

## Portfolio for Integrated Program/Project Management and Capstone Experience and Independent Undergraduate and Graduate Industry Projects

Preparing students for management, engineering , and technology practices through engaging in “real world” experiences has been the major focus of my efforts in conducting the **Integrated Program/Project Management and Capstone**.

Capstone experience includes engagement of students in real world projects performed on behalf of real world business and industrial clients. The capstone experience draws upon combinations of all the intended academic knowledge and skill outcomes. It integrates research, proposal development, and design experience based on the knowledge and skills acquired in earlier coursework. The capstone experience also incorporates standards and realistic constraints. To succeed in capstone , students must demonstrate professional competence through the accomplishment of work activities for business and industrial clients. They are required to collaborate as a team to apply their knowledge, think critically, and complete activities.

I also use other opportunities to engage students in business/industry projects. Since spring of 2010, teams of senior level and graduate students have been involved in conducting industry projects as part of individual study courses addressing client needs. **The following pages are the posters for some of the projects that were conducted during my service at North Dakota State University by students under my supervision.** Each poster summarizes project objectives, deliverables, project team members, and other relevant information .

Thanks for visiting this site,

*Reza A. Maleki*

*Updated May 10, 2012*





# TRAIL KING

## Aluminum Pneumatic Bulker (APB) Piping Supplier Analysis

### Project Objectives

- Explore opportunities to improve/replace current supplier
- Standardize APB piping through the reduction of design

### Project Team Deliverables

- Current piping system analysis
- Alternate piping system analysis
- Improvement proposals
- Recommendations based off of economic analysis
- Installation plan
- Recommendations for future projects/improvements

### Recommendation

Alternate Piping Supplier  
and kitted piping parts

### Potential Benefits

- Reduce piping inventory
- Reduce labor hours
- Welding capacity increased by 6 aluminum-welders per year
- Increased trailer throughput
- Decrease in floor space

Yearly Labor Savings	\$476,000
Yearly Supplier Cost Increase	(\$300,000)
Total Savings/Year	\$176,000

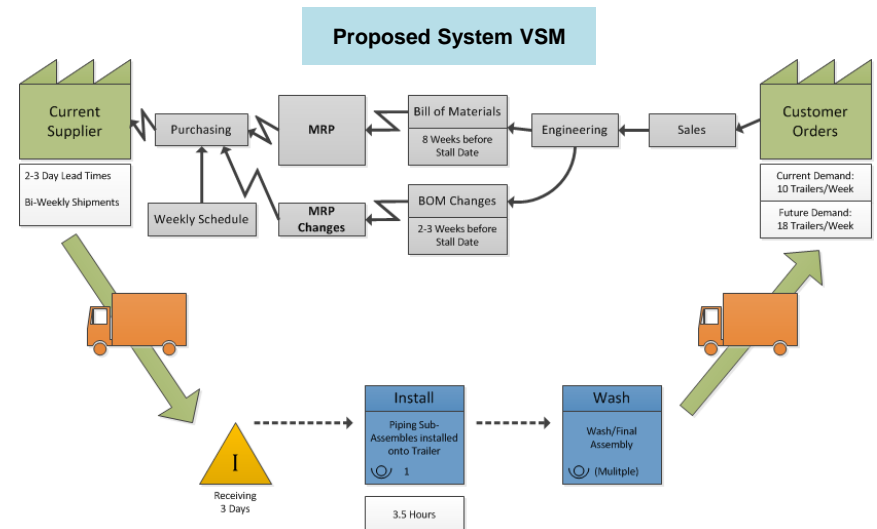
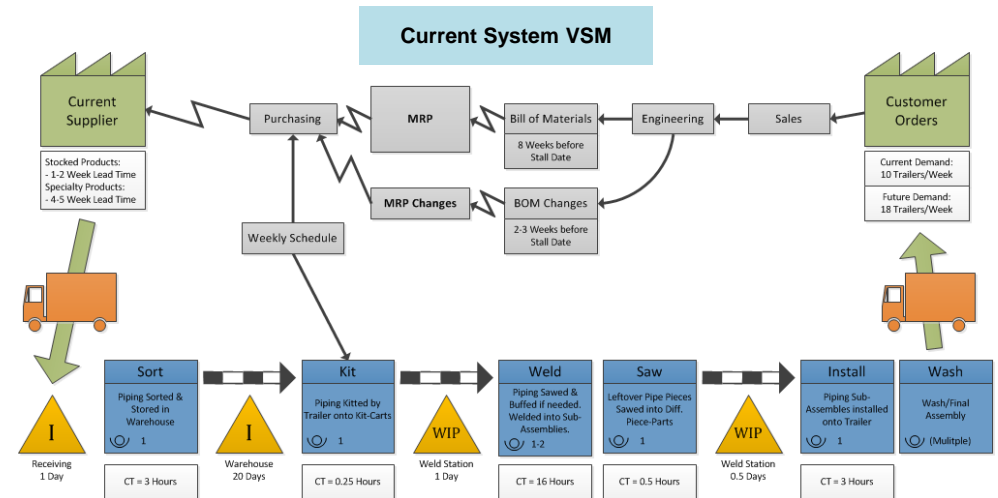
Reductions		
Area	Current	Proposed
Production time	22.75 hours	3.5 hours
Production lead time	23.5 days	3.25 days
Floor space savings	800 sq-ft	400 sq-ft

**Project Team Members:** Alex Anderson, Mark Hendrickson, Michael Schnepf, Luisa Torres.

**Faculty Advisor and Consultant:** Reza Maleki

**Department:** Industrial and Manufacturing Engineering

**Funding Source:** Trail King Industries



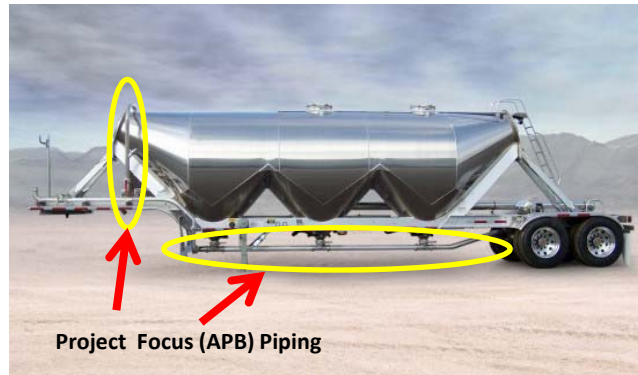
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## Aluminum Pneumatic Bulker (APB) Piping Supplier Analysis

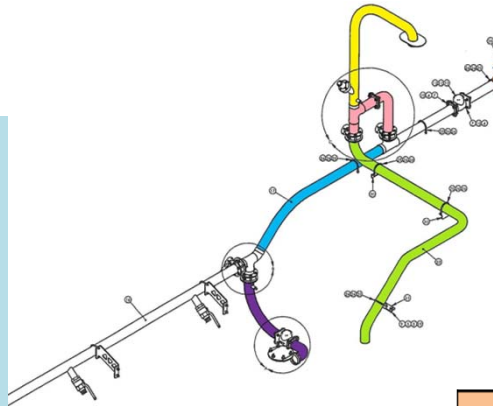


### Project Objective:

The purpose of this project is to study and standardize the APB piping through the reduction of design and specification variations. Also, explore an alternative piping supplier while evaluating their quality and availability benefits compared to current supplier

### Deliverables:

- Documentation of current piping design variations.
- Development of standardized piping specifications and alternative piping suppliers.
- Economic analysis of standardized piping specifications and alternative piping suppliers.
- Documentation of economic benefits that may result from implementing proposed suggestions.
- An outline of recommendations for future projects and improvements.



**Project Team Members:** Andrew Berglund, Cory Trana, Aayush G. Chhetri, Jason McKeever.

**Faculty Advisor and Consultant:** Reza Maleki

**Department:** Industrial and Manufacturing Engineering

**Funding Source:** Trail King Industries

	Proposals		
Problems	Design Standardization	In-House Pipe Bending	Outsource Pipe Bending and Kitting
Piping Variations	✓		
Supplier Distance		✓	✓
Warehouse Space	✓		✓
Welding/Picking Times		✓	✓
Order Quantities		✓	✓



**Programmable Pipe Bender**

	Economic Impact of Proposals (\$)			
	Current Process	Design Standardization	In-House Pipe Bending	Outsourcing
Piping Cost	643	643	190	1,000
Labor Cost	8,092	8,092	8,342	7,675
Cost/Trailer	8,735	8,735	8,532	8,675
Savings/Trailer	-	-	203	60
Annual Saving 10 Trailers/Week	-	-	101,410	29,845
Annual Saving 18 Trailers/Week			182,538	53,721

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# TRAIL KING industries

## IMPROVING WAREHOUSE LAYOUT & MANAGEMENT

### Research Project Objective

The project objective is to improve the utilization of the warehouse space by organizing parts and providing a new layout

### Deliverables

Documentation of current warehouse layout and information flow, economic analysis, Implementation plan, and future project recommendations.

		Solutions			
		New Facility Layout	Improved Shelving units	New Material Handling Equipment	Rearrangement of parts
Problems	Poor Utilization of racking space		★		★
	Storage of Excess inventory	★	★		★
	Inaccurate Location of parts		★		★
	Underutilization of warehouse area	★	★	★	★

### Potential Benefits

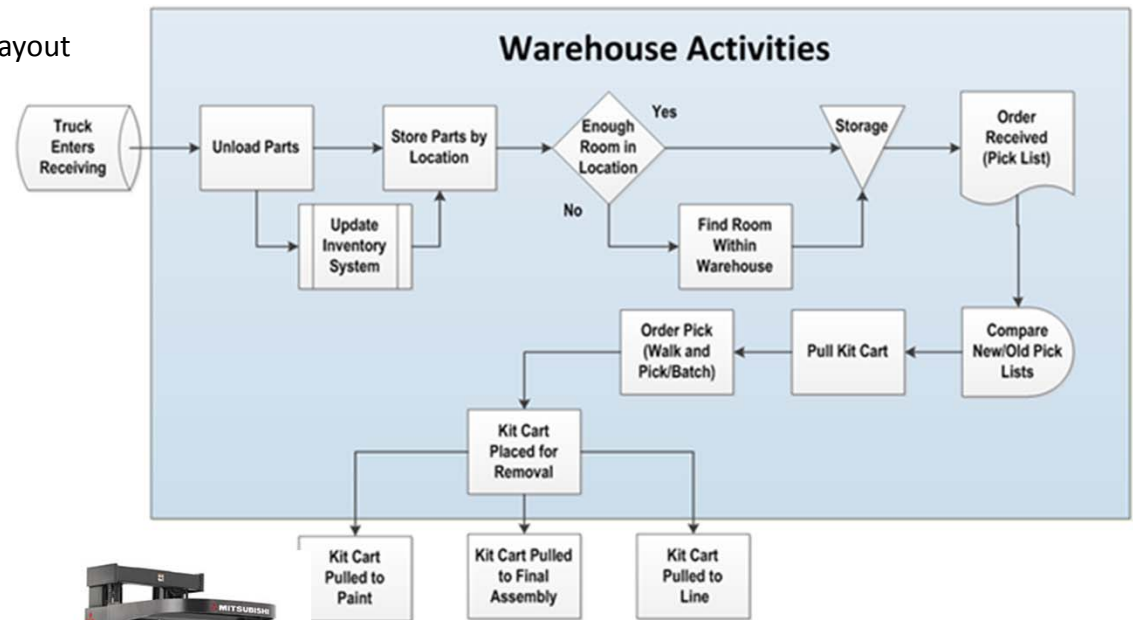
- ☐ Reduced the warehouse footprint (~25%)
- ☐ High racking system utilization
- ☐ Accurate part location easy to pick up
- ☐ Availability to add an additional production line providing potential increased profits of \$64,000 per week.

**Project Team Members:** Derek Anderson, Jie Chen, Shawn Kline, Shiyu Li.

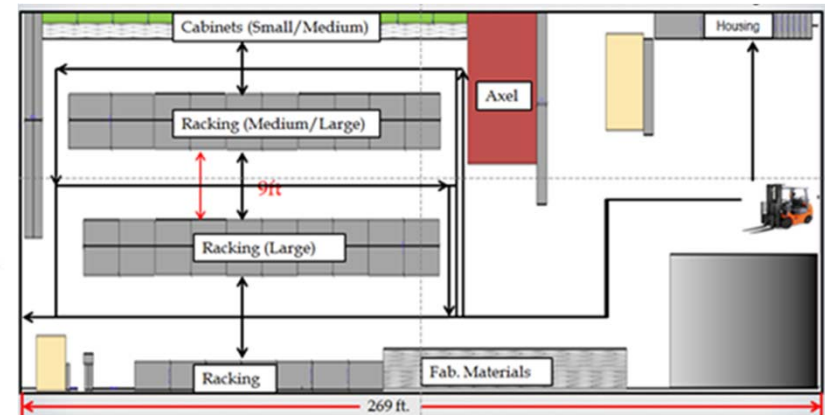
**Faculty Advisor and Consultant:** Reza Maleki

**Department:** Industrial and Manufacturing Engineering

**Funding Source:** Trail King Industries



### Proposed Layout



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# Improving Warehouse Layout and Management

## Project Objective

Improve the productivity of Trail King's warehouse operations including layout, space utilization, information flow, and material handling

## Deliverables

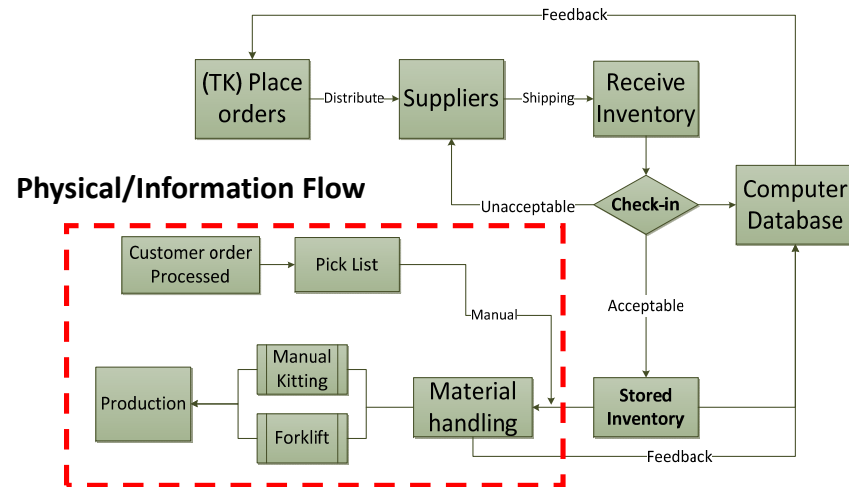
Documentation of:

- Current warehouse operations
- Improved warehouse operations
- Cost savings
- Recommended procedure for implementation

Problem/Proposal Matrix

Proposals \ Problems	Condense Storage Space	Narrow Aisle Lift Truck	Increase Rack Height	Combinations of Proposals
1. Material handling	√	√	√	√
2. Inventory Quantities	√			√
3. Storage System	√		√	√
4. Layout Design	√	√	√	√

<b>Project Team Members:</b> Yiwei Han, Kyle Kramer, Fangzheng Yuan, Jonathon Thesing.
<b>Faculty Advisor and Consultant:</b> Reza Maleki
<b>Department:</b> Industrial and Manufacturing Engineering
<b>Funding Source:</b> Trail King Industries



## Economic Analysis

Proposals	Description	Space Saving (ft <sup>2</sup> )	Cost Avoidance
A	<ul style="list-style-type: none"> <li>Rearrange inventory and condense racking space</li> <li>Reduce the total number of racks</li> <li>Relocate office and dust collectors</li> </ul>	1,398	\$136,225
B	<ul style="list-style-type: none"> <li>Use narrow aisle lift truck</li> <li>Use narrow racking system</li> <li>Relocate office and dust collectors</li> </ul>	1,008	\$ 13,025
AB	Combination of proposal A and proposal B	2,118	\$124,025
BC	Combination of proposal B and proposal C	1,547	\$61,665/ \$64,036
ABC	Combination of proposal A, proposal B, and proposal C**	2,488	\$152,236/ \$154,607
ABC+Dust Collectors + Office Pod	Combination of Proposals A, B, C and the removal the dust collectors and office pod**	3,238	\$81,089/ \$83,469

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# TRAIL KING industries

## Improving Pipe and Tube Storage and Handling

### Project Objective

The purpose of this project is to study, analyze, and document the current pipe and tube storage and handling process and develop proposals for improvements.

### Project Team Deliverables

Documentation of

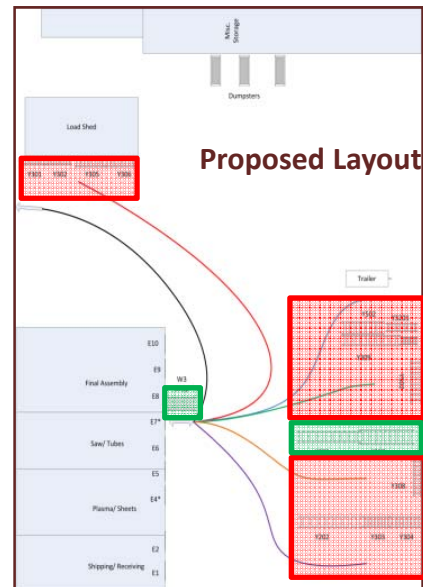
- Current Processes
- Process Improvements
- Labor and Space Savings
- Implementation Plan
- Outline for Future Projects



Multi-directional Forklift



Current Layout



Proposed Layout

**Project Team Members:** Joshua Mangahas, Yongshin Park, David Rokenbrodt, Joseph Wolverton

**Faculty Advisor and Consultant:** Reza Maleki

**Department:** Industrial and Manufacturing Engineering

**Funding Source:** Trail King Industries

	Move Current Racks	Add Labeling System	Adapt Current Racks	Information Timing	Bar and Tube Cart	Crane Attachment Device	Proposed Outdoor Layout
Space Not Fully Utilized	X		X		X		X
Generalized Stock Location System		X					X
Unprotected Storage			X				
Non-centralized Storage Locations Outside	X		X				X
No Specific Order for Cutting Parts				X			
Information Delay				X			
Hazardous Driving Conditions							X
Inefficient Material Handling Equipment					X	X	

### Benefits

- Improved space utilization
- Reduce labor time
- Better material handling
- Improved information flow

Total Savings					
Space Savings (ft <sup>2</sup> )	Space Savings (\$)	Labor Savings / Year (hours)	Labor Savings/ Year(\$)	Cost to Implement(\$)	ROI (years)
4,000	400,000	350	9,625	\$4,023	0.42

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# Improving Pipe and Tube Storage and Handling

**Project Team Members:** Jared Comegys, K. R. Gayan Jayasinghe, Tyler Samuelson, Jordan Sharp, He'er Xi.

**Faculty Advisor and Consultant:** Reza Maleki

**Department:** Industrial and Manufacturing Engineering

**Funding Source:** Trail King Industries

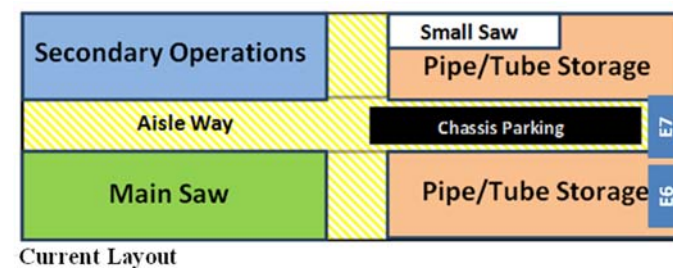
## Project Objective

Study, analyze, and document the material handling, information flow, and develop a proposal for improvements.

## Project Deliverables

- Understand the current processes
- Recommend ways to improve material handling/storage.
- Demonstrate economic benefits that may occur.
- Outline procedures for implementing the proposal.

		Problems						
		Space Utilization	Handling Material	Material Location	Current Racking System	Lack of Information Flow	Saw Operator Utilization	Mobility
Proposed Idea	Sideloading Forklift	x	x		x		x	x
	Covered Shed	x		x				
	Cantilever Racks	x	x	x	x			x
	Material Handler		x		x	x	x	



## Potential Benefits

- More floor space in the plant
- Reduce material damage
- Faster loading and delivering time
- More condensed storage and space utilization
- Reduce time waiting for material
- Increase saw operator utilization

Economic Analysis	
Initial Costs	\$142,397
Annual Costs	\$31,000
Annual Savings	\$79,750
Payback Period	2.92 yrs.

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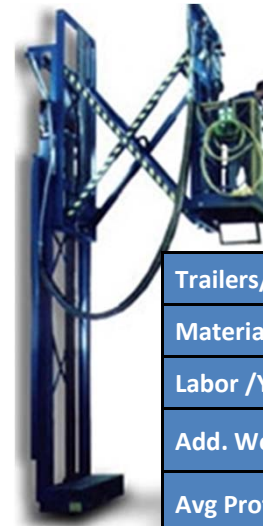
# Paint System Throughput Improvement

## PROJECT OBJECTIVE

The purpose of this project is to study, analyze and provide documentation to improve the overall efficiency of the paint system.

## PROJECT DELIVERABLES

- Documentation of the current system
- Documentation pertaining to research of paint system options
- Documentation of proposals with improvements to the paint system
- Documentation of cost and time savings Documentation outlining steps for implementing proposals
- An outline of recommendations for future improvements and projects



**Project Team Members:** Andrew Dittus, Guangjing You, Rajat Pahwa, Sam Reinhardt.

**Faculty Advisor and Consultant:** Reza Maleki

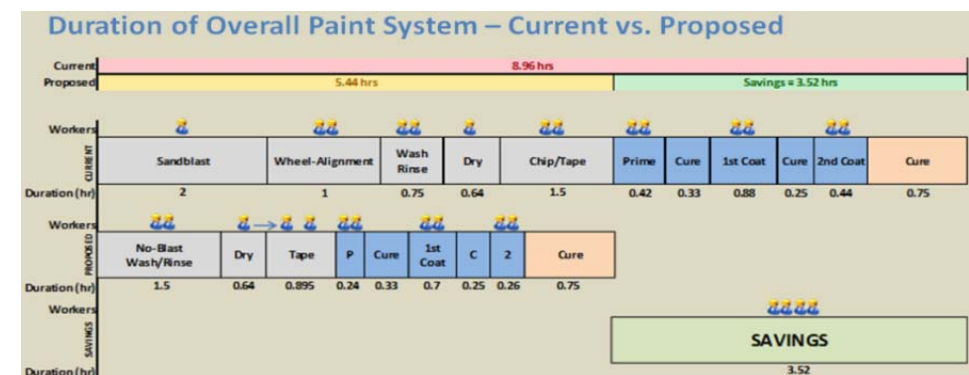
**Department:** Industrial and Manufacturing Engineering

**Funding Source:** Trail King Industries

	Current	Proposed	Difference
Trailers/Year	522	1,721	1,199
Materials Cost/Year	\$49,543	\$709,052	\$659,509
Labor /Year	\$177,866	\$363,836	\$185,970
Add. Worker Costs/Year	\$0	\$169,128	\$169,128
Avg Profit/Trailer	\$8,000	\$8,000	0
Revenue/Year	\$4,176,000	\$13,768,000	\$9,592,000
Profit/Year	\$3,948,591	\$12,525,984	\$8,577,393

## Potential Profits Resulting from Increased Throughput

		Solutions										
		Eliminate Sandblast	Relocate Wheel Alignment	Install Hose Booms	Eliminate Current Wash Chemicals on Sted Trailers	Implement Mediation Chemical No-Blast Technology	Install a Second Wash/Rinse	Welders Do Their Own Chipping	3M Dirt Trap Protection System	LPT LPS 3-Axis Mast Lift	Standardize 4 Main Colors	Install New Shelving
Prep	Problems											
	SandBlast	X			X							X
	Workers Climb Ladders	X			X							X
	Poor Lighting in Sandblast	X			X							X
	Location of the Wheel Alignment	X	X									X
	Hoses on the Floor				X		X					X
	Drip-Dry Rinse after Wash			X			X					X
Paint	Chipping is done by Anyone							X				X
	Workers Climb Ladders									X		X
	Lack of cleanliness in Paint Booth			X					X			X
	Lack of Paint Pump Utilization											X
	Lots of Colors to Choose From									X		X
	Lack of cleanliness in Paint Kitchen										X	X



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# Paint System Throughput Improvement

## Project Objective:

Study and analyze the current paint system then develop proposals that will increase the paint system's throughput without major capital expenses

## Deliverables:

Documentation of

- ☐ Current processes
- ☐ Layouts
- ☐ Proposals
- ☐ Cost savings of proposals
- ☐ Implementation plans
- ☐ Recommendation for future projects



**Project Team Members:** Melissa Bartholomay, Duanjian Feng, Alex Hawkins, Eric Nelson.

**Faculty Advisor and Consultant:** Reza Maleki

**Department:** Industrial and Manufacturing Engineering

**Funding Source:** Trail King Industries

Paint System Area		Problems
Prep	Pre-Wash	Poor method for removing weld splatter
	Masking	Poor method for masking trailer hubs Parts hanging process is inefficient
Paint		Poor lighting/ long paint inspection Low end solvent used to clean paint lines
General		Workers drifting into other areas

## Summary of Recommendations

- ☐ Better Tools for Removing Splatter
- ☐ Standardized Cart Configuration
- ☐ Better Method for Masking Hubs
- ☐ Improve Lighting in Paint Booth
- ☐ New Solvent for Paint Lines
- ☐ Standardized Work Schedule

Proposal	Cost	Yearly Time Savings (hours)	Yearly Labor Savings	Payback Period (years)	Throughput Increase per week
Pneumatic Chipping Tool	\$45	146	\$4,010	0.011	1 trailer
Standardized Paint Rack	\$3,185	176	\$4,840	0.66	1 trailer
Bag Hub Masking	\$1,500	390	\$10,700	0.14	4 trailers
Inspection Lighting	\$380	87.5	\$2,406	0.15	1 trailer

Cost Avoidance and Throughput Increase Resulting from Standardize Work Schedule			\$1,815,000		17
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*Summary of Economic Analysis*

## Potential Benefits:

- ☐ Ergonomically sound working methods
- ☐ Time and labor savings
- ☐ Increased throughput
- ☐ Reduced material handling
- ☐ Higher quality paint job
- ☐ Organized job assignment and schedule

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# Analysis of Proposals for Dedicated Production Centers






## PROJECT OBJECTIVE

The purpose of this project is to study, analyze and document proposals which can more efficiently utilize plant floor space through the implementation of target production centers in coordination with the Mitchell, South Dakota plant.

