</th>
<th>6”</th>
<th>8”</th>
<th>10”</th>
<th>12”</th>
<th>18”</th>
<th>21”</th>
<th>24”</th>
</tr>
</thead>
<tbody>
<tr>
<td>Load</td>
<td>50</td>
<td>60</td>
<td>70</td>
<td>80</td>
<td>90</td>
<td>100</td>
<td>120</td>
<td>120</td>
<td>120</td>
<td>120</td>
<td>120</td>
</tr>
<tr>
<td>(lbs.)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

QC Industries is a product that is often used as in-feed or transfer conveyors within R.A Jones and Company’ machines. It provides a clean low-profile look but the frame also has an extrusion which causes customization after purchase. This increase both material and assembly cost.

Cost varies depending on the required application.
F.N. Sheppard & Co.

Flat Belt-Available Features

- Hole Perforating
- Side Guides
- Cleats
- Side Walls
- V-Guides
- Turn Belts

Figure 4

Compounds
Urethane, PVC, Thermoplastic, Rubber, Ruff-Tops, Synthetic, Oriented Nylon, Natural Rubber, Hi-Temperature, Woven Endless, Teflon, Silicone, Plastic Modular

Capped Edges
Edges on width of belt are capped and sealed so there is no fabric exposed. This feature will be available for conveyors in which sanitation/ wash-down is necessary.

FDA/USDA Approved

Cost varies depending on the required application.

F.N. Sheppard & Company is a distributor and fabricator of flat belt conveyors along with other belt types. They provide a large inventory of wide belt rolls which are fabricated to meet their customer specifications.

Special thanks to Frank Klaene, Vice President of F.N. Sheppard & Co.
APPENDIX B: CUSTOMER SURVEY RESULTS
Data Driven Conveyor System

CUSTOMER SURVEY

Two students from the Mechanical Engineering Technology program at the University of Cincinnati are attempting to use DriveWorks in order to design a conveyor system to be used here at R.A Jones and Company. This survey is to be used as a tool to determine the most important features for designing and building the R.A Jones and Company in-house conveyor system. Any and all feedback will be greatly appreciated.

How important is each feature to you for the design of an R. A. Jones in-house conveyor?
Please circle the appropriate answer.  1 = low importance  5 = high importance

<table>
<thead>
<tr>
<th>Feature</th>
<th>1 (0)</th>
<th>2 (0)</th>
<th>3 (0)</th>
<th>4 (3)</th>
<th>5 (12)</th>
<th>N/A (0)</th>
<th>Averages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Safety</td>
<td>4.80</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Customizability</td>
<td>4.20</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aesthetics</td>
<td>3.07</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reliability</td>
<td>4.67</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Affordability</td>
<td>4.13</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Adjustability</td>
<td>3.73</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ease of Assembly</td>
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How satisfied are you with the current commercially purchased conveyors?
Please circle the appropriate answer.  1 = very UNSatisfied  5 = very satisfied

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Thank you for completing this survey. Your time and feedback are greatly appreciated.
APPENDIX C: QUALITY FUNCTION DEPLOYMENT ANALYSIS

| Paul Neal & Corey Campbell | Size | Standard Components | Weight | Material | Manufacturability | Cost | Installation Time | Clearance Geometry | Metal Finish/Color | Customer importance | Designer’s Multiplier | Current Satisfaction | Planned Satisfaction | Improvement ratio | Modified Importance | Relative weight | Relative weight % |
|---------------------------|------|---------------------|--------|----------|-------------------|------|------------------|-------------------|-------------------|-------------------|----------------------|---------------------|----------------------|----------------------|-------------------|---------------------|------------------|------------------|
| Data Driven Conveyor System Utilizing Drive works | | | | | | | | | | | | | | | | | | |
| 9 = Strong | 3 | 3 | 9 | 3 | | | | | | | | | | | | | | | |
| 3 = Moderate | | | | | | | | | | | | | | | | | | | |
| 1 = Weak | | | | | | | | | | | | | | | | | | | |
| Safety | 3 | 3 | 9 | | | | | | | | | | | | | | | | |
| Customizability | 3 | 3 | 9 | | | | | | | | | | | | | | | | |
| Aesthetics | 3 | 9 | | 3 | 9 | | | | | | | | | | | | | | | |
| Reliability | 9 | | | | 9 | | | | | | | | | | | | | | | |
| Affordability | 9 | 3 | 9 | 9 | 3 | 3 | | | | | | | | | | | | | | |
| Adjustability | | 9 | | | | | | | | | | | | | | | | | |
| Ease of Assembly | 9 | 3 | 3 | | | | | | | | | | | | | | | | |
| Documentation | 3 | 3 | 9 | | | | | | | | | | | | | | | | |
| Maintainability | 3 | 3 | | 9 | 9 | | | | | | | | | | | | | | | |
| Lead Time | 9 | 3 | 9 | | 9 | | | | | | | | | | | | | | | |
| Sanitation | 9 | | | | | | | | | | | | | | | | | | |
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| Rel. importance | | | | | | | | | | | | | | | | | | | |