## TEAM DELIVERABLES

Documentation of current production system, target products identification, economic benefits, steps for implementation

Production Shifting		
	West Fargo	Mitchell
I-Beams		Produced
Axles		Assembled
Tires	Mounted	

Potential Benefits from Freeing-up Axle Area and Installing Weld Stations in the I-Beam Area.

Increases production & Profit

Freed-up Floor Space

\$32,000/week increased profit

3 weeks Payback Period

Comparison of Reutilization Alternatives			
Free up Axle assembly & I-Beam production areas		Free up axle assembly area & install weld stations	
Advantages	Low overhead	Advantages	Increases production & profit
	Large cost avoidance		Short payback period
Disadvantages	No additional production	Disadvantages	High overhead
	Requires future reutilization		Line rebalancing & bottlenecks

**Project Team Members:** Devin A. Kasper, Akash Satija, Jingfeng Tan, Joe Zimmerman.

**Faculty Advisor and Consultant:** Reza Maleki

**Department:** Industrial and Manufacturing Engineering

**Funding Source:** Trail King Industries

Number of Shipments, I-Beam vs. Axle Bi-Weekly Demand

	0	2.6	2.9	3.2	3.5	3.8	4.1	4.4	4.7
	1	2.7	3.0	3.3	3.6	3.8	4.1	4.4	4.7
	2	2.7	3.0	3.3	3.6	3.8	4.2	4.5	4.8
	3	2.7	3.0	3.3	3.6	3.8	4.2	4.5	4.8
	4	2.8	3.1	3.3	3.6	3.9	4.2	4.5	4.8
	5	2.8	3.1	3.4	3.7	3.9	4.3	4.6	4.8
	6	2.8	3.1	3.4	3.7	3.9	4.3	4.6	4.9
	7	2.8	3.1	3.4	3.7	4.0	4.3	4.6	4.9
	8	2.9	3.2	3.5	3.8	4.0	4.3	4.6	4.9
	9	2.9	3.2	3.5	3.8	4.0	4.4	4.7	5.0
	10	2.9	3.2	3.5	3.8	4.1	4.4	4.7	5.0
	11	3.0	3.3	3.6	3.8	4.1	4.4	4.7	5.0
	12	3.0	3.3	3.6	3.9	4.1	4.5	4.8	5.1
	13	3.0	3.3	3.6	3.9	4.1	4.5	4.8	5.1
	14	3.1	3.3	3.6	3.9	4.2	4.5	4.8	5.1
	15	3.1	3.4	3.7	4.0	4.2	4.6	4.8	5.1
	16	3.1	3.4	3.7	4.0	4.2	4.6	4.9	5.2
	17	3.1	3.4	3.7	4.0	4.3	4.6	4.9	5.2
	18	3.2	3.5	3.8	4.1	4.3	4.6	4.9	5.2
	19	3.2	3.5	3.8	4.1	4.3	4.7	5.0	5.3
	20	3.2	3.5	3.8	4.1	4.3	4.7	5.0	5.3
	21	3.3	3.6	3.8	4.1	4.4	4.7	5.0	5.3
	22	3.3	3.6	3.9	4.2	4.4	4.8	5.0	5.3
	23	3.3	3.6	3.9	4.2	4.4	4.8	5.1	5.4
	24	3.3	3.6	3.9	4.2	4.5	4.8	5.1	5.4
	25	3.4	3.7	4.0	4.3	4.5	4.8	5.1	5.4
	26	3.4	3.7	4.0	4.3	4.5	4.9	5.2	5.5
	27	3.4	3.7	4.0	4.3	4.5	4.9	5.2	5.5
	28	3.5	3.8	4.0	4.3	4.6	4.9	5.2	5.5
	29	3.5	3.8	4.1	4.4	4.6	5.0	5.3	5.5
	30	3.5	3.8	4.1	4.4	4.6	5.0	5.3	5.6
		90	100	110	120	128	140	150	160

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# TRAIL KING industries

## Analysis of Proposals for Dedicated Production Centers

**Project Team Members:** Justin Bahm, Tyler Johnson, Hanzhe Li, Christian Mocchi.

**Faculty Advisor and Consultant:** Reza Maleki

**Department:** Industrial and Manufacturing Engineering

**Funding Source:** Trail King Industries

### PROJECT OBJECTIVE:

Analyze the costs and benefits associated with dedicating the production of target components

### DELIVERABLES:

Documentation of:

- ☐ Current layout and processes
- ☐ Identification of target components
- ☐ Proposed layout reflecting utilization of production centers
- ☐ Proposed transportation methods
- ☐ Economic analysis
- ☐ Implementation plan
- ☐ Recommendations for future improvements



### RECOMMENDATIONS

- ☐ Expand APB production – West Fargo
- ☐ Aluminum machining center – West Fargo
- ☐ Small steel part production – Mitchell
- ☐ Reduce shipping costs by using suppliers
- ☐ Outsource axle assembly

### West Fargo's Shipment to Mitchell Plant

Tires	Tires	Tires	Tires	Tires	Tires	Tires	Tires	Tires	Tires	Tires	Tires	Tires	Tires	Tires	Tires
12 sq. ft.	12 sq. ft.	12 sq. ft.	12 sq. ft.	12 sq. ft.	12 sq. ft.	12 sq. ft.	12 sq. ft.	12 sq. ft.	12 sq. ft.	12 sq. ft.	12 sq. ft.	12 sq. ft.	12 sq. ft.	12 sq. ft.	12 sq. ft.
Tires	Tires	Tires	Tires	Tires	Tires	Tires	Tires	Tires	Tires	Tires	Tires	Tires	Tires	Tires	Tires
12 sq. ft.	12 sq. ft.	12 sq. ft.	12 sq. ft.	12 sq. ft.	12 sq. ft.	12 sq. ft.	12 sq. ft.	12 sq. ft.	12 sq. ft.	12 sq. ft.	12 sq. ft.	12 sq. ft.	12 sq. ft.	12 sq. ft.	12 sq. ft.

### Mitchell Facility's Shipment to West Fargo Facility

53'-0" ▶															
I-Beams															
▲ 9'-6"	Axles	Axles	Axles	Axles	Axles	Axles	Axles	Axles	Axles	Axles	Axles	Axles	Axles	Axles	Axles
	20 sq. ft.	20 sq. ft.	20 sq. ft.	20 sq. ft.	20 sq. ft.	20 sq. ft.	20 sq. ft.	20 sq. ft.	20 sq. ft.	20 sq. ft.	20 sq. ft.	20 sq. ft.	20 sq. ft.	20 sq. ft.	20 sq. ft.
	I-Beams														

Item	Fixed Benefit (Cost) (\$)	Annual Benefit (Cost) (\$)
Labor Reduction - Axles	-	8,800
Labor Reduction - I-Beams	-	34,375
Shipping - Material Handling	-	(5,500)
Shipping - Fixtures	(11,400)	-
Transportation*	(150,000)	(130,375)
Shipping Cost Avoidance	-	255,200
Shipping Components to Mitchell	-	(50,000)
Equipment Removal	(25,000)	-
<b>Total</b>	<b>(186,400)</b>	<b>112,500</b>
<b>Space Saved</b>	<b>3875 ft<sup>2</sup></b>	

\* Estimated 60,000 miles/year

$$\text{Payback period: } \frac{\text{Total Fixed Cost}}{\text{Annual Savings}} = \frac{186,400}{112,500} \approx 1.7 \text{ years}$$

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# Improving In-House Belt Manufacturing and Analysis for Outsourcing

## Project Objective

Develop proposals that can help with improved belt manufacturing including processes and layouts. This project also includes studies of potential outsourcing of belt manufacturing.

## Project Team Deliverables: Documentation of:

- ❖ current processes and layout
- ❖ proposals for improved process and layout
- ❖ outsourcing potential
- ❖ economic analysis
- ❖ Implementation of new processes and layouts

Solutions	Shorter Chain Table	Adjustable Chain Table	Pre-Punched Z-bars	Z-bar Rack	Table Separation	Eliminate Extra Fixtures	New Drill Fixture
Problems							
Manual Chain Rolling					X	X	
Multiple Fixtures Transportation		X				X	
Z-bar Stack				X			
Fixed Chain Width		X				X	
Unreliable Drills			X				X
Secondary Manual Countersinks							X
Need for Metal Drilling			X				X
Excessive Walking for Welders	X	X		X		X	

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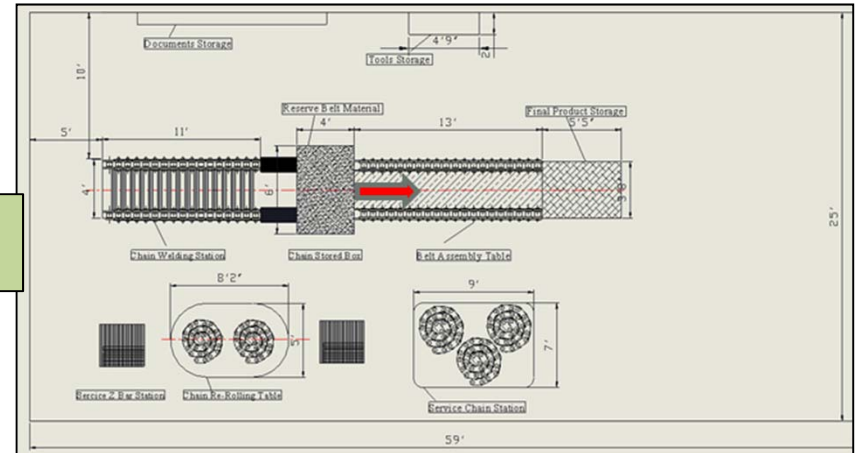
**Project Team Members:** Tucker Richardson, Hanxiao Tian, Patrick Whelan, Aaron Woytke.

**Faculty Advisor and Consultant:** Reza Maleki

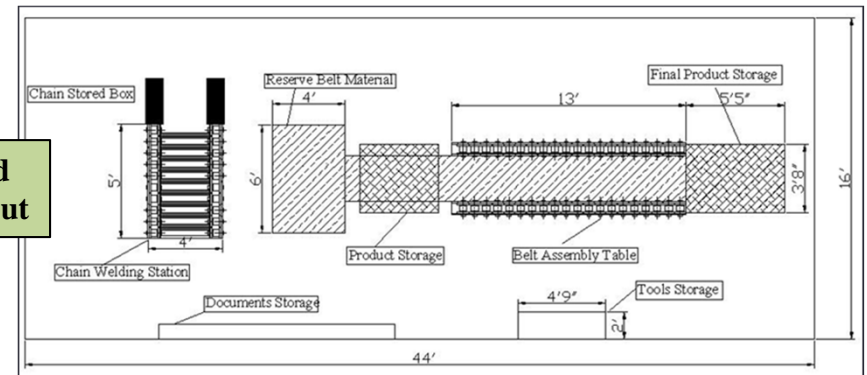
**Department:** Industrial and Manufacturing Engineering

**Funding Source:** Trail King Industries

## Current Layout



## Proposed New Layout



## Benefits Summary

Time Saved/Belt	38.21 min
Savings per year	\$15,417.30
Payback Period	2.59 Years
Potential Throughput Increase	> 100%
Space Saved	665 Sq. Ft. (45%)





# Improving In-House Belt Manufacturing and Analysis for Outsourcing



## Project Objectives

- Improve processes and equipment
- Analyze feasibility of outsourcing

## Team Deliverables

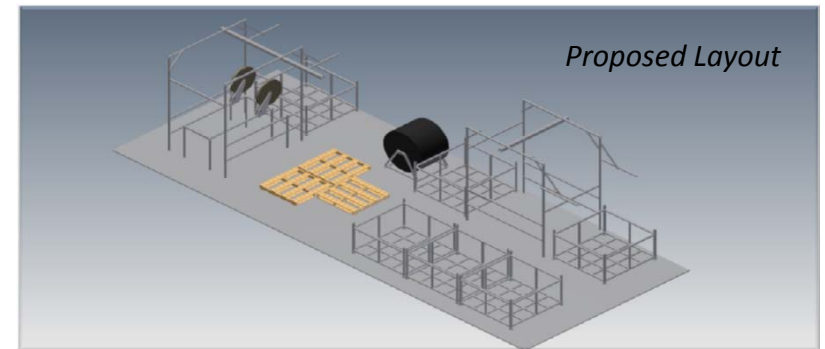
- Documentation of current process
- Economic analysis
- Recommendations
- Implementation Plan
- Future Recommendations

**Project Team Members:** Thomas Schantz, Ryan Tapper, Kathryn Whelan, Yang Yang.

**Faculty Advisor and Consultant:** Reza Maleki

**Department:** Industrial and Manufacturing Engineering

**Funding Source:** Trail King Industries



	Time Per Belt (hr.)	Avg. \$ Per Belt	Total \$ Per Yr.
Current Process	4.24	\$350	\$53,533
Proposed Process	2.63	\$217	\$33,188
<b>Savings</b>	<b>1.61</b>	<b>\$133</b>	<b>\$20,345</b>

$$\text{Payback period} = \frac{\text{Initial Cost}}{\text{Yearly Savings}} = \frac{\$30,447}{\$20,345} \cong 1.5 \text{ years}$$

## Summary of Potential Benefits

- Reduced footprint by 31%
- Decreased process time by 1.61 hr./belt
- Improved ergonomics
- Decreased material movement

Solutions	Problems	Inadequate Equipment	Inadequate Layout	Material Flow	Ergonomics
Resdesign of Belt/Chain Fixtures	X				
New Work-Cell Layout		X	X		
In-house Logistics Improvements	X		X		
Adjustable Equipment	X	X			X

**Spring Semester 2012**

**Integrated Program/Project Management and Capstone Experience**



# Analysis and Selection of Food Packaging and Seasoning Equipment



**Project Team Members:** Vaibhav Biradar..

**Faculty Advisor and Consultant:** Reza Maleki

**Department:** Industrial and Manufacturing Engineering

**Funding Source:** Giant Snacks

## Project Research Objective

To develop proposals that can help with improved throughput of the packaging equipment used in the facility.

## Deliverables

- ❖ Documentation and analysis of current processes including information flow, facility layout, and processes lead times.
- ❖ Documentation of requirements for improving the throughput of packaging equipment.
- ❖ Documentation of economic benefits.

## Productivity Improvement of Packaging Machine

- ❖ Extra weighing bucket can reduce the cleaning and washing time.
- ❖ Industrial washer can reduce washing time and help to increase production.
- ❖ Improved production planning can increase the production rate.
- ❖ Various combinations of linear and main feed parameters (amplitude and time) may help to increase efficiency and hence productivity.
- ❖ Upfront calculation of packaging time can help with better scheduling and improved throughput.
- ❖ Reducing setup time will increase the production rate.
- ❖ Continuous supply of seeds can increase machine utilization and improve productivity.

## Three (3) Major Opportunities for Productivity Improvement

- ❖ Extra packaging machine buckets for select machines.
- ❖ New Industrial washer and dryer.
- ❖ New production planning to reduce setup time.

	New Buckets	Industrial Parts washer	New Production Schedule
Initial Investment	\$23,000	\$5,200	\$1,572
Operating Cost	0	0	0
Production Hours (per week per machine)			
AS IS Production Hours	80	80	80
Actual Production Hours	68	68	68
Improved Production Hours	74	74	72
Increase in Production Hours	6	6	6
% increase Production Hours	8%	8%	8%
Labor Hours (per week per machine)			
AS IS Labor Hours	160	160	160
Improved Labor Hours	160	148	154
Labor Hours Saving	0	12	12
% labor Hours Saving	0%	8%	8%
\$ Labor Savings (per week)	0	\$720	720
Production (per week single machine)			
Average Production per Minute	40	40	40
Increase in Production	14,400	14,400	14,400
Profit Margin	\$0.10	\$0.10	\$0.10
Profit due to INCREASED Production	\$1,440.00	\$1,440.00	\$1,440.00
Benefit per Week	\$2,880	\$4,320	\$2,160
Payback Period (weeks)	7.99	1.20	0.73

Summer Session 2011

Individual Study Design Research Project





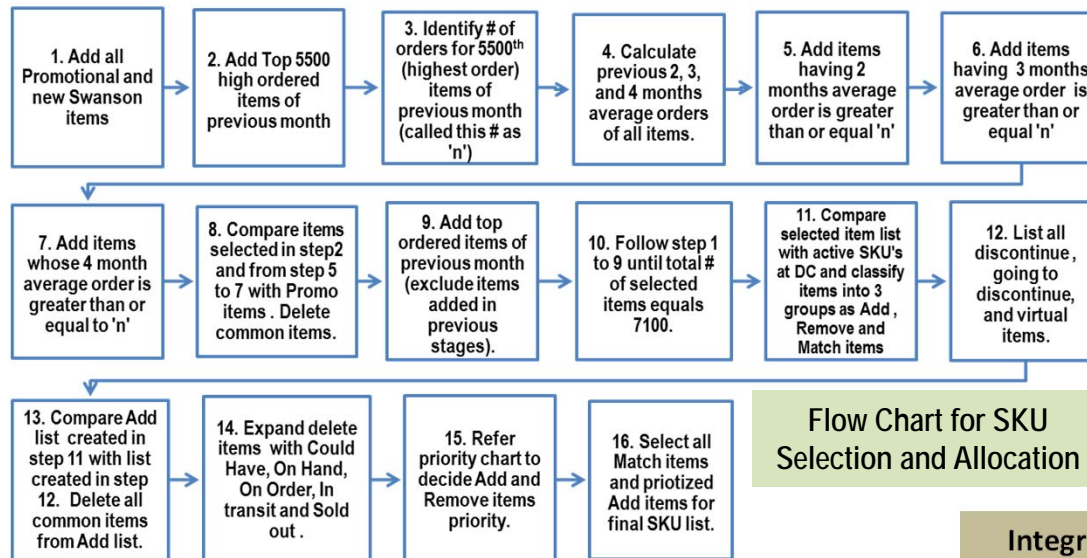
## Improving Allocation of SKUs to Distribution Centers

### Research Project Objective

The purpose of this project is to assist with developing proposals for allocating the SKUs to Harrisburg and Sparks centers so they can achieve the SHP's goal of meeting the target percentage for processing and shipping "complete" orders to customers in their regions.

### Deliverables

- Documentation and analysis of current orders from customers that are targeted to be served by the Harrisburg and Sparks "centers."
- Documentation and analysis of SKUs allocated to the centers.
- Documentation of proposals that can help with improved allocation of SKUs to the centers.

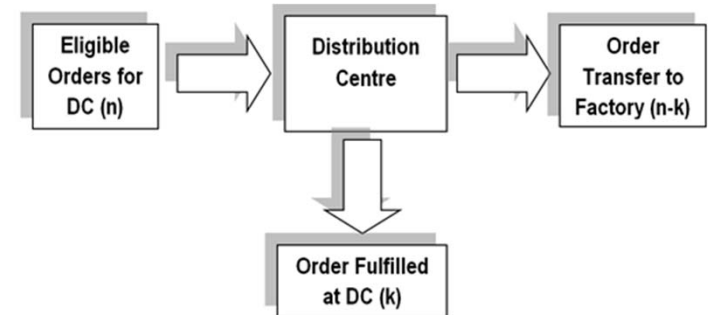


**Project Team Members:** Vaibhav Biradar..

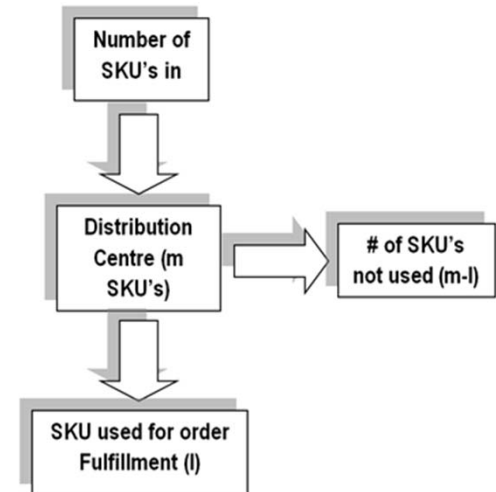
**Faculty Advisor and Consultant:** Reza Maleki

**Department:** Industrial and Manufacturing Engineering

**Funding Source:** Giant Snacks



Flow chart for order fulfillment by Eligible Distribution



Flow chart for Number of SKU used in Eligible Distribution Centre

Fall Semester 2011

Integrated Program/Project Management and Capstone Experience





# Process Emission Analysis

## Research Project Objective

The purpose of this project is to study, document, and analyze the facility's frying process emissions, as well as calculate the current emission levels for a typical day of production

## Deliverables

- ❑ Documentation of:
  - ❑ Research on Clean Air Act and MPCA Standards and Regulations
  - ❑ Frying Processes That Use Oil (Flow Charts)
  - ❑ Traditional Potato Chips
  - ❑ Tortilla Corn Chips
  - ❑ Kettle-Cooked Potato Chips
  - ❑ Calculations of Current Emission Levels
- ❑ Recommendation for Acquiring Air Permit



## Project Activities

- ❑ Researched Particulate Matter Emissions PM-10 & 2.5 for Frying Process.
- ❑ Documented the Barrel O' Funs Frying Processes and Estimated a Typical Day of Emissions
- ❑ Analyzed Other Filtration Systems to Reduce Emissions in Future
  - ❑ Scrubbers
  - ❑ Mist-Eliminators
  - ❑ Impingement Devices

Pollutant	Total Facility PTE* Thresholds (tons per year)	
	Federal	State
PM10	100	25
PM2.5	100	100

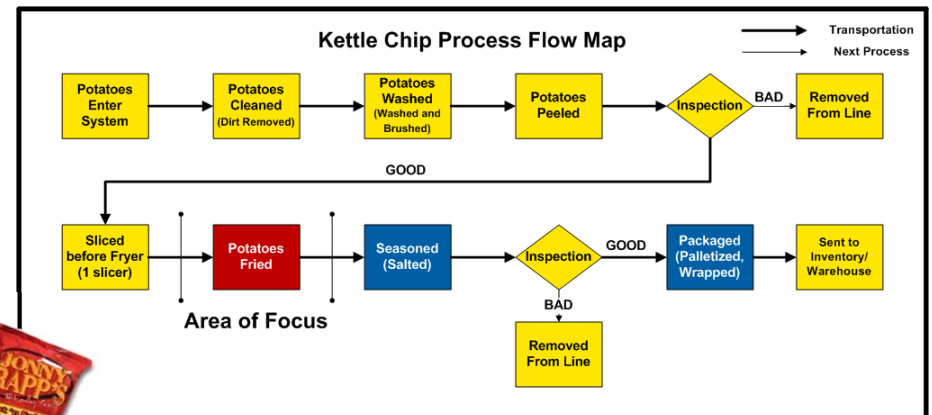
Federal and Minnesota Pollution Control Agency's Potential to Emit (PTE) Threshold for a Facility

**Project Team Members:** Kirsten Kelly, Chance Krom, Tom Swenson , Jianchao Xiao

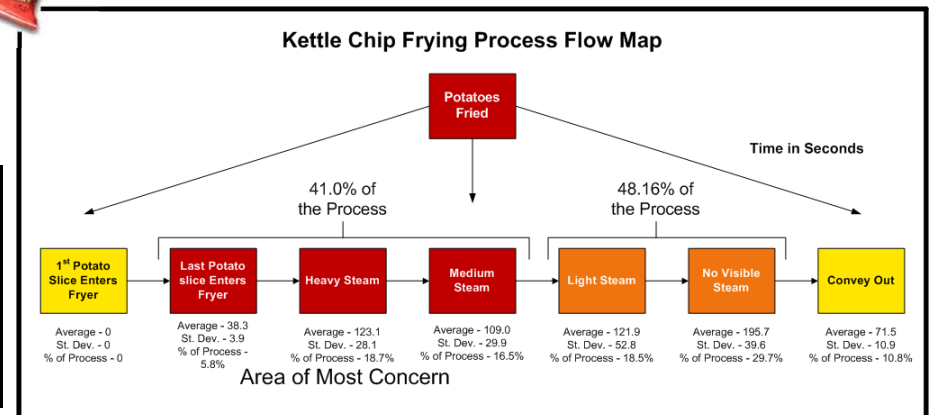
**Faculty Advisor and Consultant:** Reza Maleki  
Email: [Reza.Maleki@ndsu.edu](mailto:Reza.Maleki@ndsu.edu)

**Department:** Industrial and Manufacturing Engineering

**Funding Source:** Barrel O' Fun



Flow Charts of Kettle-Cooked Frying Processes



## Project Results

The results show that Barrel O' Fun's meets state and federal requirements for process emission.

Spring Semester 2011

Integrated Program/Project Management and Capstone Experience





## Packaging Line Layout and Labor Analysis

**Project Team Members:** Reece Bunnell, Patrick Jenkins, Matthew Lanoue, Cuiyuan Lu, Simon Deng

**Faculty Advisor and Consultant:** Reza Maleki  
Email: [Reza.Maleki@ndsu.edu](mailto:Reza.Maleki@ndsu.edu)

**Department:** Industrial and Manufacturing Engineering

**Funding Source:** Barrel O' Fun

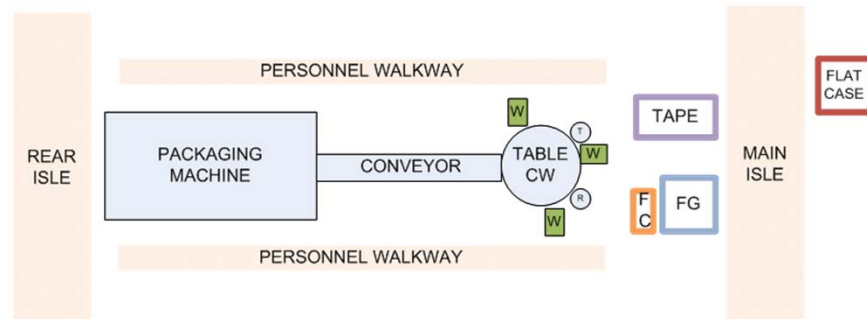
### Project Objectives:

- Observe and document current layout and labor practices
- Establish packaging and layout standards

### Project Deliverables:

- Documentation of current system
- Proposal of improvements
- Economic analysis

		Solutions		
		Time Standards Matrix	Standardized Layout	Set-up Reduction Team
Opportunities	Standardization of Packaging Rates	✓		
	Production Scheduling Optimization	✓		
	Packaging System Layout		✓	
	Minimization of Packaging Downtimes			✓



Proposed Standardized Layout

### Proposed Standardized Machine Output Rates (Bags/Min)

3 Workers		Bag Size (weight in ounces)													
		1	1.5	2	2.13	5	5.3	7	8	9	10	11	13	14	16
Bags per Case	8	100	100	100	100	70	70	60	60	50	50	50	45	40	40
	9	100	100	100	100	70	70	60	60	50	50	50	45	40	40
	10	100	100	100	100	70	70	60	60	50	50	50	45	45	40
	12	100	100	100	100	70	70	60	60	50	50	50	45	45	40
	14	110	110	110	110	75	75	65	65	55	55	55	50	50	45
	15	110	110	110	110	75	75	65	65	55	55	55	50	50	45
	24	110	110	110	110	80	80	70	70	60	60	60	50	50	45
	60	110	110	110	110	80	80	70	70	60	60	60	50	50	45
	72	110	110	110	110	80	80	70	70	60	60	60	50	50	45

Proposed Profit of Packaging System Production (\$/min)						
Line Workers Bags/Min	Bag Weight (oz.)	Bags/Case	lbs/min	Profit/Min		
				2008	2009	2010
80	1.5	60	7.50	\$ 12.60	\$ 13.28	\$ 13.50
50	5	14	15.63	\$ 26.25	\$ 27.66	\$ 28.13
40	7	12	17.50	\$ 29.40	\$ 30.98	\$ 31.50
40	8	10	20.00	\$ 33.60	\$ 35.40	\$ 36.00
35	9	12	19.69	\$ 33.08	\$ 34.85	\$ 35.44
35	10	12	21.88	\$ 36.75	\$ 38.72	\$ 39.38
35	11	12	24.06	\$ 40.43	\$ 42.59	\$ 43.31
30	13	12	24.38	\$ 40.95	\$ 43.14	\$ 43.88
25	14	8	21.88	\$ 36.75	\$ 38.72	\$ 39.38
25	16	9	25.00	\$ 42.00	\$ 44.25	\$ 45.00
Sum				\$ 331.80	\$ 349.58	\$ 355.50

### Potential Benefits:

- More consistent and predictable packaging rates
- Improved production planning
- Increase in throughput

Spring Semester 2011

Integrated Program/Project Management and Capstone Experience





# Improve Seasoning Line Capacity Through Setup Reduction

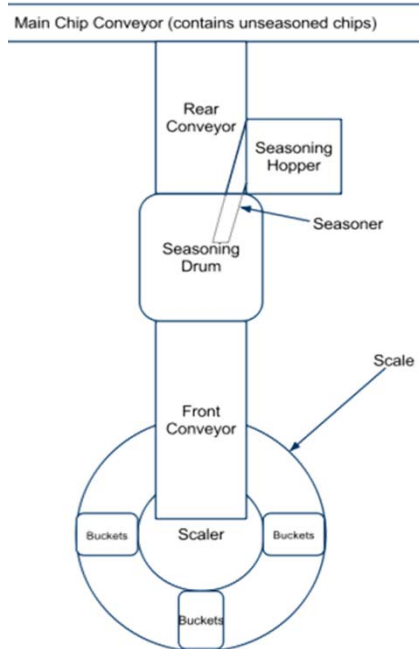
## Project Objectives:

- Study, document and analyze current setup procedures
- Improve Seasoning line capacity

## Team Deliverables:

- Documentation of current setup procedures
- Documentation of proposed setup procedures
- Documentation of cost savings
- Recommendations for future projects and improvements

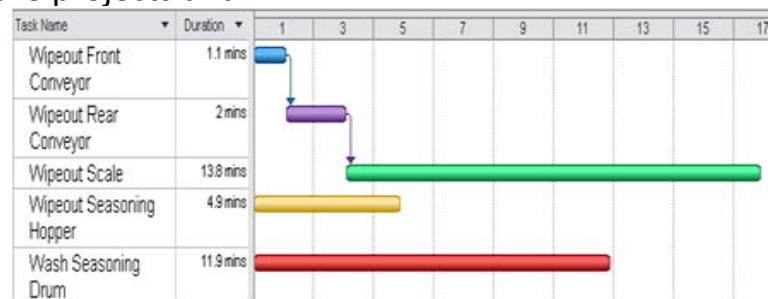
### Seasoning Line Layout:



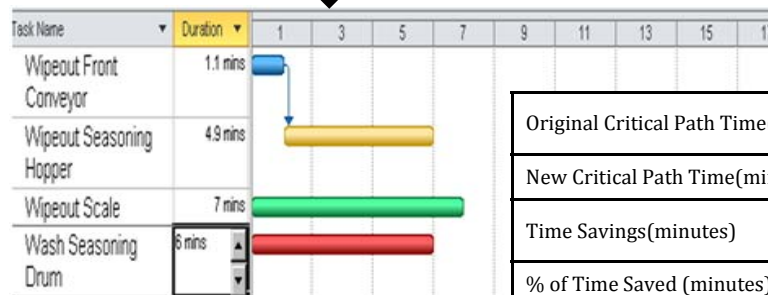
## Project Activities:

Researched and developed improved setup processes

### Current Wipeout Times:



### Proposed Wipeout Times:



Original Critical Path Time(minutes)	17.00
New Critical Path Time(minutes)	7.00
Time Savings(minutes)	10.00
% of Time Saved (minutes)	59%

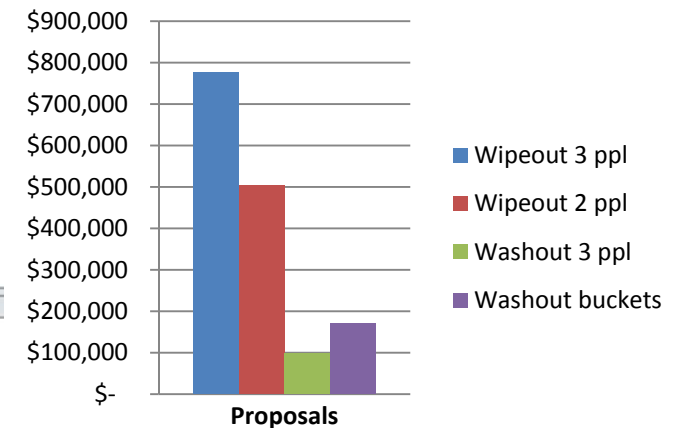
**Project Team Members:** Andrew Lembcke, Xing Zhuang, Shuang Shi, Andy Ryan

**Faculty Advisor and Consultant:** Reza Maleki  
Email: [Reza.Maleki@ndsu.edu](mailto:Reza.Maleki@ndsu.edu)

**Department:** Industrial and Manufacturing Engineering

**Funding Source:** Barrel O' Fun

## Potential Profit Gain



## Project Benefits:

- Capacity increase for traditional and kettle chip seasoning lines
- Potential Profit gain
- Labor savings
- Improved utilization of resources

Spring Semester 2011

Integrated Program/Project Management and Capstone Experience





## Tugger Cart Logistics

### Project Objective:

The purpose of this project is to study, analyze, and document proposals for improved tugger cart logistic

### Deliverables:

- Document current tugger cart flow
- Identify problems in the system
- Document proposals to improve tugger cart logistic
- Document economic benefits
- Outline recommendations for future projects and i



**Project Team Members:** Prabesh Joshi, Yaquan Wang, Jason McDonald, Felicity Lunden, Kyle Rolfsrud

**Faculty Advisor and Consultant:** Reza Maleki  
Email: [Reza.Maleki@ndsu.edu](mailto:Reza.Maleki@ndsu.edu)

**Department:** Industrial and Manufacturing Engineering

**Funding Source:** Case New Holland

### Proposals:

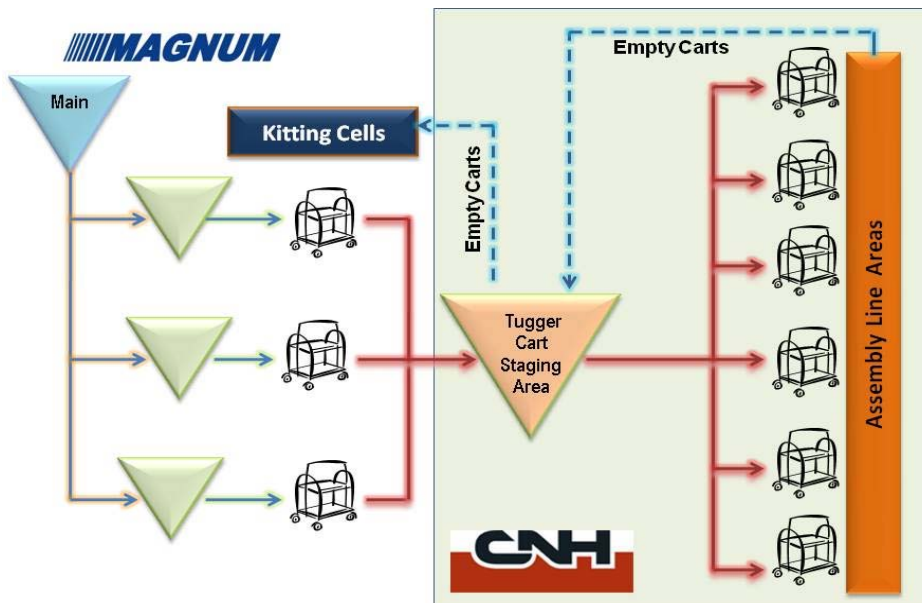
- Implement CNH Labor Scheduling at Mangum
- Implement Inventory Tracking System
- Staging Area Organization
- Follow designated CNH Routes
- Universal Cart Connection

### Economic Analysis

	Proposal #1	Proposal #2	Proposal #3	Proposal #4	Proposal #5
Profit	NA	NA	\$ 15,714	\$ 2,946.30	\$ 11,460
Cost	NA	\$ 5,080.88	NA	\$ 450	\$ 0
Total	NA	\$-5,080.88	\$15,714	\$ 2,496.30	\$ 11,460

### Potential Benefits:

- Better employee utilization
- Better communication
- More room in the staging area
- More reliable cart connections
- Large amounts of time and money saved



Spring Semester 2011

Integrated Program/Project Management and Capstone Experience



### Project Objectives

Develop an assembly line that:

- ☐ Supports TAKT Time
- ☐ Increases Labor Efficiency
- ☐ Improves Ergonomics
- ☐ Provides Visual Controls that Highlight Production Issue

### Team Deliverables

Documentation of:

- ☐ Current Assembly Line
- ☐ Proposed Solutions
- ☐ Cost and Time Savings from Proposed Solutions
- ☐ Implementation Plan
- ☐ Recommendations

### Proposed Solutions

1. Electronic Display for IP/SWIs
2. Ergonomic Tool Arm
3. Improved Work Cell Layout
4. Improved Workstation Design
5. Component Placement Display
6. Sealant Application
7. Cycle Time Reduction

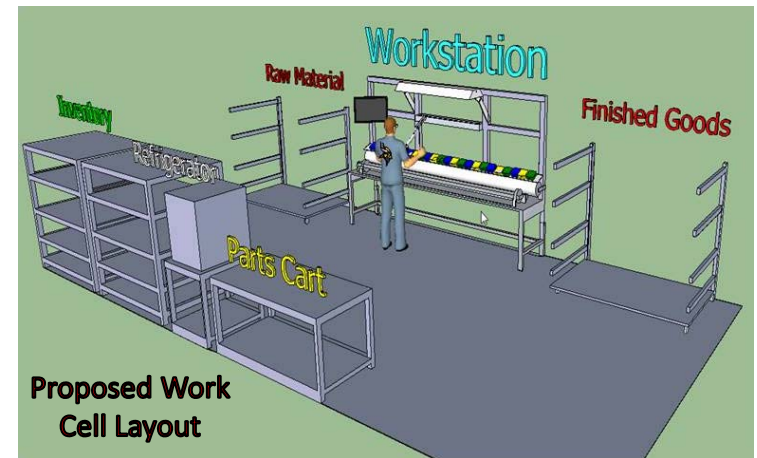


**Project Team Members:** Marcus Bruhn, Lindsey Hermanson, Katie Roesler, Rob Strand, Chris Winning

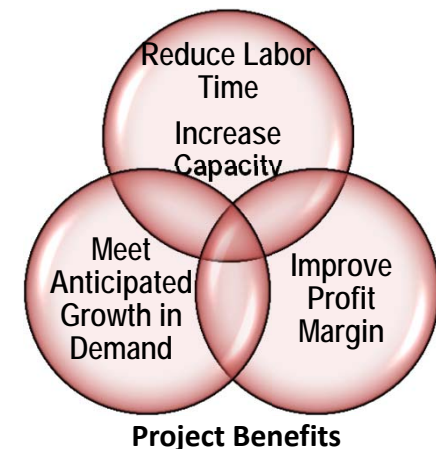
**Faculty Advisor and Consultant:** Reza Maleki  
Email: [Reza.Maleki@ndsu.edu](mailto:Reza.Maleki@ndsu.edu)

**Department:** Industrial and Manufacturing Engineering

**Funding Source:** Goodrich



System Metrics	Current	Proposal #1	Proposal #2	Proposal #2 Rev 1
Throughput/Day	10	18-20	16-18	23-26
WIP Cart	Yes	No	Yes	Yes
# of Workstations	2	1	2	2
Square Feet Consumed	400	245.5	400	400
# of Workers	1	1	1	2
Labor Cost/Day	\$172.80	\$172.80	\$172.80	\$345.60
Revenue/Day	\$20K	\$36K-\$40K	\$32K-\$36K	\$46K-\$52K



Spring Semester 2011



# GOODRICH

## Paint Line Analysis

**Project Team Members:** Jeff Schmaltz, Lars Peterson, Zach Bullinger, Conor Herron, Baird Cuppy

**Faculty Advisor and Consultant:** Reza Maleki  
Email: [Reza.Maleki@ndsu.edu](mailto:Reza.Maleki@ndsu.edu)

**Department:** Industrial and Manufacturing Engineering

**Funding Source:** Goodrich

### Project Objective:

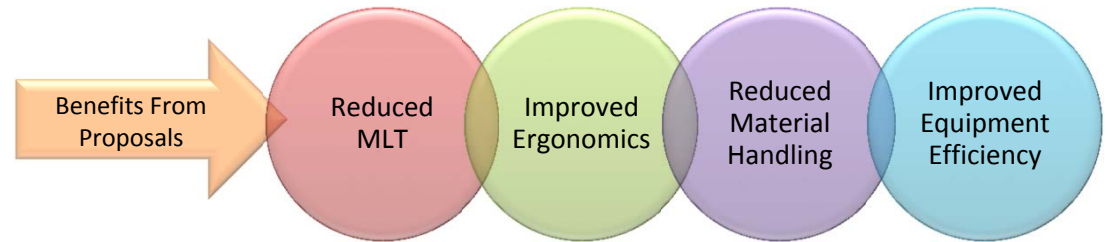
Improve the efficiency and use of the paint line

### Deliverables:

- Document current paint line operations
- Document researched paint system options
- Recommend proposals to improve the paint line
- Document potential economic benefits from proposals
- Develop a phased installation plan
- Recommended future projects and improvements

### Proposals:

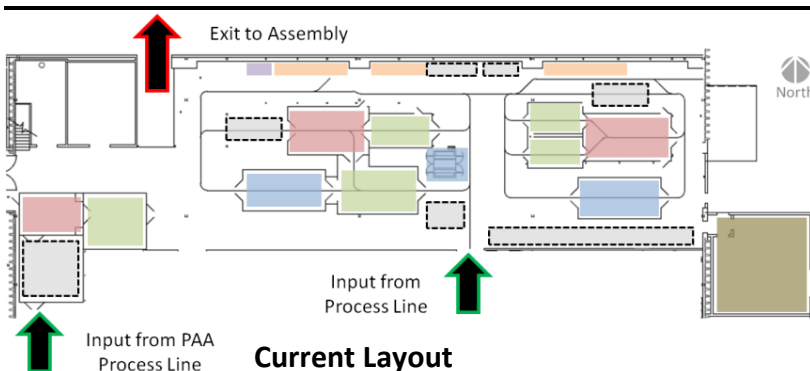
- Redesigned Facility Layout
- New Curing Ovens
- Color Coded PAA Paint Booth
- Ergonomic Material Handling Carts
- New Ergonomic Work Stations
- Color Coded Prep Work Instruction
- Multi Axis Tape Dispensers



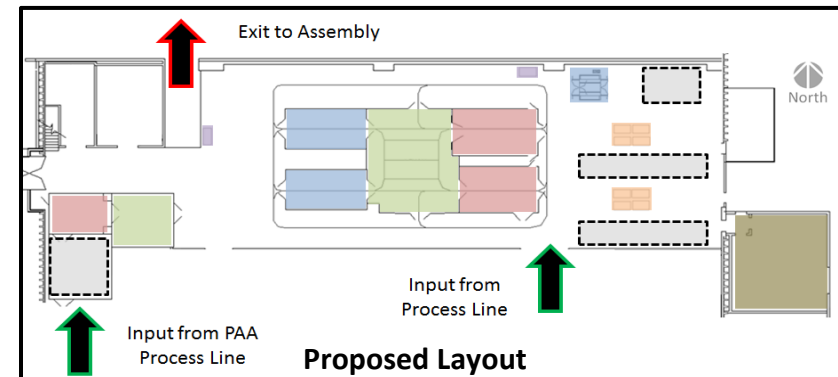
Process	Current/ Proposed	Mfg. Lead Time (hr/batch.)	Savings	
			Hours	Percentage
1	Current	7.17	0.99	14%
	Proposed	6.18		
2	Current	20.37	3.36	16%
	Proposed	17.01		
3	Current	43.28	3.87	9%
	Proposed	39.41		
4	Current	55.49	7.44	13%
	Proposed	48.05		
		<b>Average</b>	<b>3.92</b>	<b>13%</b>

Material Handling Savings	
Travel Distance Saved	15,816,120 ft.
Time Saved	2,746 hrs.
<b>Annual Savings</b>	<b>\$ 123,563.44</b>

Economic Analysis Summary	
Initial Investment	\$ 422,737.50
Annual Savings	\$ 200,771.68
Payback Period	2.11
ROR	46.80%



KEY	
Prep Station	[Orange Box]
Paint Booth	[Red Box]
Flash Off	[Green Box]
Curing Ovens	[Blue Box]
Remove Prep	[Purple Box]
Material Storage	[Brown Box]
Staging/Storage	[Dashed Box]



Spring Semester 2011

Integrated Program/Project Management and Capstone Experience



## Patient Throughput Improvements

**Project Team Members:** Ryan Adams, Cooper Anderson, Kayla Bergee, Evan Buchholz, Jacob Makuei

**Faculty Advisor and Consultant:** Reza Maleki  
Email: [Reza.Maleki@ndsu.edu](mailto:Reza.Maleki@ndsu.edu)

**Department:** Industrial and Manufacturing Engineering

**Funding Source:** NDSU Student Health Service

**Project Objective:** Analyze and document services to discover opportunities for improvement in throughput.

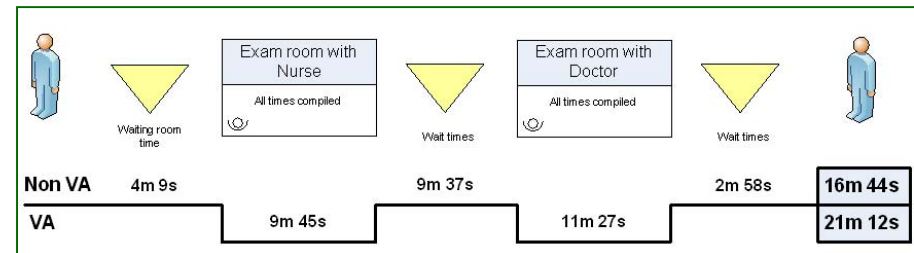
### Project Deliverables:

Documentation of:

- ✓ current practices and proposals for information and patient flow
- ✓ benefits analysis from implementation of the proposed suggestions
- ✓ recommendations for future projects and improvement

	Printers in each exam room	First come first serve provider queuing	Nurse resource pooling	Shifted hours of availability to the evening	Staggered lunch breaks	Customized daily schedule	Fix the audible alert for student arrivals	Fix or discontinue using the overhead light system	Standardize patient questioning procedures	
<b>Provider Backtracking</b>	X									
<b>Scheduling</b>		X	X	X	X					X - Directly Assists
<b>Communication</b>			O			X	X	X		O - Indirectly Assists

Recommendation	Patients/Day	Patients/Year	\$Daily Value	\$Yearly Value
<b>Current Schedule</b>	<b>66</b>	<b>11,404</b>	<b>\$5,478</b>	<b>\$944,108</b>
Purchase Printers	+12	+1,632	+\$996	+\$135,456
Nurse Pooling	+9	+1,465	+\$747	+\$128,484
Nurse and Provider Pooling	+24	+4,179	+\$1,992	+\$342,624
Staggered Lunch	+2	+410	+\$166	+\$28,607
Shifted 9-6	+4	+691	+\$333	+\$57,214
New Daily Schedule	+8	+1,338	+\$665	+\$114,428
Standardize patient questioning procedure	Improved throughput			
Audible Alert	Improved throughput			
Fix or Discontinue use of expansion overhead light system	Improved throughput			



### Recommendation Benefits:

- ✓ Reducing provider backtracking could allow for up to three more patients/provider/day
- ✓ First come first serve queuing in simulation helped to show benefits of pooled resources
- ✓ Better communication through questioning procedures and notification systems will reduce miscommunication occurrences and wait times
- ✓ Final recommendation allows for 87 patients per day or 22 patients per provider per day

Spring Semester 2011

Integrated Program/Project Management and Capstone Experience





## The Development and Documentation of an ESD Control Program

**Project Objective:** Construct an ESD control program so SJE Rhombus can meet certification requirements according to the ANSI/ESD S20.20 standard.

### Deliverables

- ☐ Document current operations highlighting major ESD concern areas
- ☐ Construct ESD control program
- ☐ Create manuals/slideshows used to train Personnel
- ☐ Provide an outline of recommendations



**Project Team Members:** Cory Kiemele, Matt Roberts, Laura Vaske, Yachao Wang

**Faculty Advisor and Consultant:** Reza Maleki  
Email: [Reza.Maleki@ndsu.edu](mailto:Reza.Maleki@ndsu.edu)

**Department:** Industrial and Manufacturing Engineering

**Funding Source:** SJE Rhombus

### Overview of ESD Control Program Document

Introduction	<ul style="list-style-type: none"> <li>Purpose</li> <li>Scope</li> <li>Responsibilities</li> <li>Applicable Documents</li> <li>Definitions</li> </ul>
ESD Control Program Plan	<ul style="list-style-type: none"> <li>Basic Control Standards</li> <li>General Guidelines</li> </ul>
Training Plan	<ul style="list-style-type: none"> <li>Training Requirements</li> <li>What is Covered in Training</li> <li>How Often Training is Required</li> </ul>
EPA Requirements	<ul style="list-style-type: none"> <li>ANSI Technical Requirements</li> <li>Testing of Grounding Equipment</li> <li>Workstation Requirements</li> </ul>
Compliance Verification	<ul style="list-style-type: none"> <li>Requirements for resistance of surfaces</li> <li>Test Procedure</li> <li>Test frequency</li> <li>Who is responsible for testing</li> </ul>

**Level One:** Full ESD Protection (Heel and Wrist Strap with Smocks)

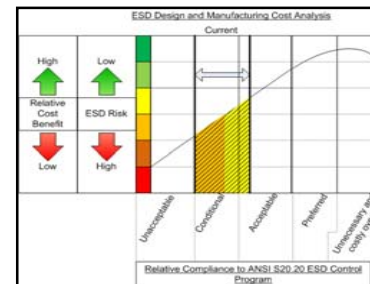
**Level Two:** Moderate ESD Protection (Heel Strap and Smock)

**Level Three:** Slight ESD Protection (Smock)

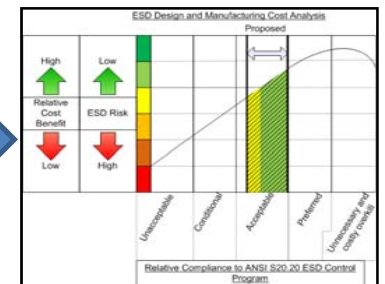
**Weighted Recommendations Table**

General Evaluating Criteria	Recommendations		Scale (1-10)									
	WEIGHT	Personal Precedures (log book)	Well Marked EPA	Smocks/Heel-Wrist Straps	Drop Chains	Dissipative Surface Mat	ESD Packaging Requirements	Ionized Fans	Conductive Floor Paint	Conductive Vinyl Tile	Humidity Control	
Cost	3	10	10	9	10	9	10	7	7	1	1	
Resulting ESD Control	2	9	8	9	4	5	5	8	9	9	10	
Estimated Installation Time	1.5	10	9	9	9	9	9	6	5	6	1	
Expected Life	1.25	7	7	4	9	8	2	7	7	9	10	
Ease of Implementation	1.25	10	9	9	9	8	9	6	2	3	1	
Maintenance	1	9	7	9	9	8	9	7	7	9	8	
<b>TOTAL WEIGHT</b>	<b>10</b>											
		87	84	83	79	76	69	65	54	46		
		<b>CALCULATED RANKED WEIGHT</b>										

### Current ESD Compliance



### Proposed ESD Compliance



Spring Semester 2011

Integrated Program/Project Management and Capstone Experience



## APEX Warehousing and Distribution Center Design

### Project Objective

The purpose of this project is to study, analyze, and document proposals which can help Tecton with improved manufacturing, warehousing and distribution of APEX siding systems.