Paul Neal & Corey Campbell
Data Driven Conveyor System Utilizing Drive works
9 = Strong
3 = Moderate
1 = Weak

Appendix C1
APPENDIX D: PRODUCT FEATURES AND OBJECTIVES

Project objectives are written on the basis of the desired customer feature list. Below each feature is the engineering characteristic followed by the method or objective that will be used for the initial design of the project prototype.

1. Safety 10.9%
   a. Guarding
      i. Cover moving parts for user safety as per company standards
   b. Emergency stop
      i. Ensure conveyor shuts down as emergency stop on machine is engaged

2. Reliability 10.6%
   a. Refer to vendor component life/warranty
   b. System built to specifications

3. Maintainability 9.7%
   a. Ability to replace belt without disassembly of conveyor
   b. Accessibility to wear parts such as bearings in less than five steps

4. Customizability 9.5%
   a. Conveyor Speed
      i. Correct motor, bearings, gears, and pulleys provided for required speed
   b. Height, width and length requirements
      i. Conveyor created using DriveWorks with required dimensions
   c. Mounting
      i. Provide universal mounting design within the various machines
   d. Belt type
      i. Offer various belt surfaces
   e. Frame and drive system
      i. Frame driven by engineer input dimensions

5. Affordability 9.4%
   a. Reduce engineering hours by 20%
   b. Built to fit requiring no additional customization
   c. Manufacturing costs reduced compared to purchased conveyor system
      i. Machining and fabricating processes to be done in shop

6. Ease of Assembly 9.3%
   a. Reduce assembly time
      i. Uniform fastener type
      ii. Reduce the number of required parts
      iii. Eliminate rebuild of purchased conveyors
   b. Designed to fit the machine

7. Lead time 8.6%
   a. Conveyor system will be released and ready when needed for assembly

8. Adjustability 8.5%
   a. Required parameters will be custom per design specifications

Appendix D1
b. Belt Tracking
   i. Provide individual adjustment on each side to center belt

c. Belt tensioning
   i. Provide single location tool adjustment for belt tensioning

d. Flexible side guides
   i. Tool-less guide adjustment

9. Documentation  8.2%
a. Automated drawings will be created
b. Any changes required will be documented and added to database for future builds
   i. Drawings will be updated using company Form 20 when necessary
c. Commercial parts will be documented and include all paperwork

10. Sanitation  8.2%
a. Unnecessary holes will be eliminated
   i. Reduces contaminant build-up
b. Wash down availability as per R.A Jones and Company’ standards

11. Aesthetics  6.9%
a. Sheet metal frame design
   i. No unused holes in frame
   ii. Class A surface finish
b. Designed to match R.A Jones and Company’ appearance standards
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Paul Neal & Corey Campbell
Data Driven Conveyor System

Appendix E1
APPENDIX F: SUPPORT LETTER

OYSTAR North America

September 20, 2012

Dear Professor Caldwell,

I am writing in reference to a senior design project that will be executed by Paul Neal and Corey Campbell. This project will be funded by OYSTAR North America.

Paul and Corey’s project will comprise of the following:

- Research commercially available conveyor systems
- Define the requirements of the conveyor systems utilized by Oystar North America
- Development of customizable conveyor system - considering the impact of materials, speed, torque, and cost
- Development of a parametric CAD configurator utilizing Solidworks and Driveworks for the design of an in house conveyor solution

Currently, conveyors are either purchased outside of the company from a variety of different suppliers, or custom engineered for each application. Purchased conveyors often require customization once they arrive; although the resulting cost is better than the custom engineered solution compromises are often made.

This project is expected to provide Oystar with the ability to provide custom conveyor solutions at or below the cost of commercially available system. Additionally the project will demonstrate the value of using a configuration tool in design of the products we produce.

In my opinion that the effort required to complete this project; in the time frame allotted by the Senior Design course, will require both Paul and Corey.

Sincerely,

[Signature]

Robert Kalany
Principle Engineer, Product Development
OYSTAR North America
859-341-0400 Ext. 4130
kalany.r@oystar.rajones.com