### Project Team Deliverables

Documentation of...

- Current warehouse layout and practices
- Current process for assembling marketing kits
- Proposed improvements
- Proposed cost savings
- An outline of recommendations for future project



APEX Siding

### Recommendations

Opportunities	Warehouse Layout	Recommendations			
		New Warehouse Layout	Racking System	Redesign Workstation	New Mfg. Process
		Excessive material handling	✓	✓	✓
	Less than optimal space utilization	✓	✓	✓	✓
	Improper racking system		✓		
	Marketing Kits	Multiple workstations	✓	✓	
		Lack of fluidity	✓	✓	✓
		Excessive operator travel	✓	✓	✓

### Racking Systems

	Current	Cantilever Racks	Pallet Racks
Ease of Picking	3	2	1
Material Handling	3	2	1
Foot Print (Sq.Ft.)	1185	1755	2048
Cost	-	\$56,681.64	\$22,953.45

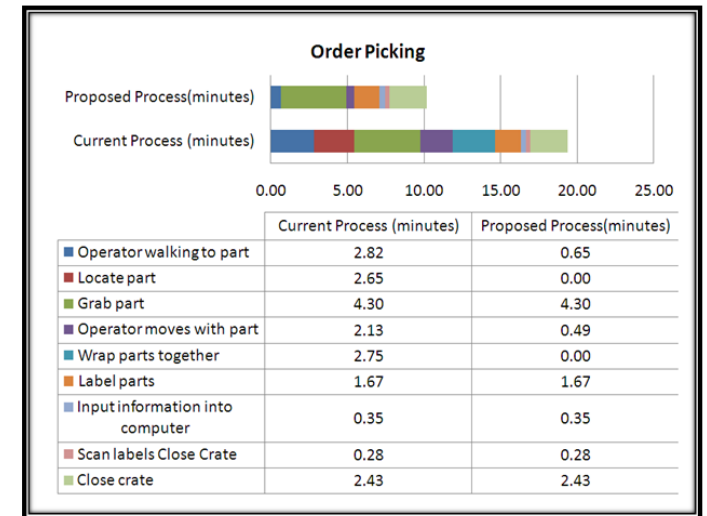


**Project Team Members:** Nadeesha Bellana, Weichao Chen, Ashit Datta, Tyler Hahn, Katie Sable

**Faculty Advisor and Consultant:** Reza Maleki  
Email: [Reza.Maleki@ndsu.edu](mailto:Reza.Maleki@ndsu.edu)

**Department:** Industrial and Manufacturing Engineering

**Funding Source:** Tecton Products



	Total Saved		
	Distance (ft)	Space (Sq ft)	Time (Min)
Warehouse Layout	1583 (77%)	590.58 (12%)	9.2/Order (48%)
Marketing Kits	370 (84%)	242.3 (45%)	1.28/Kit (29%)

### Benefits

- Reduced material handling
- Better space utilization
- Balanced manufacturing processes
- Reduced manufacturing lead time
- Reduced order picking time

Spring Semester 2011

Integrated Program/Project Management and Capstone Experience





# Analysis of Dynamometer Process and Scheduling



## Research Project Objective

- Analyze the current dynamometer and testing resources to develop a testing schedule for the demand for the next four years.
- Analyze the current development procedure and recommend changes that would allow for more testing or earlier completion dates.

## Project Team Deliverables

- Documentation and analysis of current setup processes including information flow, facility and work force utilization, and test lead time.
- Documentation of proposals for improving engine dynamometer facility utilization.
- Documentation of economic benefits that may result from implementing proposed suggestions.

**Project Team Members:** Vaibhav Biradar, Jay Kothman, Michael Mathers, Waylon Thomas.

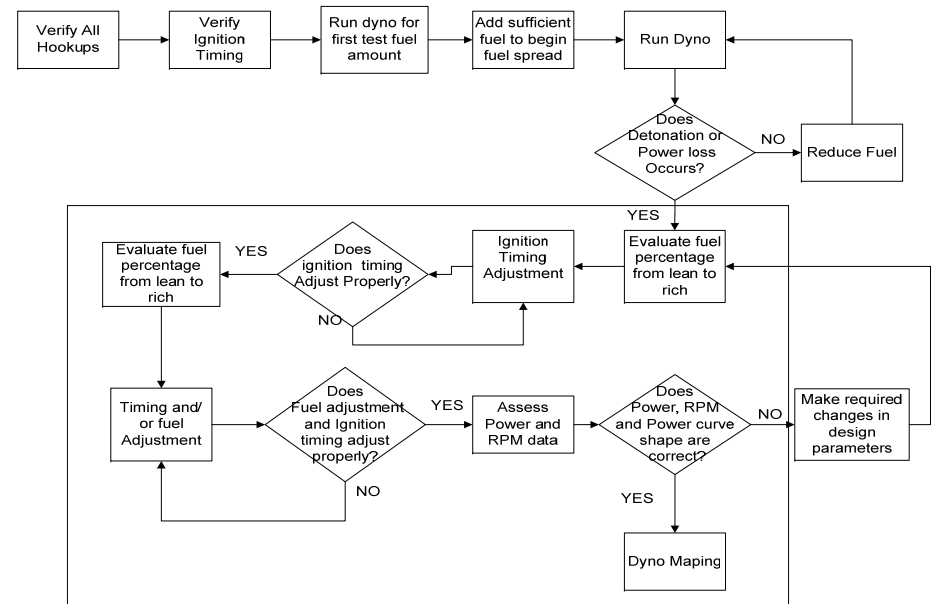
**Faculty Advisor and Consultant:** Reza Maleki

Email: [Reza.Maleki@ndsu.edu](mailto:Reza.Maleki@ndsu.edu).

**Department:** Industrial and Manufacturing Engineering

**Funding Source:** Arctic Cat

ENGINE DEVELOPMENT FLOW CHART



Resource Needed for Dyno Cells (Solution 2, Snowmobile Group Dyno Status)			
Dyno No.	Equipment Needed	Capital Cost	Operating Cost /Year
Dyno 1	Data acquisition Software	\$144,500	
	New Dyno	\$53,675	
	Dyno Base	\$8,000	
	Dyno Shaft	\$4,500	
	Fuel System Upgrade	\$2,200	
	New Operator	\$0	\$50,000
Dyno 2	Data acquisition Software	\$144,500	
	New Dyno Base	\$8,000	
	Dyno Shaft	\$4,500	
	New Dyno	\$53,675	
	Emission Tester Cells 1&2	\$60,000	
	New Operator	\$0	\$50,000
Dyno 3	Data acquisition Software	\$151,000	
Dyno 4	Emission Tester Cells 3&4	\$210,000	
Total		\$844,550	\$100,000

		Percentage of Utilization					
No. of hours/ Day		100%	90%	80%	70%	60%	50%
	8	2.13	2.37	2.67	3.05	3.56	4.27
	10	1.71	1.90	2.13	2.44	2.85	3.42
	12	1.42	1.58	1.78	2.03	2.37	2.85
	14	1.22	1.36	1.52	1.74	2.03	2.44
	16	1.07	1.19	1.33	1.52	1.78	2.13

Spring Semester 2010

Individual Study Design Research Project





**Phoenix  
International**  
A John Deere Company

# SHIPPING FACILITY LAYOUT AND IMPROVEMENTS

**Project Team Members:** Benjamin Flotterud, John Koehler, Brandon Vold.

**Faculty Advisor and Consultant:** Reza Maleki

Email: [Reza.Maleki@ndsu.edu](mailto:Reza.Maleki@ndsu.edu)

**Department:** Industrial and Manufacturing Engineering

**Funding Source:** Phoenix International

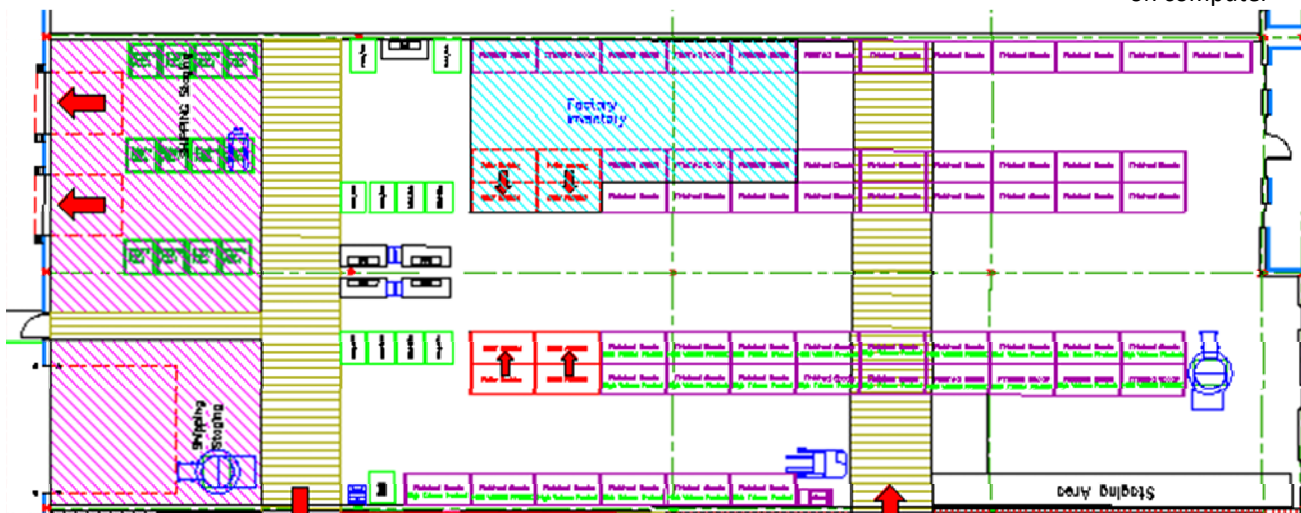
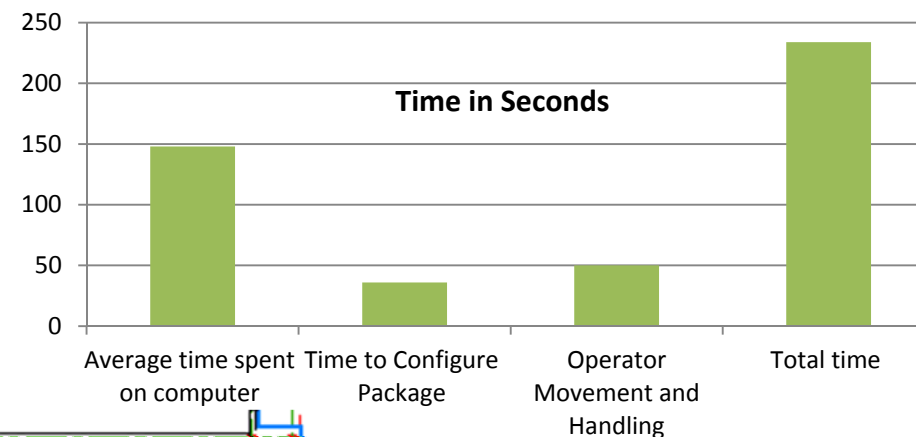
## Research Project Objective:

The objective of this project is to develop a new layout for the shipping area that can help with improved operational efficiencies for production, storage and inventory management, and shipping.

## Team Deliverables:

Documentation of the following:

- ☐ Current production, inventory management, and shipping practices.
- ☐ Current facility layout.
- ☐ Proposals for improving production, inventory management, and shipping practices
- ☐ Improved layout alternatives
- ☐ Estimated shipping labor requirements.
- ☐ Economic analysis of proposals



## Benefits:

The proposals can help with:

- ☐ Minimize labor required to ship product
- ☐ Adequate storage capacity during peak seasons
- ☐ Maintain a safe working environment
- ☐ Minimize capital expense
- ☐ Provides for First-In-First-Out inventory movements

Spring Semester 2010

Individual Study Design Research Project



# Setup Reduction For Engine Emission Testing



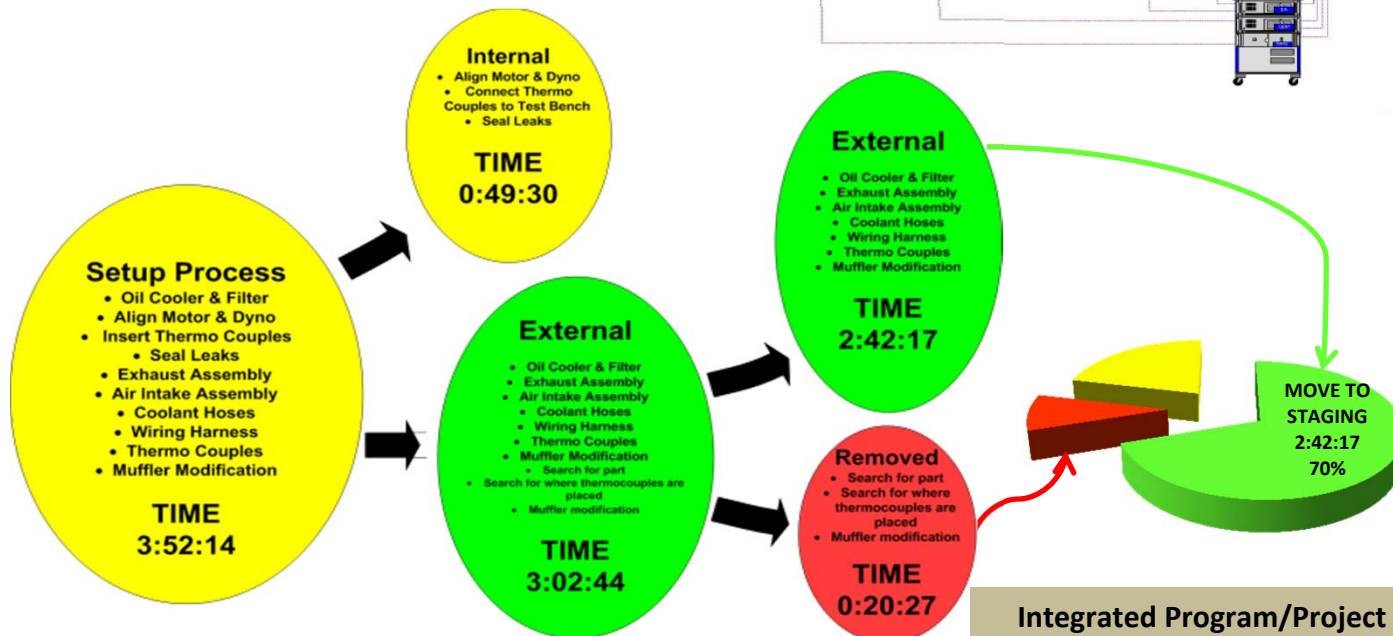
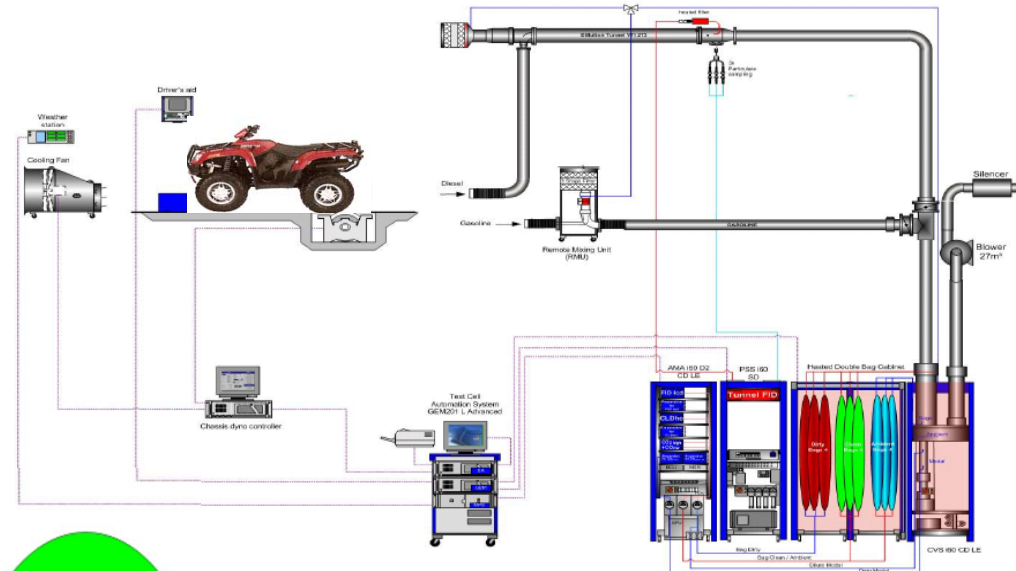
## Research Project Objectives

- 1) To study, analyze, and document proposals which can help improve the Emissions Testing Facility Utilization.
- 2) Research will be done to identify required equipment for Chassis Testing.

## Team Deliverables

Documentation of:

- 1) Current testing processes.
- 2) Proposals for improved testing processes.
- 3) Specifications and Requirements of chassis testing equipment.
- 4) Economic benefits.
- 5) An outline of recommendations for future projects and improvements.



## Project Benefits

- 1) Proposed recommendations can help Arctic Cat to better utilize the Emissions Test Facility.
- 2) Recommended Test equipment will allow Arctic Cat to continue and meet the future EPA emission regulations.

Spring Semester 2009

Integrated Program/Project Management and Capstone Experience



# Engine Emissions Testing Facility Layout



## Research Project Objective

- Analyze the current engine emission testing facility.
- Develop proposals to include chassis testing.

## Project Team Deliverables

Documentation of:

- The current emission testing facility layout and procedures.
- Equipment, capacity, and space requirements.
- Proposals to accommodate both current and chassis testing.
- Recommendations for future projects and improvements.

**Project Team Members:** Peter Nelson, Robert Berg, Neil Viola.

**Faculty Advisor and Consultant:** Reza Maleki

Email: [Reza.Maleki@ndsu.edu](mailto:Reza.Maleki@ndsu.edu).

**Department:** Industrial and Manufacturing Engineering

**Funding Source:** Arctic Cat

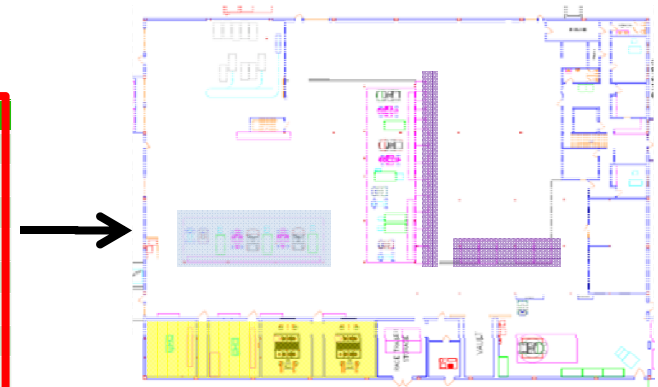
Functional Areas	Projected ft <sup>2</sup>	Alternative A	Alternative B
Engine Dynamometer Cell	494	494	1000
Storage	668	0	668
Setup	446	450	800
Support Systems	378	378	378
Engine Receiving	n/a	n/a	n/a
Field Test	n/a	n/a	n/a
Chassis Dynamometer Cell	828	828	1000
<b>Total</b>	<b>2814</b>	<b>2150</b>	<b>3492</b>

## Summary of Benefits

- Reduce the number of engine testing cells from four to two.
- Have additional setup area to accommodate external setups.
- Create two chassis dynamometer cells to meet EPA requirements.
- Allow for shared resources with other departmental groups.
- Have sufficient storage with secure access.



Recommendation Criteria	Weight	Alternative A		Alternative B	
		Rating	Weighted	Rating	Weighted
Support Chassis Test	17	4	68	5	85
Effectiveness Setup Area	12	3	36	5	60
Sufficient Storage System	13	1	13	5	65
Updated Support Systems	17	5	85	5	85
Closeness of Engine Receiving	5	5	25	3	15
Closeness of Field Test	7	5	35	3	21
Possibility of Shared Resources	12	1	12	5	60
Ease/Cost of Implementation	13	1	13	4	52
Work Environment	5	3	15	4	20
	<b>100</b>		<b>302</b>		<b>463</b>



Spring Semester 2009

Integrated Program/Project Management and Capstone Experience









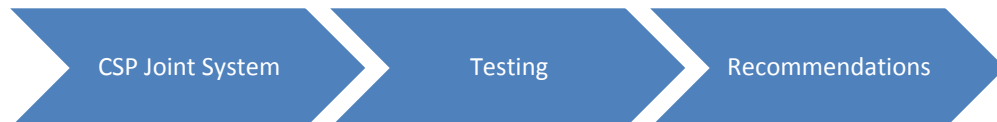
# Corrugated Steel Pipe (CSP) Joint System

**Research Project Objective:** The objective of this project is to test and document the performance of various gaskets for a watertight CSP coupling system.

## Deliverables:

- Documentation reflecting research and testing of the CSP joint system
- Documentation of recommendation for improving CSP joint system
- Recommendations for future projects and improvements

## Project Work and Research Activities



- Band Design
- Gasket

- Development of Apparatus
- Testing, Data Collection, Analysis

- Band Design
- Gasket
- Cost Analysis
- Future Projects

## Test Results and Recommendations

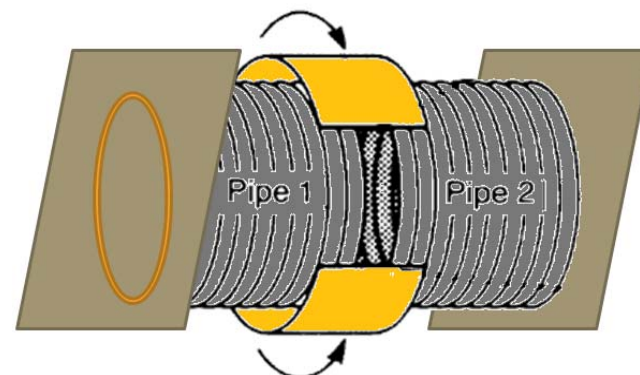
Various Bands and Gaskets were tested, but all failed to meet proposed standards. Based on tests performed and literature reviewed, a CSP Joint System Recommendation Matrix was developed.

**Project Team Members:** Matthew Bishoff, Brandon Scherber, Christopher Nilson.

**Faculty Advisor and Consultant:** Reza Maleki,  
Email: [Reza.Maleki@ndsu.edu](mailto:Reza.Maleki@ndsu.edu).

**Department:** Industrial and Manufacturing Engineering

**Funding Source:** Johnston Fargo Culvert, Inc.



**CSP Joint System Recommendation Matrix**

			Band Design									
			Profile					Clamp			Structure	
S	Superior											
?	Questionable											
P	Poor											
I	Incompatible											
Gaskets	Profile	O-ring	Annular	Semi Annular	Flat	Hat	Universal	Band Angle	Lug Angle	Bar and Strap	1 Piece	2 Piece
		Sleeve	Annular	Semi Annular	Flat	Hat	Universal	Band Angle	Lug Angle	Bar and Strap	1 Piece	2 Piece
		Strip	Annular	Semi Annular	Flat	Hat	Universal	Band Angle	Lug Angle	Bar and Strap	1 Piece	2 Piece
		Wrap	Annular	Semi Annular	Flat	Hat	Universal	Band Angle	Lug Angle	Bar and Strap	1 Piece	2 Piece
	Installation	In Corrugation	Annular	Semi Annular	Flat	Hat	Universal	Band Angle	Lug Angle	Bar and Strap	1 Piece	2 Piece
		Around Pipe	Annular	Semi Annular	Flat	Hat	Universal	Band Angle	Lug Angle	Bar and Strap	1 Piece	2 Piece
		Applied	Annular	Semi Annular	Flat	Hat	Universal	Band Angle	Lug Angle	Bar and Strap	1 Piece	2 Piece
	Material	Rubber	Annular	Semi Annular	Flat	Hat	Universal	Band Angle	Lug Angle	Bar and Strap	1 Piece	2 Piece
		Foam	Annular	Semi Annular	Flat	Hat	Universal	Band Angle	Lug Angle	Bar and Strap	1 Piece	2 Piece
		Mastic	Annular	Semi Annular	Flat	Hat	Universal	Band Angle	Lug Angle	Bar and Strap	1 Piece	2 Piece

Spring Semester 2009

Integrated Program/Project Management and Capstone Experience



# Laminated Residential Garage Panel Assembly Line Analysis

## Research Project Objective

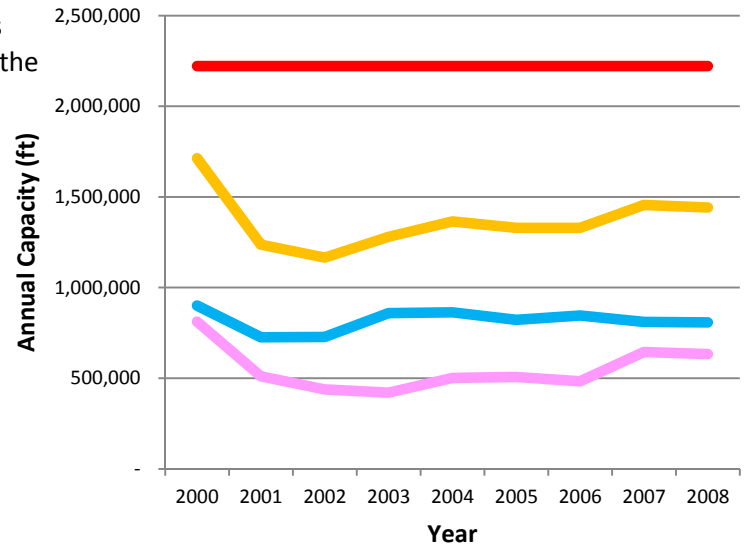
Determine if the current residential laminated door panel assembly line has the capacity and capability to produce the commercial laminated door panels

## Project Deliverables

Documentation of:

- Residential line capability and capacity
- Residential and Commercial Door demand
- Proposal for modifications to Residential Line
- Economic analysis
- Future project recommendations

2000-2008 Production Chart



**Project Team Members:** Kevin Ronsberg, Kim Lammers, Erika Hedger, Adam Hilzendager

**Faculty Advisor and Consultant:** Reza Maleki  
Email: [Reza.Maleki@ndsu.edu](mailto:Reza.Maleki@ndsu.edu)

**Department:** Industrial and Manufacturing Engineering

**Funding Source:** Midland Garage Door Manufacturing

Modification	Cost
<b>End Style Machine</b>	
1 Change	\$ 40,000
2 Changes	\$ 50,000
3 Changes	\$ 60,000
Change Overs	\$ 20,000
Screw Station	\$ 50,000

Commercial Panel Dimensions			Cost	Commercial Feet/Year	Labor Time Savings/Year (hrs)	Labor Savings/Year (\$)	Payback Period (yrs)
Length (ft)	Thick. (in)	Percentage					
≤18	≤2	46%	\$ 90,000	291,434	778	24,894	3.6
≤18	≤3	75%	\$ 100,000	475,164	1,268	40,588	2.5
≤40	≤2	53%	\$ 120,000	335,783	896	28,682	4.2
≤40	≤3	100%	\$ 130,000	633,552	1,691	54,117	2.4

## Potential Benefits

The proposed modifications will allow Midland to produce commercial door panels on the current residential assembly line. The modifications can help with cost savings as well meeting some growth in demand.

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# Facility Layout Analysis and Improvements

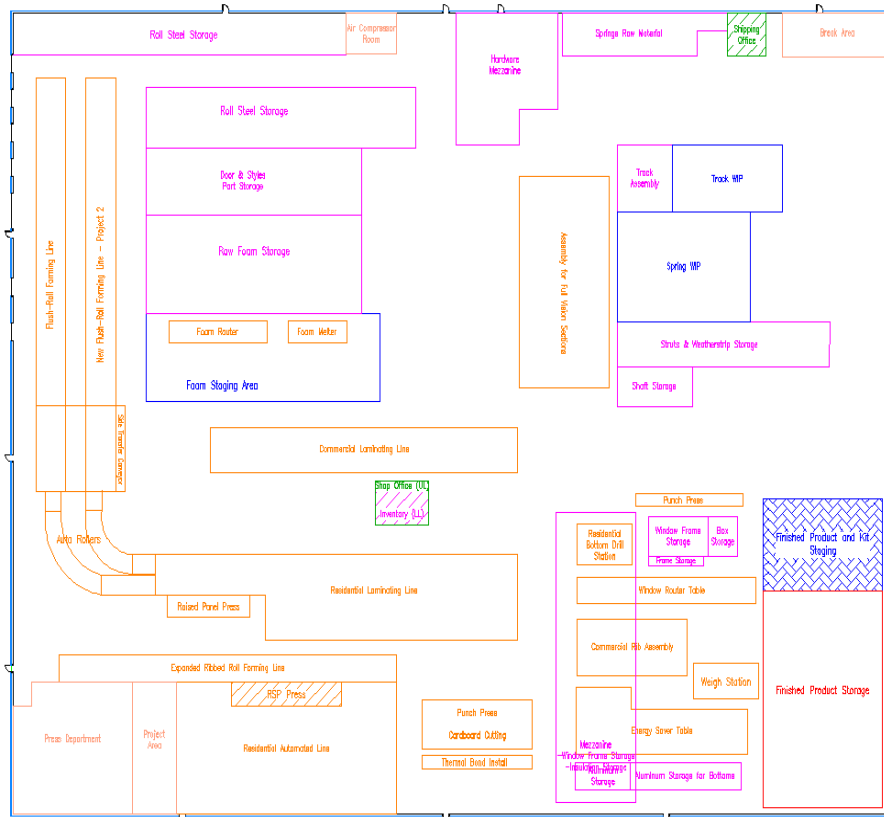
## RESEARCH PROJECT OBJECTIVE

To develop proposals for improving layout which will provide more efficient flow of product, reduced WIP, and improved manufacturing lead time.

## PROJECT DELIVERABLES include documentation of:

- Current layout and production methods
- Improved layout
- Economic analysis

### Proposed Layout



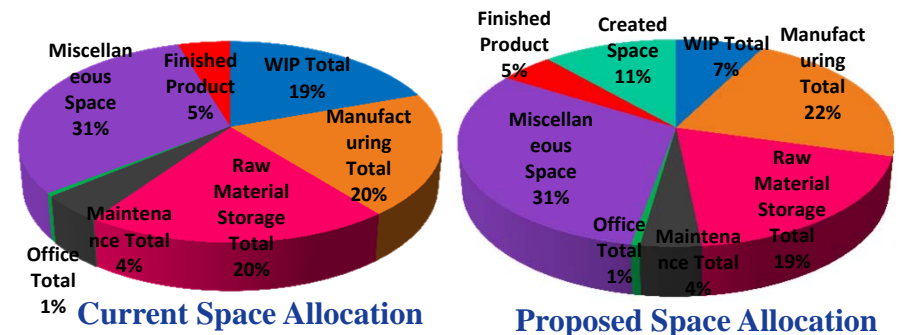
**Project Team Members:** Kurt Semanko, Jacob Chan, Ray Berry, Sean Osowski

**Faculty Advisor and Consultant:** Reza Maleki

Email: [Reza.Maleki@ndsu.edu](mailto:Reza.Maleki@ndsu.edu)

**Department:** Industrial and Manufacturing Engineering

**Funding Source:** Midland Garage Door Manufacturing Company



## Potential Benefits



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# NEAL'S INDUSTRIAL PAINTING

## Facility Layout and Process Improvements

### Research Project Objective

The purpose of this project is to study, document, analyze, and propose improvements for the facility layout and process systems.

### Deliverables

- Documentation of:
  - Current facility layout and coating systems processes
  - Proposal for improvements
  - Analysis of the required space to meet the current and anticipated growth in demand
  - Economic impact of the proposed recommendations
  - Proposals for future projects

**Project Team Members:** Jenna Ludwig, Paul Gieseke, Luke Johnson, Anthony Ross, Chris Opland.

**Faculty Advisor and Consultant:** Reza Maleki  
Email: [Reza.Maleki@ndsu.edu](mailto:Reza.Maleki@ndsu.edu)

**Department:** Industrial and Manufacturing Engineering

**Funding Source:** Neal's Industrial Painting

Alternative Layouts	Monorail	Small Utility Oven	Large Utility Oven	Wet Booth Monorail Compatible	Small Powder Booth	Improved Vacuum	Equipment Movement	Expansion	Continuous Oven	Removal of wall	Vinyl Covering	Total Cost
	500K	54K	225K	22K	22K	5K	18K	360K	285K	5K	4K	
1		x			x	x	x			x	x	108,000
2	x			x	x	x	x		x	x	x	861,000
3	x		x	x	x	x	x	x	x	x	x	1,446,000

	Capacity Increase					Pay Back Period (years)		
	Current Labor	Additional Labor	Labor Reduction	Profit Margin	Capital Expenditure	10%	20%	30%
Alternate 1	56%	97%	0%	32%	108K	2.75	1.90	1.60
Alternate 2	96%	245%	20%	37%	861K	7.20	5.10	4.20
Alternate 3	96%	245%	20%	37%	1,446K	9.30	6.60	5.40

### Potential Benefits

Proposed Facility Layouts and Process Improvements

Reduced Man-hours  
Increased Capacity

Process Orders Faster  
Meet Anticipated Growth in Demand  
Improved Profit Margin

Spring Semester 2009

Integrated Program/Project Management and Capstone Experience





# DUST COLLECTION SYSTEM DESIGN

**Project Team Members:** Dayne Efta, James Dravitz, Thomas Steckler, George Auen.

**Faculty Advisor and Consultant:** Reza Maleki

Email: [Reza.Maleki@ndsu.edu](mailto:Reza.Maleki@ndsu.edu)

**Department:** Industrial and Manufacturing Engineering

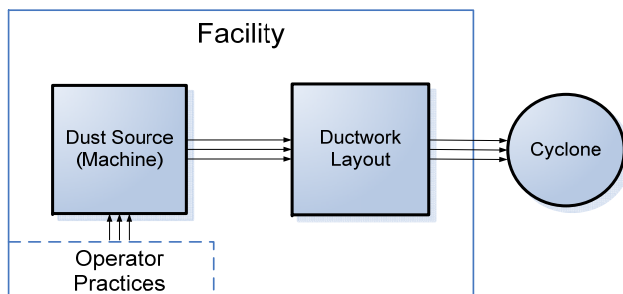
**Funding Source:** Northern Contours

## Research Project Objective

The purpose of this project is to document, analyze, and propose improvements to the current dust collection system.

## Project Team Deliverables

- Documentation of current processes and evaluation of dust collection system
- Proposals that can help with effective collection and containment of dust
- Economic analysis
- Recommendations for future projects and improvements



Areas of Impact	Problems	Recommendations													
		Move return air	Bridge gaps with door brush seal	Remove cooling fans	Limit use of compressed air at workstations	Responsible operator cleanup	Utilize workstation suction tools	Utilize lumber carts	Multiple suction locations at source	Reduce material removal rate	Use denser brushes to block dust spray	Reduce amount of compressed air at source	Implement downdraft prototype	Seal all gaps in ductwork	Install blast gates and pipe plugs
Facility	Return air	1													4
	Cooling fans		2												
	Gaps between different rooms in facility	5													
Operator Practices	Compressed air														
	a. Clean off finished part/sacrificial board				-	5	5								
	b. Clean operators themselves				-	5	5								
	Leaving doors open														
	Stacking finished products						5								
Dust Source (Machine)	Cutting scrap material					5	5								
	Poor tool housing design														
	a. Compressed air shoots at rotating tool							5			5				
	b. Insufficient suction							5	3		3	5		5	4
	Material removal rate								5	3					
Ductwork Layout	Brushes do not block spray of dust							4		5	5	5			
	Gaps in ductwork - unsealed holes												5		
	Pipes constantly consuming air velocity												5	5	
	No way to balance air in system												5	5	
	Not Feasible														5
Cyclone	Feasible - No Cost/Low Cost													5	5
	Feasible - Requires Investment													5	4

1 to 5	Solution Impact Rating: 1 - Least	5 - Significant
-	Negative Impact	
	Indirectly Hinders Dust Containment	

## Potential Benefits

The recommendations shown in the above chart (labeled “feasible”) can help reduce the spread of dust and reduce the number of defects caused by dust. Some recommendations can help reduce operational expenses as well

Spring Semester 2009

Integrated Program/Project Management and Capstone Experience



# Facility Layout Analysis and Improvements



## Research Project Objective

Study, analyze, and Document proposals which can help with improving layout to reduce manufacturing lead time within the Fastlane building

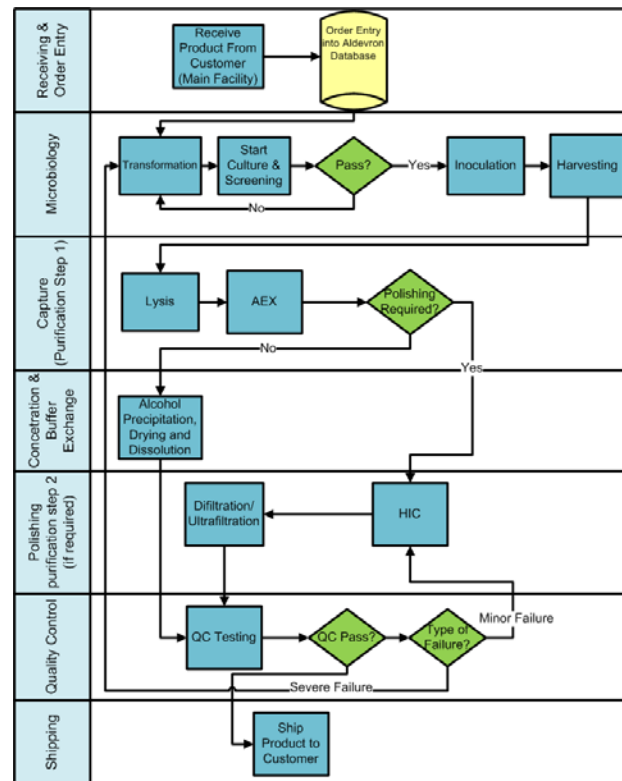
## Project Deliverables

- Documentation of:
  - Current production processes including layout, product, and process flow
  - Improved facility layout
  - Economic benefits from implementing proposed suggestions
- Recommendations for future projects and improvements

Macro Process Flow

## Recommendations

- Revise Layout
  - Process relocation
  - Improved wash station
  - Additional equipment
- New scheduling practices

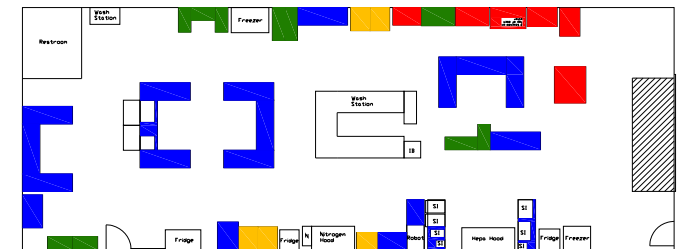


**Project Team Members:** Brad Buck, Tony Noga, Ashley Kringle, Jordan Debilzen.

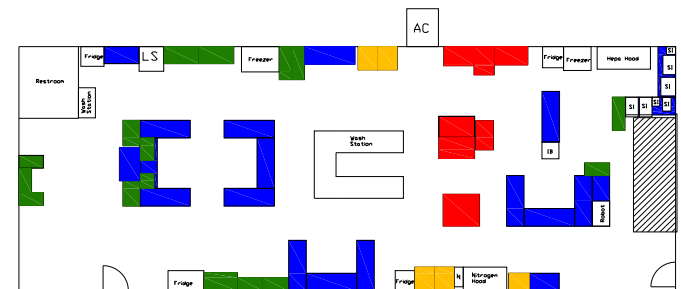
**Faculty Advisor and Consultant:** Reza Maleki  
Email: [Reza.Maleki@ndsu.edu](mailto:Reza.Maleki@ndsu.edu).

**Department:** Industrial and Manufacturing Engineering

**Funding Source:** Aldevron



Current Fastlane Layout



Proposed Fastlane Layout

Spring Semester 2008





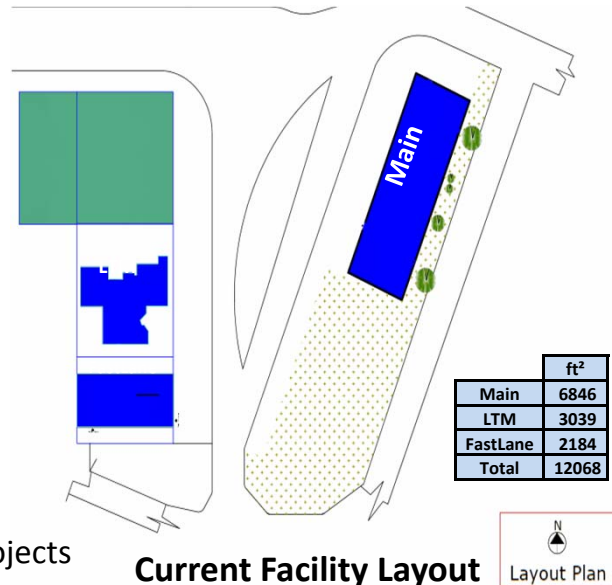
# New Facility Layout Design

## RESEARCH PROJECT OBJECTIVE:

To develop a proposal for a new facility layout capable of accommodating future growth in production and expansion of research and development activities.

## PROJECT TEAM DELIVERABLES:

- Documentation of the current layout and processes
- Documentation for a new facility layout
- Estimation of building costs
- Recommendations for future projects



Current Facility Layout

## Space Analysis

	Facility Categories	Current Square Feet	Adjusted Square Feet	100% Increase In Production
1	Support	1728	1782	2256
2	Lab Support	1455	1813	2645
3	GMP Lab	1293	1293	2000
4	Research Grade Lab	3375	3709	4810
5	Receiving	0	150	150
6	Shipping	121	200	300
7	Storage	225	375	470
8	Maintenance	636	766	800
9	QC	426	475	500
10	Office	1523	2250	2500
	Total: *Hallways Not Included	10782	12813	19511

## PROJECT BENEFITS:

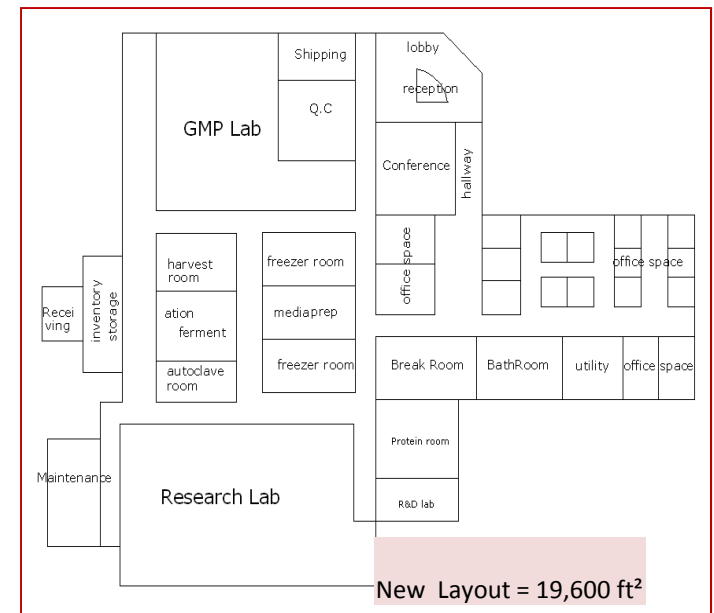
- New facility layout that accommodates future growth
- Improved product flow
- Reduced risk of contamination
- Improved communication

**Project Team Members:** Jeff Comegys, Doug Peterson, Chris Rivard, Dheeraja Kaja

**Faculty Advisor and Consultant:** Reza Maleki  
Email: [Reza.Maleki@ndsu.edu](mailto:Reza.Maleki@ndsu.edu)

**Department:** Industrial and Manufacturing Engineering

**Funding Source:** Aldevron



Proposed Facility Layout

Spring Semester 2008

Integrated Program/Project Management and Capstone Experience





# Facility Layout Improvements

Solutions Problems

## Research Project Objective:

The purpose of this project is to develop a proposal for an improved facility layout, which will reduce manufacturing lead time, lower work in process inventories and lower material handling.

## Project Team Deliverables:

Documentation of...

- Current layout, including flow of products and work in process inventories
- Improved layout, including flow of products and work in process inventories
- Cost savings that may result from implementing proposed suggestions
- Recommendations for future projects and improvements

## Recommendations:

Relocate machines which will improve the problem areas that BTD clients defined

**Project Team Members:** Jesse Johnson, Woo Kim, Yasaman Kazemi, Robert Wessel

**Faculty Advisor and Consultant:** Reza Maleki  
Email: [Reza.Maleki@ndsu.edu](mailto:Reza.Maleki@ndsu.edu)

**Department:** Industrial and Manufacturing Engineering

**Funding Source:** BTD Manufacturing, Inc.

	WIP	External Handling	Internal Handling	Lead Time
Move Press Brake to Plant 1	x	x		x
Press Brake, Spot Weld, Hand Weld Cell	x	x	x	x
Move Two Hand Welders to Plant 1	x	x		x
Laser, Press Brake and Hand Weld Cell	x		x	x

## Benefits:

- Reducing manufacturing lead time resulting in higher productivity
- Elimination of WIP will result in lower inventory carrying cost
- Decreasing travel distance will reduce material handling costs

Spring Semester 2008

Integrated Program/Project Management and Capstone Experience



# Warehouse Operations Analysis

## Research Project Objective

Study, analyze and improve the utilization of the warehouse space and operations.

## Project Team Deliverables

- **Analysis of current warehouse** layout and processes
- Documentation of **proposed recommendations**
- Documentation of **economic benefits** resulting from implementation of proposed recommendations
- Recommendations for **future projects and improvement**

## Recommendations

### 5S

- Reduce amount of cross-traffic
- Save 1,600+ square feet
- Organize east and south walls

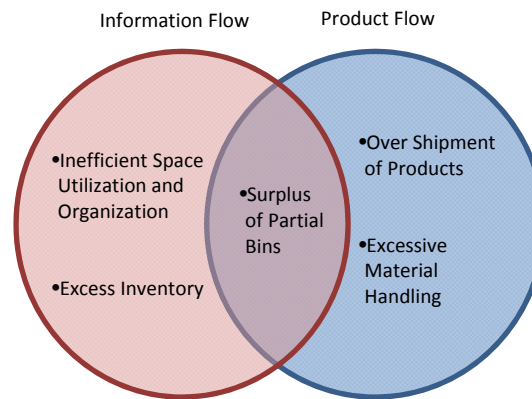
### Kanban

- Set order date requirement for customer
- Pull reports based on firm order date
- Send orders to production of what is not in warehouse

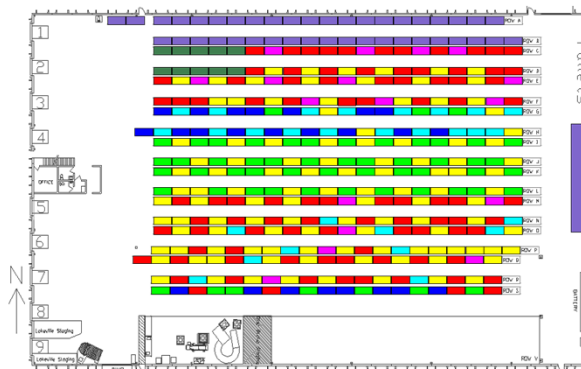
### Shelf Standardization

- Group customers' parts in common areas
- High-volume parts closest to shipping docks
- Specific spot for partial bins

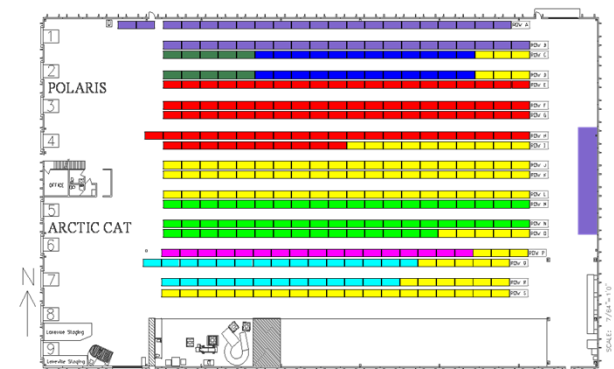
## Problem Identification



## Current Product Placement



## Proposed Product Placement



**Project Team Members:** Andrew Larson, Scott Engberg, Andrea Hopf, Matt Olson.

**Faculty Advisor and Consultant:** Reza Maleki  
Email: [Reza.Maleki@ndsu.edu](mailto:Reza.Maleki@ndsu.edu).

**Department:** Industrial and Manufacturing Engineering

**Funding Source:** BTD Manufacturing, Inc.

**Spring Semester 2008**

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# CONTAINER LOGISTICS

**Project Team Members:** Jon Reimche, Brett Winkelman, Gretchen Meiser.

**Faculty Advisor and Consultant:** Reza Maleki  
Email: [Reza.Maleki@ndsu.edu](mailto:Reza.Maleki@ndsu.edu).

**Department:** Industrial and Manufacturing Engineering

**Funding Source:** Case New Holland

## Research Project Objective:

The purpose of this project is to analyze and document the current logistics of the returnable racks used at the CNH Fargo plant. Through this analysis recommendations will be made to improve tracking methods for the racks.

## Team Deliverables:

Documentation of the following:

- Current information flow
- Physical rack flow
- Current physical rack count
- Possible improvements for tracking system
- Economic analysis of recommendations
- Recommendations for Future projects



## Benefits:

- Streamlined system with better communication
- Reduction in lost racks
- CNH reimbursed for lost racks
- Substantial cost avoidance

## Problems

## Recommendations

	Losing Racks	Poor Communication	Lack of Liability	Inadequate Number of Racks Available	Difficulty Locating Racks	Difficulty Identifying Racks	Inaccurate count of Rack Inventory	Lack of Rack Financial Management	Shipping Incorrect Rack
Improve CSCN	X	X		X	X		X	X	X
Liability Contract	X		X						
Tracking Technology	X	X	X		X	X	X	X	X

**All recommendations contribute to better management and tracking of the returnable racks**

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## Improving Inventory Management and Warehousing Operations

### RESEARCH PROJECT OBJECTIVE:

The purpose of this project is to study, analyze and improve warehouse locations and reduce inventory management difficulties

### PROJECT TEAM DELIVERABLES

Based on extensive observation and research, the following documents were provided to the client:

- Current warehouse practices, information, & process flow
- Proposed improvements
- Proposed cost savings
- An outline of recommendations for future projects

### RECOMMENDATIONS

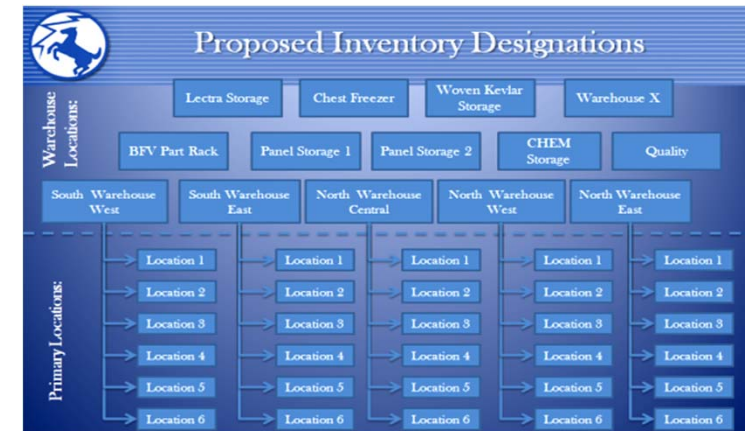
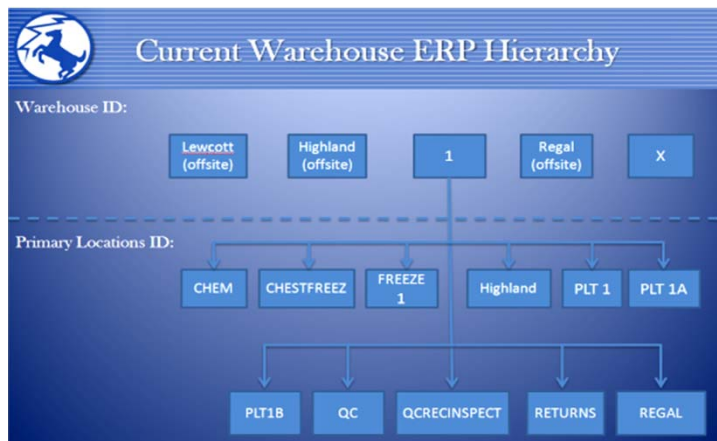
- New warehouse ID inventory locations
- Corresponding warehouse names within ERP
- Cellularize workstation to decrease travel
- Enhance barcode system

**Project Team Members:** Dave Holloway, Nate Granquist, Mike Hedlund, Dave Stenseth.

**Faculty Advisor and Consultant:** Reza Maleki  
Email: [Reza.Maleki@ndsu.edu](mailto:Reza.Maleki@ndsu.edu).

**Department:** Industrial and Manufacturing Engineering

**Funding Source:** Sioux Manufacturing Corporation



### PROJECT BENEFITS

- Making the physical production facility match the ERP system will result in ease of tracking inventory
- Reduction in search area will considerably reduce time spent searching for inventory
- Relocating the Epoxy/Sanding workstation will result in reduced travel distances

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**Integrated Program/Project Management and Capstone Experience**



# SK Food Specialty Processing

## Improving Packaging and Warehousing Operations

**Project Team Members:** Nate Bruns, Joshua Brantner, Tom Cinnamon, Jennifer Vad.

**Faculty Advisor and Consultant:** Reza Maleki  
Email: [Reza.Maleki@ndsu.edu](mailto:Reza.Maleki@ndsu.edu)

**Department:** Industrial and Manufacturing Engineering

**Funding Source:** SK Food Specialty Processing

### Research Project Objective

The purpose of this project is to develop a proposal for the improvement of packaging and warehousing operations; included in this will be the layout, inventory tracking, material handling practices, and ergonomics

### Deliverables

- Documentation of the current processes
- Documentation of the proposal for improvements
- Documentation of the economic analysis
- An outline of recommendations for future projects and improvements

### Problems Identification

- Inefficient Packaging
- Difficulties tracking inventory
- Poor utilization of warehouse

### Recommendations

- Purchase and install a Super Sack frame and filler and scissor lift table
- Implement a bar coding system to improve the inventory tracking
- Purchase and install a new racking system, allowing more efficient access to all products
- A new layout is recommended to utilize the new racking system



**New racking system allowing more efficient access to all products**

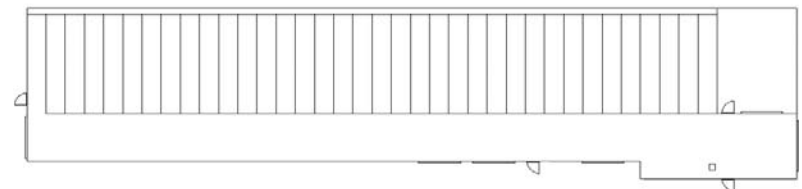


**Super Sack Frame and Scissor lift to assist with packaging**

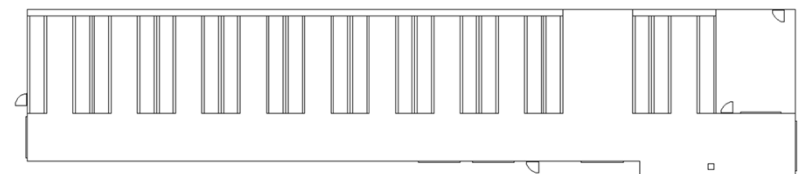


**Very Narrow-Aisle Turret Truck**

**Current Layout**



**Recommended Layout**



**Added access aisles to accommodate new racks**

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# IMPROVING WAREHOUSING AND MANUFACTURING OPERATIONS



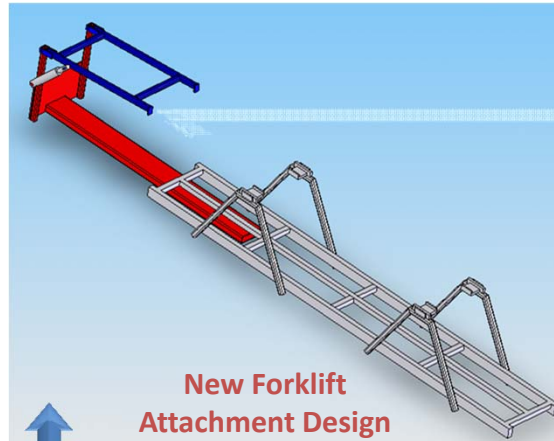
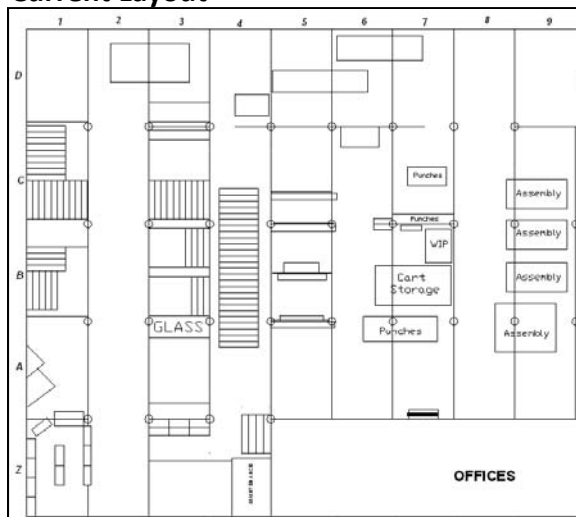
## Research Project Objective

The purpose of this project is to study, analyze and improve the raw material warehousing practices, inventory management, and the pre-assembly operations in order to decrease work in process and material handling."

## Team Deliverables

- Documentation of current processes
- Improve warehousing and pre-assembly operations
- Economic analysis of proposed solutions
- Recommendations for future projects

## Current Layout



**New Forklift Attachment Design**

## Recommendations / Benefits

- **New Warehouse Layout**
  - Decrease Handling
  - Visible Workplace
- **Material Movement Cart**
  - Decrease Handling
- **Forklift Attachment**
  - Decrease Handling
- **New Manufacturing Layout**
  - Reduce WIP
  - Reduce MLT

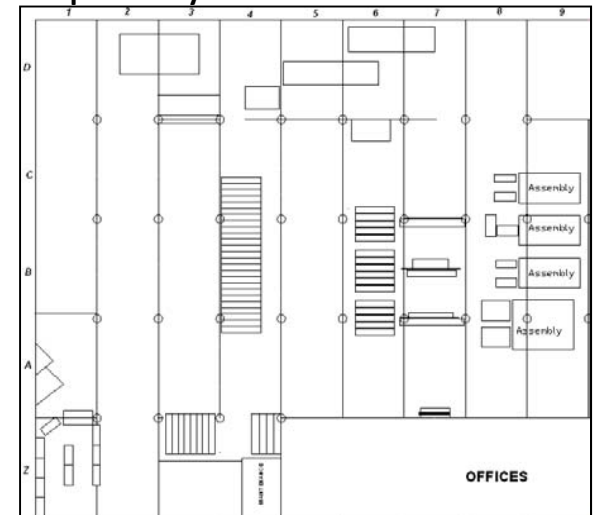
**Project Team Members:** Lance Straabe, Nathan Noble, Jared Baldwin, Joey Marvig.

**Faculty Advisor and Consultant:** Reza Maleki  
Email: [Reza.Maleki@ndsu.edu](mailto:Reza.Maleki@ndsu.edu)

**Department:** Industrial and Manufacturing Engineering

**Funding Source:** Vinylite Windows

## Proposed Layout



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# bobcat® Anti-Corrosive System Design

## Research Project Objectives

Research and document the design of an anti-corrosive system for hydraulic cylinder components that offers safety and economic advantages over the current painting methods while meeting the production requirements

## Project Team Deliverables

- Documentation of the current systems that relate to the project
- Documentation of researched alternatives of anti-corrosive methods, and application systems
- Documentation of recommendations for a new, more robust anti-corrosive system
- Documentation of cost and time savings that may result from implementing proposed suggestions.
- An outline of recommendations for future projects and improvements

## Problems Identified

- Fully assembled cylinders are powder coated
- Internal seals exposed to high heat
- Expensive seal warranties due to excessive heat
- Bore hole manually cleaned

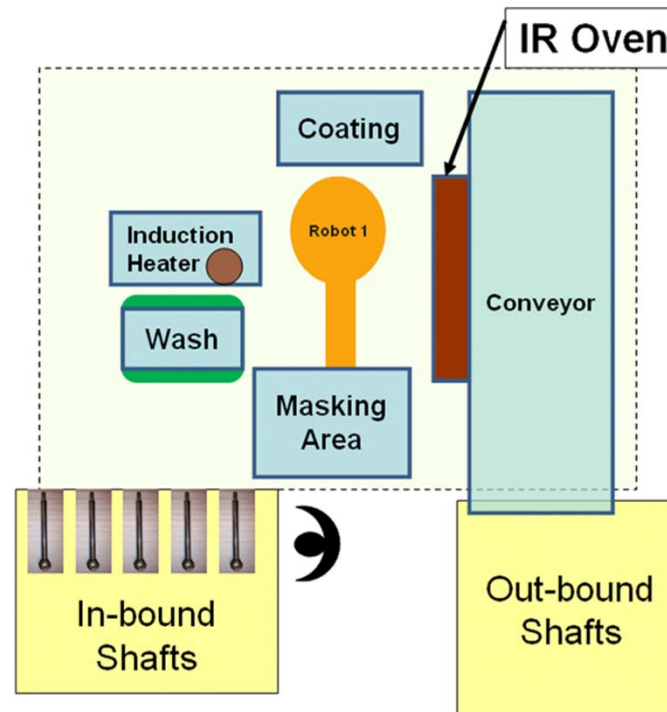


**Project Team Members:** Sean Bittle, Chase Kelner, Cynthia DeAustin, Anthony Schwan.

**Faculty Advisor and Consultant:** Reza Maleki  
Email: [Reza.Maleki@ndsu.edu](mailto:Reza.Maleki@ndsu.edu)

**Department:** Industrial and Manufacturing Engineering

**Funding Source:** Bobcat



## Proposed System Design

## Proposed Process

- Shafts coated in parallel with cylinder tubes
- Hydraulic cylinder assembled after coating processes
- Seals no longer exposed to heat

## Potential Benefits

- Purchase less expensive seals
- Reduce warranty costs
- Decrease masking costs
- Pay back period of 1.61 years

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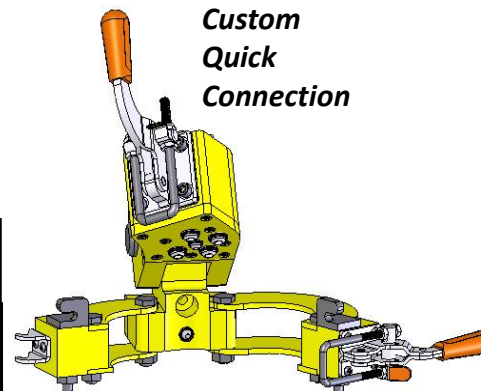
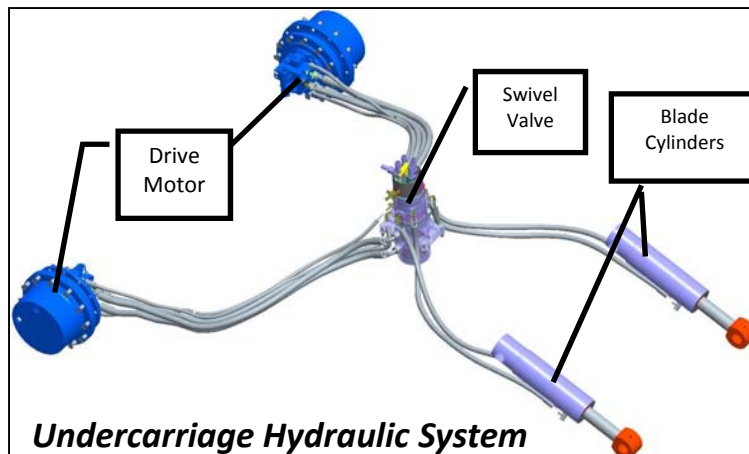
# Hydraulic Test Bench Design

## Research Project Objectives

Design a test bench to verify the quality and functionality of a fully assembled undercarriage hydraulic system for a 430 / 435 excavator. The system needs to identify any leaks, verify component functionality and specifications in less than 5 minutes.

## Project Deliverables

- Documentation of Current Assembly and Testing Procedure
- Research Alternative Methods
- Recommendations for Improved Assembly
- Recommendations for Test Bench
- Recommendations for Future Improvements



**Project Team Members:** Mark Henning, Joseph Haman, Jack Lubka, Kristopher Braaten.

**Faculty Advisor and Consultant:** Reza Maleki  
Email: [Reza.Maleki@ndsu.edu](mailto:Reza.Maleki@ndsu.edu)

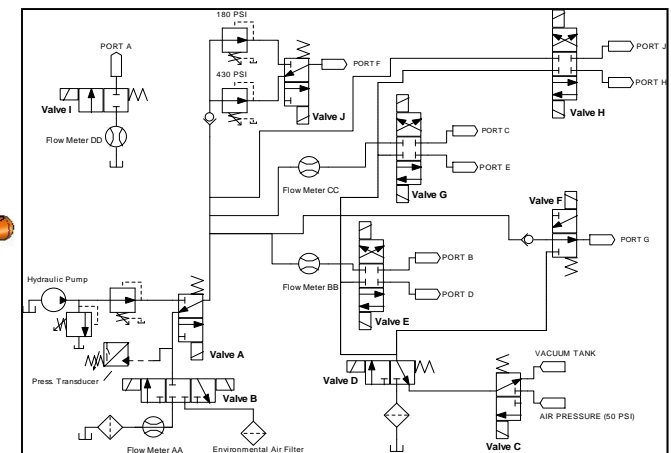
**Department:** Industrial and Manufacturing Engineering

**Funding Source:** Bobcat

## Potential Benefits

- Proposed assembly procedure will help improve quality of hydraulic system and decrease costs.
- The proposed testing procedure will help confirm that the machine is indeed a quality product.

## Proposed Hydraulic Circuit



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# Manufacturing Lead Time Improvements

**Project Team Members:** Melissa Brown, Ivan Anheluk, Damon Anderson, Jean Ostrom-Blonigen, Laura Sagness.

**Faculty Advisor and Consultant:** Reza Maleki  
Email: [Reza.Maleki@ndsu.edu](mailto:Reza.Maleki@ndsu.edu).

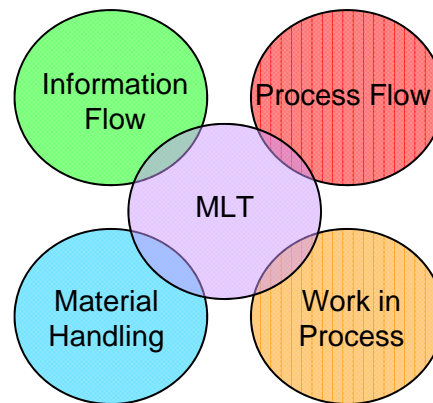
**Department:** Industrial and Manufacturing Engineering

**Funding Source:** Rapat Industries

## Causes of Excessive MLT

### Research Project Objective

The Purpose of this Project is to Document the Current Production Processes and Information Flow and to Develop Proposals to Help Improve the Productivity of the Resources.



### Team Deliverables

- ☐ Documentation of current system, production processes and Information Flow
- ☐ Documentation of recommendations for improved production processes and Information Flow
- ☐ Documentation of associated Cost and time Savings
- ☐ Documentation of Future Recommendations

### Recommendations

- ☐ Schedule/Hire a Material Handler
- ☐ Implement Staging Areas
- ☐ Routings Sheets
- ☐ Implement Scheduling Methods
- ☐ Utilize ERP System
- ☐ Companywide Training

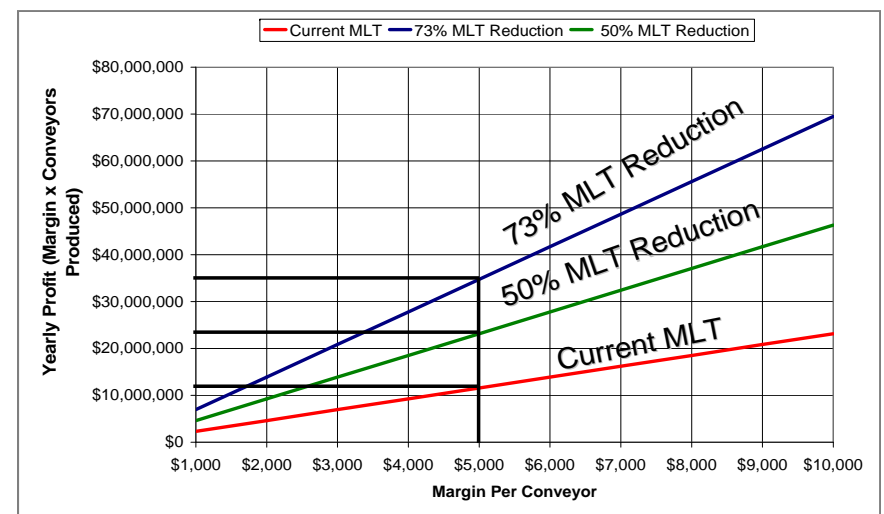
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## Throughput Improvement

		Critical Areas Addressed			
		Information Flow	Process Flow	Material Handling	WIP
Areas Impacting MLT	Information Flow	Improvement	Improvement		
	Process Flow	Improvement	Improvement	Improvement	Reduction
	Material Handling	Reduction	Reduction	Reduction	Reduction
	WIP	Reduction	Reduction		Reduction
	Safety		Improvement	Improvement	Improvement
	Labor	Reduction	Reduction		Reduction
	Space Utilization		Improvement		Improvement
	Excessive Operator Movement	Reduction	Reduction	Reduction	Reduction
	Shop Floor Organization	Improvement	Improvement	Improvement	Improvement
	Material Availability	Improvement		Improvement	
	Process Operation Control	Improvement	Improvement		Improvement
	Project Management	Improvement	Improvement		Improvement
	Process Time	Improvement	Improvement	Improvement	
Individual Impact On MLT		- 4 Days	- 7 Days	- 4 Days	- 24 Days
Total Impact On MLT (Current MLT: 53.23 Days)		- 39 Days			

Current MLT = 53.23 days Potential MLT = 14.23 days  
Potential Decrease in MLT = 73 %





# RAPAT

## CORPORATION

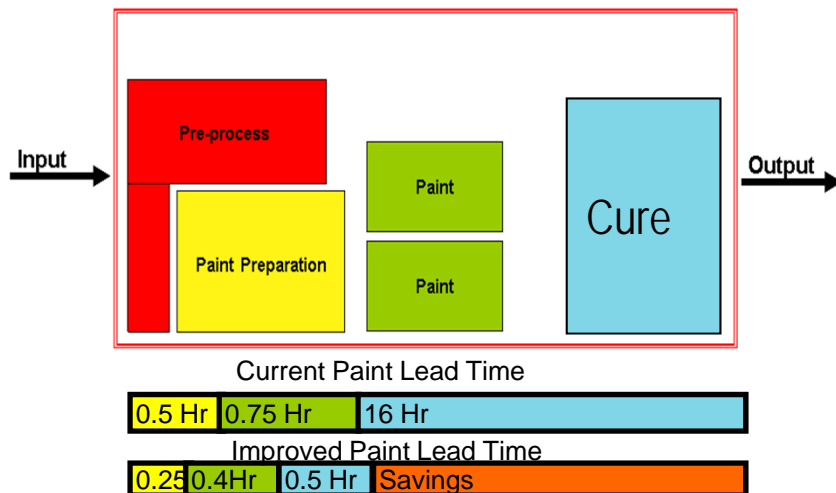
### Paint System Design

#### Research Project Objectives

Develop a document that reflects research and identification of a paint system that can adequately address the current and future needs of the Rapat Corporation.

#### Team Deliverables

- Document Current Paint System
- Research Paint System Options
- Recommend Improved Paint Systems
- Document Cost and Time Savings
- Recommend Future Projects



**Project Team Members:** Emily Walstead, Cameron Wahl , Ryan Steinert, Jason Melcher .

**Faculty Advisor and Consultant:** Reza Maleki

Email: [Reza.Maleki@ndsu.edu](mailto:Reza.Maleki@ndsu.edu).

**Department:** Industrial and Manufacturing Engineering

**Funding Source:** Rapat Industries

#### RECOMMENDATIONS / BENEFITS

##### Three Proposals Pertaining To Capital Investment

- Cure Oven – Reduces Curing Time
- Powder Coat Booth – Improve Ventilation & Quality
- Chemical Wash System- Speeds Up Preperation Time

##### Purchase Hose Spools

- Decrease painter travel Distance
- Increase time available to paint

##### Parking Lot Spots for Fabricated Material

- Decrease Material Handler Time
- This includes looking for and moving parts

##### Utilize Both Booths In Between Paint Coats

- Increase Painter Utilization By 20%

##### Utilize 2nd Employee to Paint when Available

- Increase Throughput

Economic Analysis				
Costs		Savings		
Annual Utilities	Equipment Cost	Coating	Quality	Time
\$12,000	\$179,931	\$70,241	\$8,303	\$14,000
Total	\$191,931	Total	\$92,544	
Simple Payback Period				
2.23 Years				

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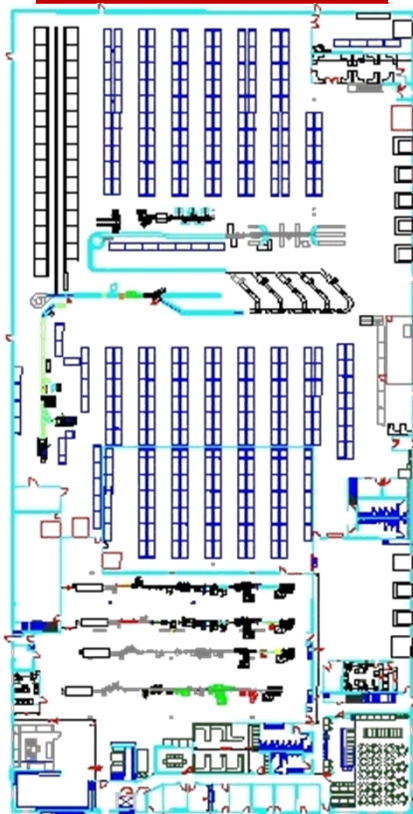


# Facility Expansion Plan

## Research Project Objective

- o Study, analyze, and document the requirements of manufacturing, order fulfillment, material handling, and storage/warehousing for the purpose of developing alternative layouts that can be used for the facility's planned expansion.
- o Integral to this project is the development of a plan that facilitates the move into the expanded facility.

### Current Facility Layout



## Project Deliverables

- o Documentation of processes & material flow
- o Develop a layout that utilizes the facility expansion and accommodates alternative equipment and systems
- o Benefit analysis of proposed solutions
- o Move plan which minimizes downtime
- o Recommendations for future projects & improvements

## Benefits of Proposed Layout

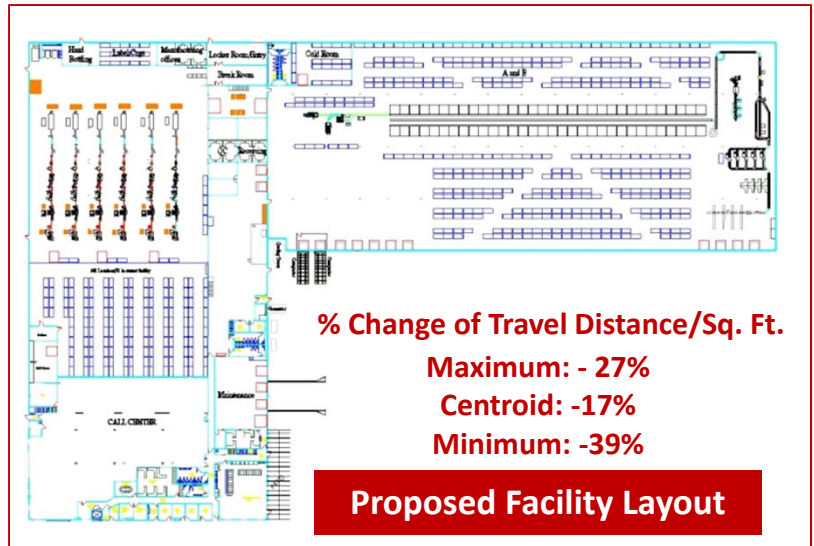
- o Material flow reduces material handling and is critical to an efficient layout
- o Flexibility is necessary to accommodate future growth
- o A meticulous move plan is necessary to accomplishing a move of this magnitude

**Project Team Members:** Bryan Gefroh,, Brooke Pulkrabek, Jason Materi, Megan Aaseth, Carah Barrett, Amanda Girodat.

**Faculty Advisor and Consultant:** Reza Maleki  
Email: [Reza.Maleki@ndsu.edu](mailto:Reza.Maleki@ndsu.edu).

**Department:** Industrial and Manufacturing Engineering

**Funding Source:** Swanson Health Products



## Move Plan Summary

- o Cost of move plan will be \$97,685.50
- o Does not include the cost of any temporary systems or rental equipment
- o 7-day move plan for order fulfillment
- o 3-day move plan for manufacturing

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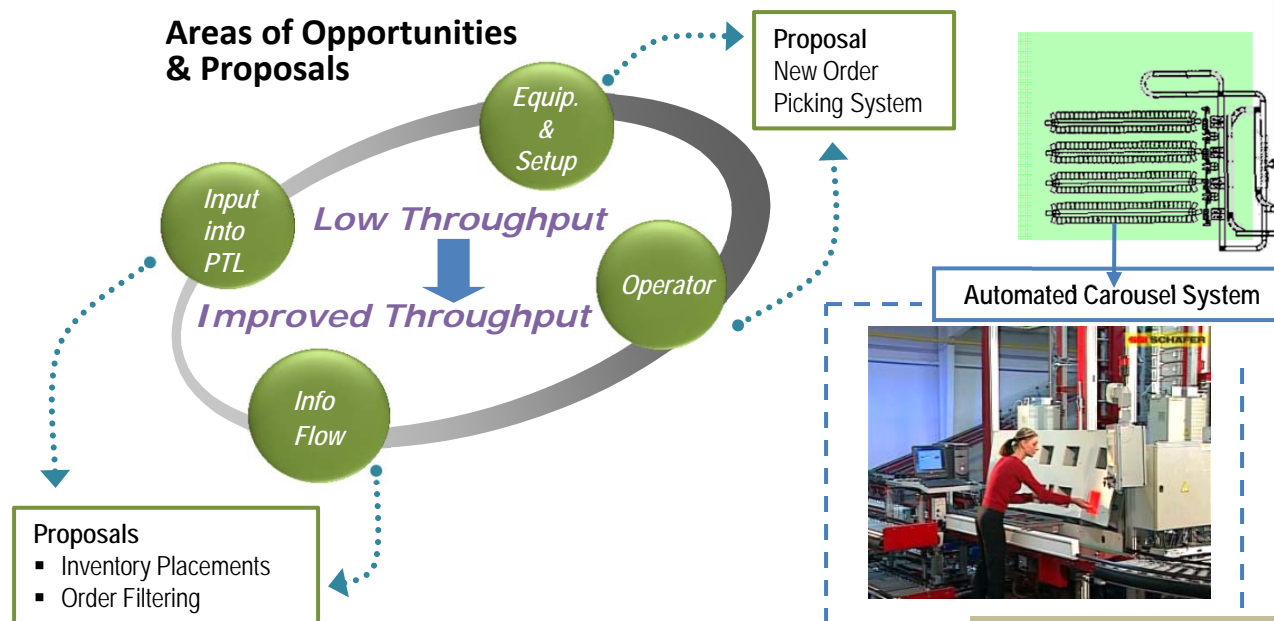
# Order Picking Improvements

## Research Project Objective

The purpose of this project is to analyze and develop proposals that can help to improve the order picking throughput at Swanson Health Products.

## Deliverables

- Documentation of current order picking process.
- Documentation of proposals for improved throughput.
- Cost/benefit analysis for proposed improvements.
- Outline of the opportunities for future projects.

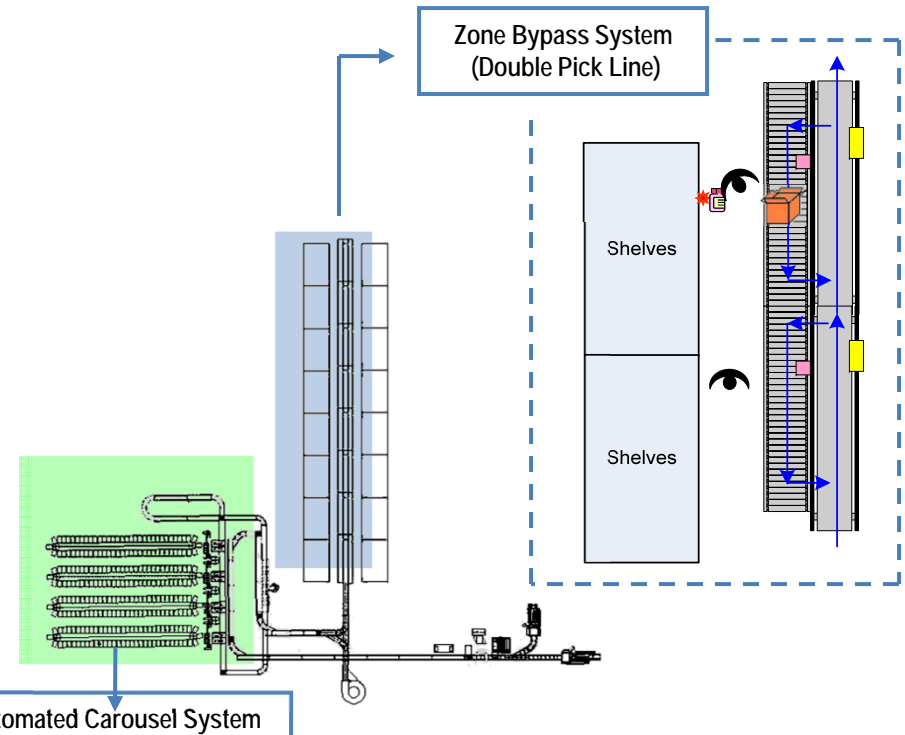


**Project Team Members:** Aki Yanagi, Shaun Phipps, Kelsey Foldesi, Laura English.

**Faculty Advisor and Consultant:** Reza Maleki  
Email: [Reza.Maleki@ndsu.edu](mailto:Reza.Maleki@ndsu.edu).

**Department:** Industrial and Manufacturing Engineering

**Funding Source:** Swanson Health Products



## Benefits

- Throughput increase: 11000 → 18000 orders/day
- Balanced workload among zones
- Reduced manual handling of boxes

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# Wil-Rich Material Handling Analysis and Improvements

**Project Team Members:** John Kline, Eric Wieland, Jeremy Hjelseth, Adam Gumke.

**Faculty Advisor and Consultant:** Reza Maleki

Email: [Reza.Maleki@ndsu.edu](mailto:Reza.Maleki@ndsu.edu).

**Department:** Industrial and Manufacturing Engineering

**Funding Source:** Wil-Rich

## Research Project Objective

The purpose of this project is to study, analyze, and develop proposals to improve the material storage and handling, as well as material delivery schedule to the fabrication shop.

## Project Team Deliverables

- Documentation of current raw material and information flow processes
- Analysis of current processes
- Proposed improvements for processes
- Economic analysis reflecting potential benefits of proposed recommendations

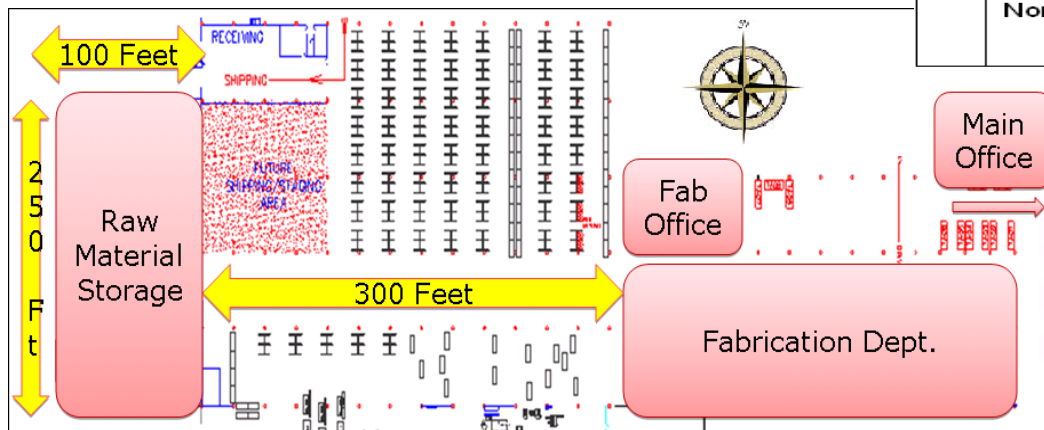
## Recommendation

- Optimize Batch Picking Model
- Streamline Information Flow
- Combine current Work Order and Pick Slip into Traveler
- Incorporate Planning Board
- Proactive Scheduling

## Improvement Breakdown

Information Flow	Proactive Scheduling	<ul style="list-style-type: none"> <li>Visually see trends and patterns of machine usage</li> <li>Planning board will allow forward thinking and scheduling</li> <li>Planning board will allow travelers to be ranked by priority</li> <li>Hot orders easily inserted in planning board when necessary</li> </ul>
	Combination	<ul style="list-style-type: none"> <li>Work order combined with pick slip</li> <li>Elimination of the pick slips</li> <li>Paper work reduced by 22%</li> <li>Combine traveler orders to eliminate redundant trips</li> </ul>
	Non Value Added Activities	<ul style="list-style-type: none"> <li>Reduce amount of retrievals by Material Handler</li> <li>Creation of work order and pick slip is now one step of creating a traveler</li> <li>Only one document needed for data entry</li> </ul>

## Current Facility Layout



## Potential Economic Annual Savings

- Distance: 288.06 Miles
- Time: 17,250 Minutes
- Dollars: 18,488.92

Spring Semester 2007





# Wil-Rich, LLC

## Paint System Analysis and Improvements

**Project Team Members:** Eric Vasko, Chris Dalland, Stu Black.

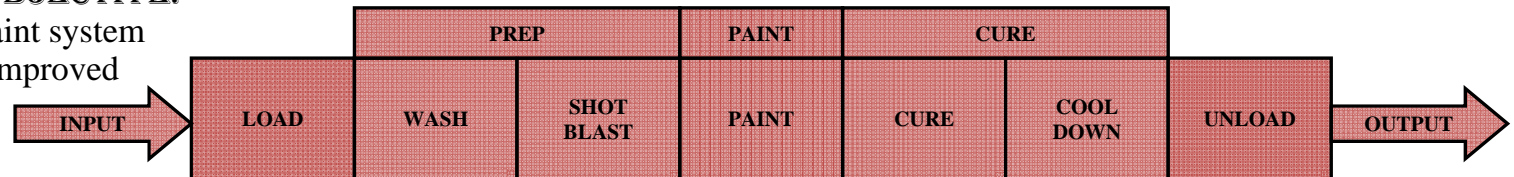
**Faculty Advisor and Consultant:** Reza Maleki  
Email: [Reza.Maleki@ndsu.edu](mailto:Reza.Maleki@ndsu.edu)

**Department:** Industrial and Manufacturing Engineering

**Funding Source:** Wil-Rich

### RESEARCH PROJECT OBJECTIVE:

To study and analyze the paint system and develop proposals for improved throughput



### PROJECT DELIVERABLES:

- Documentation of current paint line processes
- Documentation of proposals for improved paint line processes
- Documentation of economic analysis showing the impact of proposed improvements
- An outline of recommendations for future projects and improvements



### Potential Recommendation Benefits

Painting Facility Sub-system Analysis	Processes	Reduce Rework	Decrease Line Shutdowns	Increase Throughput	Improve 5S
	Input	X		X	X
	Load				X
	Wash				
	Shot Blast	X	X	X	X
	Paint		X		
	Cure		X	X	
	Cool Down				
	Unload		X	X	X
	Output	X		X	X

### PROPOSAL SUMMARY AND BENEFITS:

- Identified areas of improvement throughout the paint system
- Developed proposals for increasing system utilization and reducing part rework
- Developed proposals for increased cleanliness and safety throughout the paint system

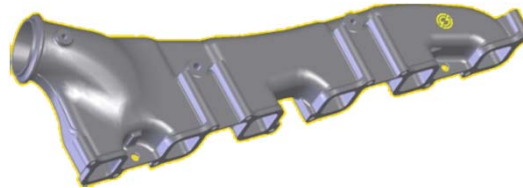
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# Production Cell Analysis and Redesign



**Project Team Members:** Jacob Schnabel,  
Steve Martineau, Phil Wolf, Chelsea Buck, Sam Jacobson.

**Faculty Advisor and Consultant:** Reza Maleki  
Email: [Reza.Maleki@ndsu.edu](mailto:Reza.Maleki@ndsu.edu).

**Department:** Industrial and Manufacturing Engineering

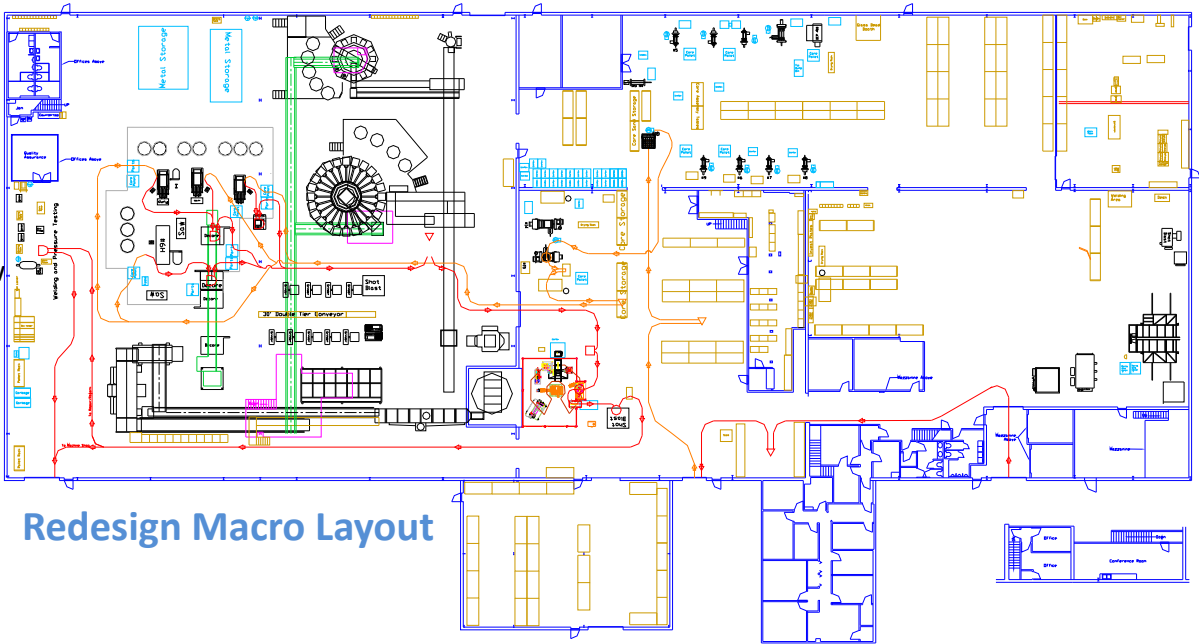
**Funding Source:** Dee, Incorporated

## Research Project Objective

The purpose of this project is to study, analyze and improve the production line for the DD133A intake manifold including the layout, manufacturing processes, and material handling

## Project Team Deliverables

- Documentation of:
- Current layout and manufacturing process flow
  - Proposed improvements for layout and process flow
  - Cost and time savings from improvements
  - Recommendations for future improvements



Redesign Macro Layout

**Bottlenecks**

- Permanent Mold
- Robot
- Machine Cell

**Areas of Improvement**

- Reduce Work in Process (WIP)
- Reduce Lead Time
- Increase Throughput
- Reduce Travel Distance for Parts
- Reduce Material Handling
- Move Inspection 'Up the Line'
- Soft Costs
- -Building Insurance
- -Overhead Costs

	Travel Distance (feet)	
	Without Rework	With Rework
Current	3,948	6,452
Proposed	3,375	3,826
% Changes	14.5	40.70

- Project Benefits**
- Reduced material handling
  - Significantly decreased WIP
  - Increased throughput
  - Decreased optimal lead time

Spring Semester 2006





# Fargo Tank & Steel

## Decreasing Manufacturing Lead Time

**Project Team Members:** Ben Horejsi, Chad Consoer, Phil Siek, Santiago Garza, Jeremy Korczak.

**Faculty Advisor and Consultant:** Reza Maleki  
Email: [Reza.Maleki@ndsu.edu](mailto:Reza.Maleki@ndsu.edu).

**Department:** Industrial and Manufacturing Engineering

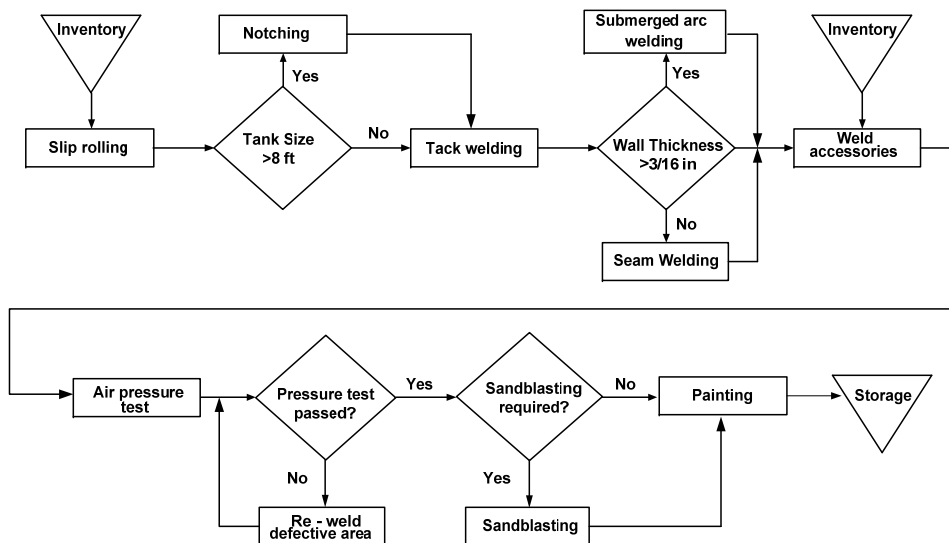
**Funding Source:** Fargo Tank & Steel

### Research Project Objective

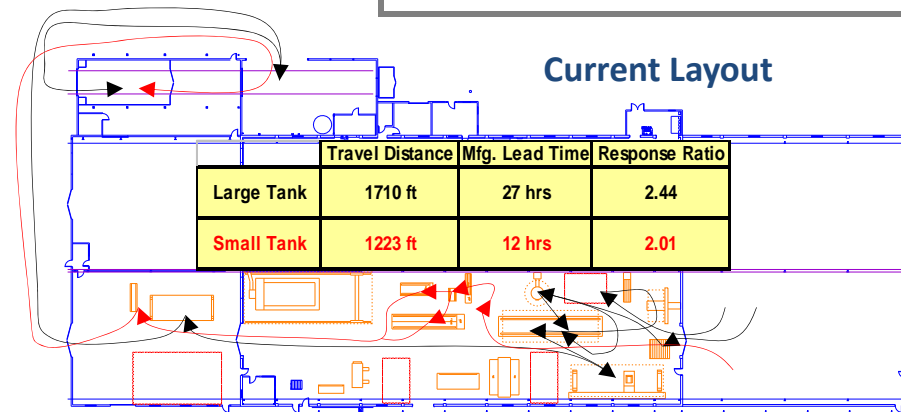
To document current layout and manufacturing processes, identify problems and make recommendations to decrease manufacturing lead time and increase throughput of tanks

### Project Deliverables

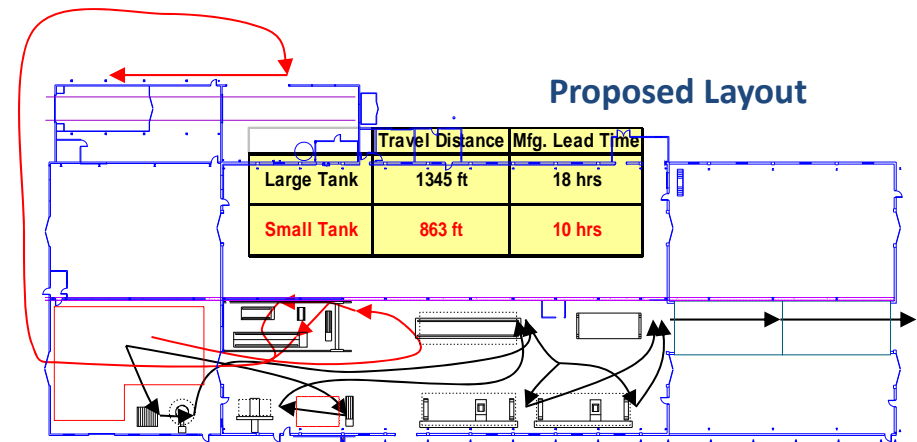
- ❑ Documentation of:
  - ❑ Current manufacturing processes, layout and flow of tanks
  - ❑ Recommendations for to improving:
    - Manufacturing processes
    - Layout
    - Work in process inventory
- ❑ Cost and time savings for proposed improvements



### Current Layout



### Proposed Layout



### Benefits

Decreasing lead time will enable increased throughput  
Reconfiguration of the layout will enable better tank flow

Spring Semester 2006

Integrated Program/Project Management and Capstone Experience





# Fargo Tank & Steel Co.

## Office Needs Analysis & Redesign

**Project Team Members:** Colby Grupa, Amy VanderLinden, Emily Tarr, Tom Mohagen, JT Rhode.

**Faculty Advisor and Consultant:** Reza Maleki  
Email: [Reza.Maleki@ndsu.edu](mailto:Reza.Maleki@ndsu.edu).

**Department:** Industrial and Manufacturing Engineering

**Funding Source:** Fargo Tank & Steel

### Research Project Objective

The purpose of this project is to develop proposals for improving the current office layout that will effectively utilize the space and meet the anticipated staff growth.

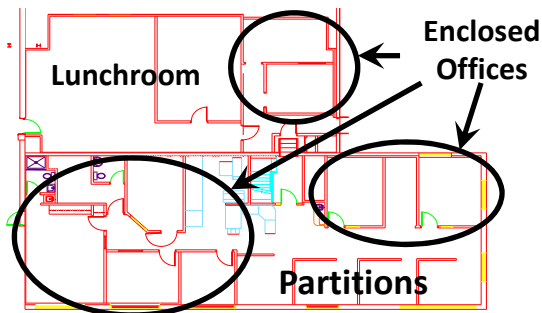
### Team Deliverables

- Documentation of current layout and space utilization
- Documentation of proposals for redesigned layout
- Documentation of required budgets to support proposed improvements and cost savings
- Outline of recommendations for future planning and additional projects

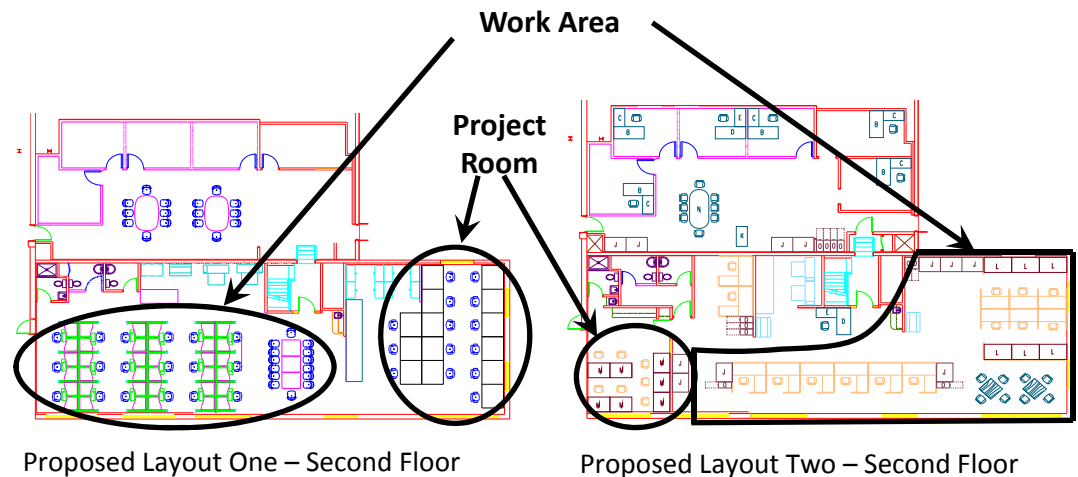
### Recommendations

- A demolition and construction plan to create an open-office layout and allow for future growth
- Introduce systems furniture to utilize work area and promote efficient working environment

Zoning Space	Floor	Current	Proposed	
		Square Feet	Option 1 Square Feet	Option 2 Square Feet
Work	First	2090	1227	1094
	Second	2055	2076	1678
Storage	First	105	99	40
	Second	144	47	207
Community	First	258	1265	1222
	Second	1161	575	545
Employees		25	32	30



Current Layout – Second Floor



Spring Semester 2006

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# Airbus A380LD Cell Layout and Cycle Time Reduction

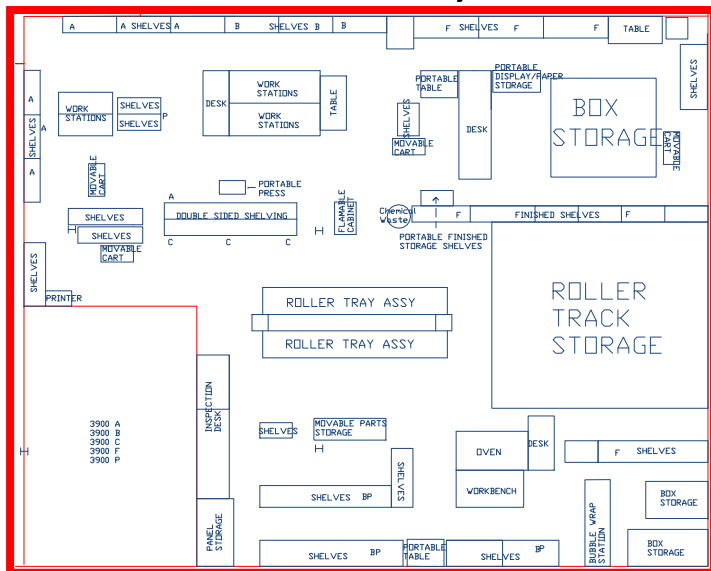
## Research Project Objective

The purpose of this project was to redesign the A380LD manufacturing cell to help with reducing cycle time and increasing capacity

## Team Deliverables

- Documentation of current manufacturing cell including the major issues effecting cell throughput
- Documentation of proposed cell addressing key issues utilizing lean concepts
- Documentation of cost and time savings that may result from implementing proposed solutions
- Document for implementation plan
- An outline of recommendations for future projects and improvements

**Current A380LD Cell Layout**



**Project Team Members:** Mitch Keller, Adam Steinke, Adam Buckhouse, Jeremy Heim.

**Faculty Advisor and Consultant:** Reza Maleki  
Email: [Reza.Maleki@ndsu.edu](mailto:Reza.Maleki@ndsu.edu).

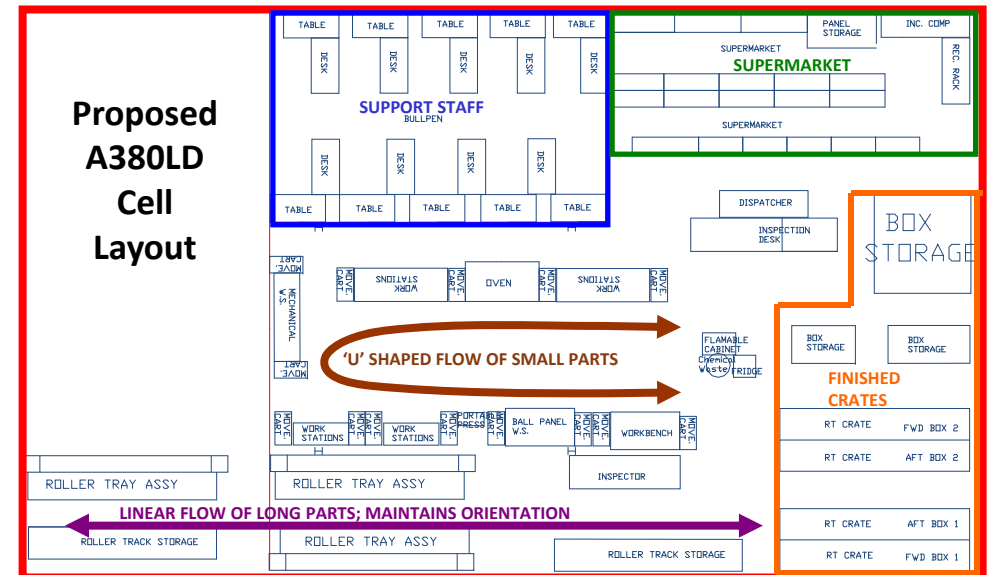
**Department:** Industrial and Manufacturing Engineering

**Funding Source:** Goodrich

## Techniques Used

- Design of kitting to reduce operator part collection
- Centralized parts storage/"Supermarket" optimization
- Eliminated non-value added operations
- Addition of three workstations (future growth)
- Improve existing assembly methods (workstation design, product design)

**Proposed A380LD Cell Layout**



## Potential Benefits

- MLT reduced by 16%
- Operator travel distance reduced by 97%
- \$8,500 cost savings per cargo system
- Support Staff area accommodates two more engineers
- Cell supports three additional workstations

Spring Semester 2006

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# Airbus A380 Lower Deck Packaging and Logistics Redesign

**Project Team Members:** David Bartholome,  
Yuriv Astanasov, Kristin Nuss, Adam Maus.

**Faculty Advisor and Consultant:** Reza Maleki  
Email: [Reza.Maleki@ndsu.edu](mailto:Reza.Maleki@ndsu.edu).

**Department:** Industrial and Manufacturing Engineering

**Funding Source:** Goodrich

## Research Project Objective

Develop Improved Processes and Procedures for the Packaging and Shipping Logistics for the Airbus A380LD Cargo Handling System.

## Deliverables

- ➔ Documentation of Current Processes
- ➔ Documentation of Alternative Methods for Improved Packaging and Shipping
- ➔ Documentation of Cost and Time Savings
- ➔ Recommendations for Future Improvements

## Cargo Handling System



## Improving Process

- ➔ Standardize Packaging Process
- ➔ Standardize Packaging Material

## Explore Alternatives

- ➔ Reusable Shipping Containers
- ➔ Methods of Transportation
- ➔ Eliminate Repackaging in Hamburg

## Potential Benefits



## Current Packaging and Shipping Operations

Proposed Method	Range of Savings*		Remarks
	Min	Max	
Standardization	\$750	\$2,000	Includes 7.5 Hours Material Preparation Time
Packaging Material	\$0	\$400	Cost Savings Only
Shipping Method	\$4,122	\$6,571	Ocean
<b>Total Savings/Shipment</b>	<b>\$4,872</b>	<b>\$8,971</b>	
<b>Total Savings/Year</b>	<b>\$243,600</b>	<b>\$448,550</b>	1 Shipment/Week by 6/2007

\* One Cargo Handling System (Savings Based on \$25-\$40 Wage)

Spring Semester 2006

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# Gremada Industries, Inc.

## Material Numbering Transition

**Project Team Members:** Kyle Rolfson, Chris DeHaan, Shawn Nieuwsma, Jace Manning

**Faculty Advisor and Consultant:** Reza Maleki  
Email: [Reza.Maleki@ndsu.edu](mailto:Reza.Maleki@ndsu.edu)

**Department:** Industrial and Manufacturing Engineering

**Funding Source:** Gremada Industries

### RESEARCH PROJECT OBJECTIVE

The purpose of this project is identifying what processes and procedures are affected and determine what material number cross-references are required to support operations at Gremada Industries, Inc. due to Gremada transitioning to a new business model

### RECOMMENDATIONS

- ☐ Additional production support and system analyst positions
- ☐ Additional computer monitors for production support
- ☐ New Wireless Data Collection System
- ☐ Mobile Wireless Data Collection Hardware
- ☐ Online Quality Assurance forms



### PROJECT DELIVERABLES

- ☐ Documentation of requirements for a new numbering system.
- ☐ Recommendations for a numbering system to satisfy the requirements.
- ☐ Recommendations for training employees.
- ☐ Recommendations for the use of Gremada's current infrastructure to support the proposed numbering system.
- ☐ Documentation of potential benefits.
- ☐ Recommendations for future projects.

### POTENTIAL BENEFITS

- ☐ Better understanding of functional department needs
- ☐ Tighten inventory control
- ☐ Increase control over shipping and receiving
- ☐ Create an environment to explore engineering opportunities
- ☐ Accommodate new customers at a faster rate
- ☐ Increase employee access to information
- ☐ Reduce paper consumption inline with ISO requirements
- ☐ Establish organizational identity unique to Gremada

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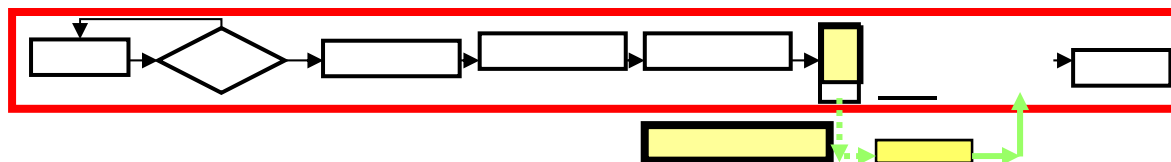
## New Facility Design and Analysis of Supply Chain

### Research Project Objectives

Develop a proposal for a new facility layout as well as a proposal for an improved supply chain to help IMAR Group, LLC meet expected growth and demand.

### Project Team Deliverables

- ❑ Document the current layout, manufacturing and assembly processes, as well as procurement practices
- ❑ Document of recommendations for improved processes, layout and supply chain
- ❑ An outline of recommendations for future projects and improvements
- ❑ Documentation of cost and time savings that may result from implementing proposed suggestions



### Proposed Layout and Supply Chain Recommendations

- ❑ Decreased mold transportation distances
- ❑ Side by Side gel-coating and fiberglass operations
- ❑ vs. single mold Bottlenecks
- ❑ Increased Curing area square footage
- ❑ Increased Grind Shop Capacity
- ❑ Decreased Buffing time
- ❑ Optimized Final Assembly Kitting
- ❑ Cellular Manufacturing Techniques
- ❑ Alleviated Finished Product Bottlenecks
- ❑ Trailer assembly close to shipping doors
- ❑ Develop Tool to Evaluate Suppliers
- ❑ Work to Establish Local Network of Suppliers
- ❑ Reduce some lead time issues
- ❑ Develop metrics to have better control over information flow
- ❑ Introducing a Kanban Ordering System
- ❑ Lead into MRP system
- ❑ Enhance 5S Program (housekeeping)

**Project Team Members:** Scott Blegen, Ryan Schumacher, Scott Bader, Adam Guderian, Tim Mack, Matt Buchnan.

**Faculty Advisor and Consultant:** Reza Maleki  
Email: [Reza.Maleki@ndsu.edu](mailto:Reza.Maleki@ndsu.edu).

**Department:** Industrial and Manufacturing Engineering

**Funding Source:** IMAR Group, LLC

Station/Operation	Average Time (min)
Move Boat from Storage	82
Gel Coat	271
Fiberglass Shop	1597
Grind Shop	333
Engine Installation / Merging	334
Buffing/Inspecting	61
Final Assembly/Trailer	112
	<b>46 Hours</b>



Station/Operation	Average Time (min)
Move Boat from Storage	20
Gel Coat	80
Fiberglass Shop	1355
Grind Shop	212
Buffing/Inspecting	30
Final Assembly (Manufacturing Cells)	389
Trailer/Move Outside	10
	<b>35 Hours</b>

Current Building and Layout Capacity			
	Gekko	Sugar Sand	Total Boats
Per Day	1	1.8	2.8
Per Week	5	9	14
Per Year	250	450	<b>700</b>

Model Mix	35%	65%	
New Facility and Layout Capacity			
	Gekko	Sugar Sand	Total Boats
Per Day	2.5	4.5	7
Per Week	12.5	22.75	35
Per Year	625	1125	<b>1750</b>

Model Mix 35% 65%

Spring Semester 2006

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# Ultrrex® Waste Reduction

**Project Team Members:** Hugh Medal, Eric Rossland, Peter Sedgeman, Dana Martin.

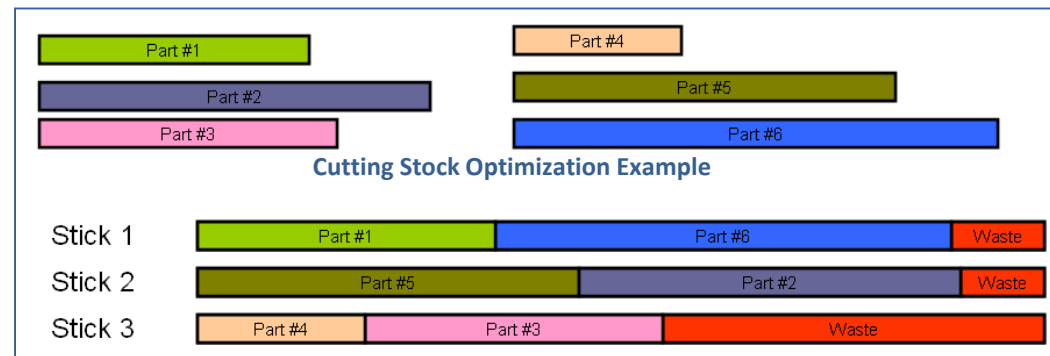
**Faculty Advisor and Consultant:** Reza Maleki  
Email: [Reza.Maleki@ndsu.edu](mailto:Reza.Maleki@ndsu.edu).

**Department:** Industrial and Manufacturing Engineering

**Funding Source:** Infinity Windows and Doors

## Research Project Objective:

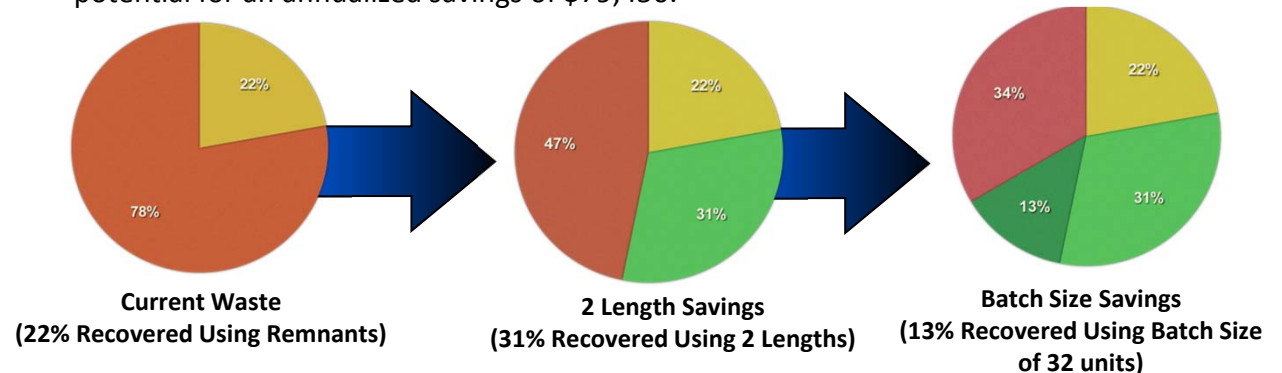
Analyze, refine, & document processes for reducing and accurately measuring Ultrrex waste.



## Recommendations:

- Change system to accommodate 2 lineal lengths of Ultrrex and larger batch size
- Order and install self dumping hoppers
- Phase in computational weight recording method

**Expected Benefit:** Waste reduction (44%) and ergonomic improvements present potential for an annualized savings of \$79,450.



## Project Team Deliverables:

- Documentation of current Ultrrex utilization process
- Procedures for accurate measurement & disposal of Ultrrex waste
- Methods for reducing waste
- Financial justification
- Recommendations for future projects & improvements

Spring Semester 2006

Integrated Program/Project Management and Capstone Experience





# Facility Layout Improvements

**Project Team Members:** Justin Brotzler, Brent Swanson, Kurt Landwehr.

**Faculty Advisor and Consultant:** Reza Maleki

Email: [Reza.Maleki@ndsu.edu](mailto:Reza.Maleki@ndsu.edu)

**Department:** Industrial and Manufacturing Engineering

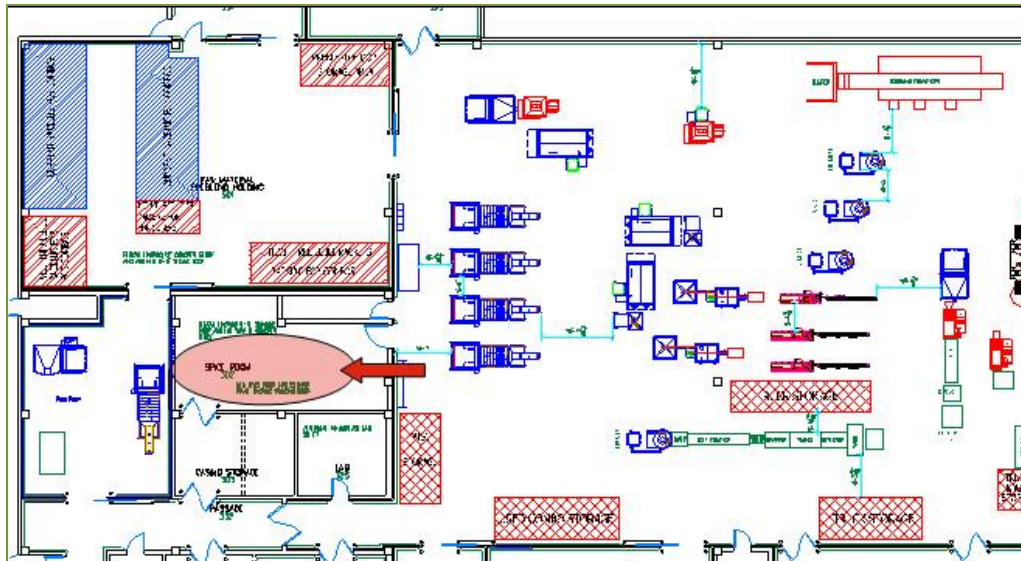
**Funding Source:** Cloverdale Meats

## Research Project Objective

Provide the documentation of current and proposed process flow and layout in the production facility. Study and document operations for improved ergonomics in facility.

## Project Deliverables

- 🍖 Documentation of current and proposed production Kitchen area layout and flow
- 🍖 Documentation of current and proposed material handling system
- 🍖 Documentation of current ergonomic issues and recommendations for improvements



## Time Savings Summary

Product Family	Current Dist Traveled	Proposed Dist Traveled	Total Savings
Emulsified	1884 ft.	608 ft.	1276 ft.
Coarse Ground	2339 ft.	1233 ft.	1106 ft.
Fresh Ground	881 ft.	623 ft.	258 ft.
Total Distance Traveled X 2 (1)	8446 ft.	2464 ft.	5982 ft.
Time @ 2.5 FT/Sec	3378 sec.	986 sec.	<b>40 min.</b>

## Space and Investment Savings Summary

Floor Space Saved	SQFT
Cooler	638
S Side of Current	239
Cooler	325
Used Combo Storage	583
Total Storage Added	1785
Warehouse Space Saved	1202
Production Space Saved	583
Cost for Warehouse Space	\$75
Cost for Production Space	\$200
<b>Total Cost to Add Space</b>	<b>\$206,746</b>

**Spring Semester 2005**

**Integrated Program/Project Management and Capstone Experience**





# Material Handling Analysis

**Project Team Members:** Tadd Busch, Mike Lougheed, Mathew Mueller, Marcus Vetter  
**Faculty Advisor and Consultant:** Reza Maleki  
 Email: [Reza.Maleki@ndsu.edu](mailto:Reza.Maleki@ndsu.edu)

**Department:** Industrial and Manufacturing Engineering

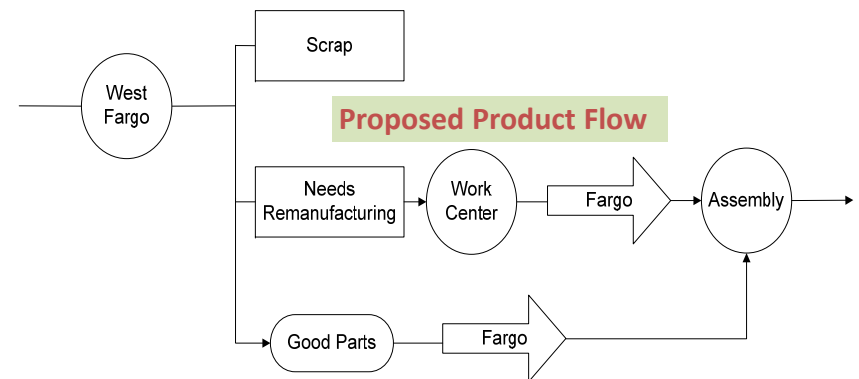
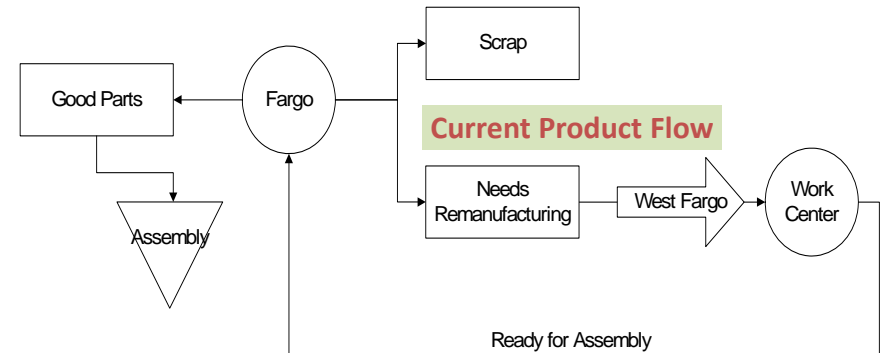
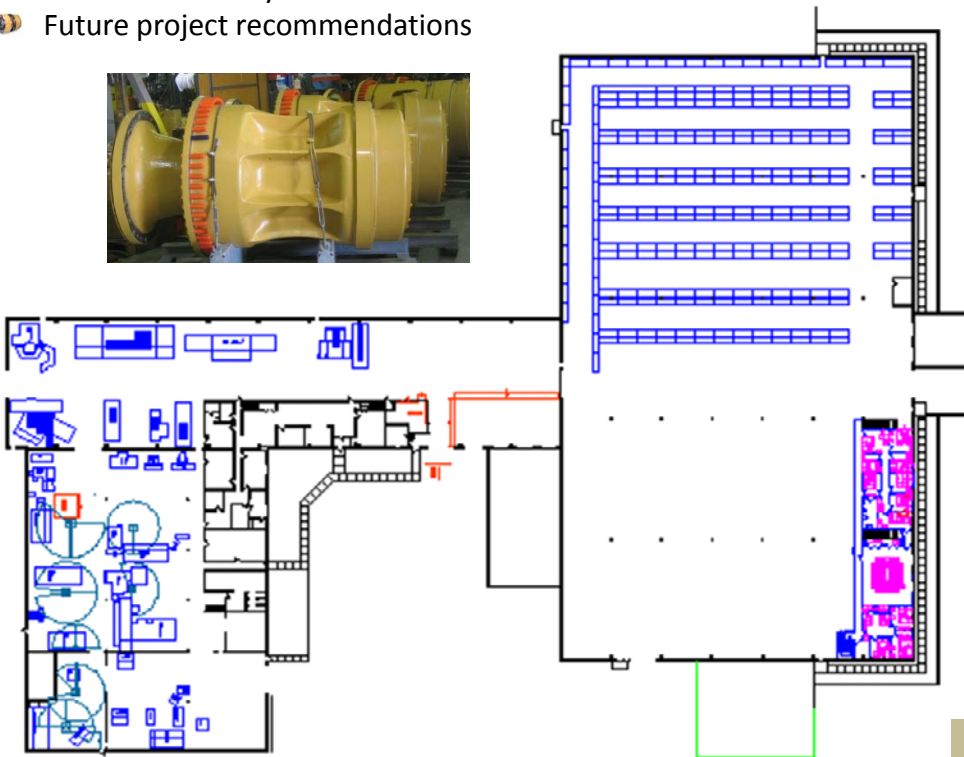
**Funding Source:** Gremada Industries, Inc.

## Research Project Objective

- Analyze material handling and its effect on warehousing cost
- Quantify the benefits and costs associated with relocating the inspection and disassembly of transmission units to West Fargo

## Deliverables

- Document outlining recommendations
- Cost benefit analysis
- Future project recommendations



## Potential Benefits

- More reliable data associated with material handling and transportation costs providing for better management decisions
- Improved product and process flow
- Reduced material handling and warehousing costs

**Spring Semester 2005**

**Integrated Program/Project Management and Capstone Experience**



# New Facility Layout

**Project Team Members:** Lisa McCarvel, Tyler Albert, Derrick Tuma, Jordan Graff, Laura Anderson.

**Faculty Advisor and Consultant:** Reza Maleki  
Email: [Reza.Maleki@ndsu.edu](mailto:Reza.Maleki@ndsu.edu).

**Department:** Industrial and Manufacturing Engineering

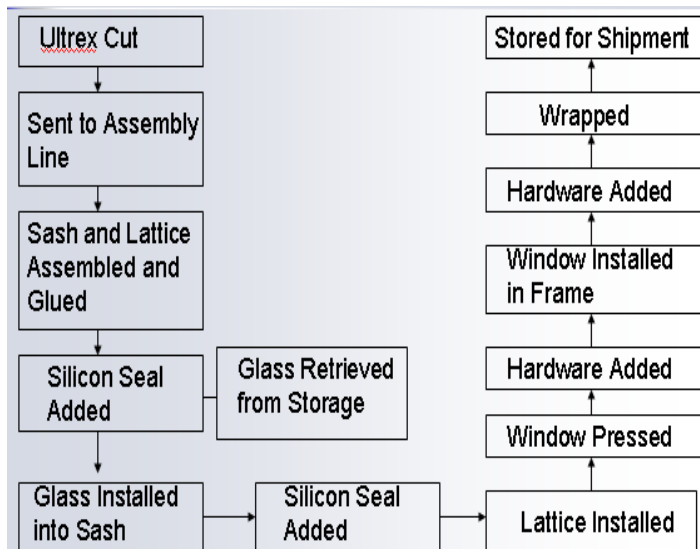
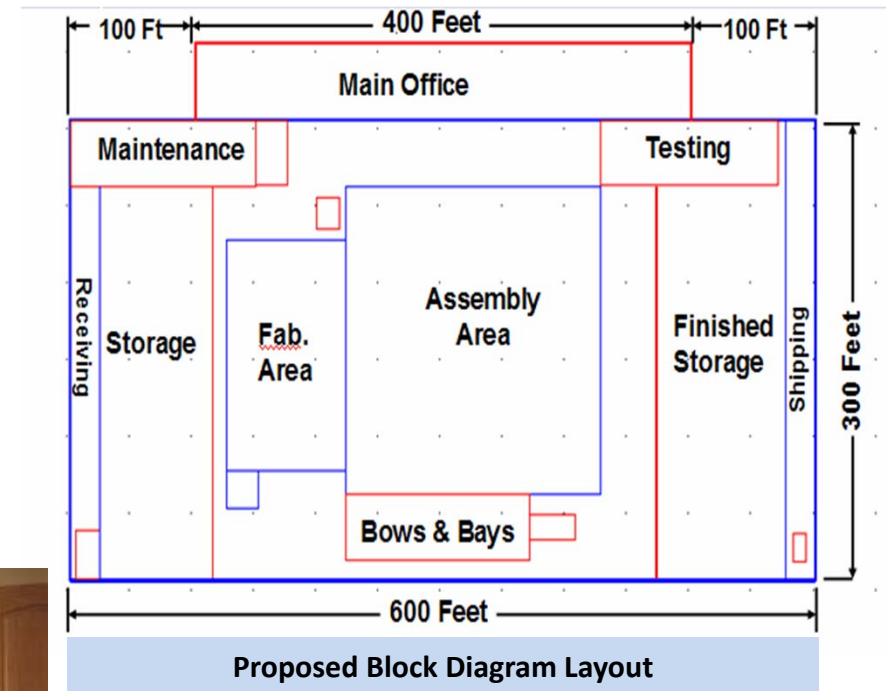
**Funding Source:** Infinity Windows and Doors

## Research Project Objective

To develop a proposal for a new facility layout capable of meeting anticipated production needs and future expansion.

## Project Team Deliverables:

- ❑ Document of current process flow, material handling, and storage requirements
- ❑ Detailed plan for new layout
- ❑ Cost estimate of the site preparation and building construction



## Implementation Plan:

- Create schedule for moving into new facility
- Organize purchased equipment in new facility
- Move existing equipment gradually
- Train employees on new layout & equipment

**Spring Semester 2005**

**Integrated Program/Project Management and Capstone Experience**



# NDSU ADVANCE

## Childcare Facility Feasibility Study

### Research Project Objective

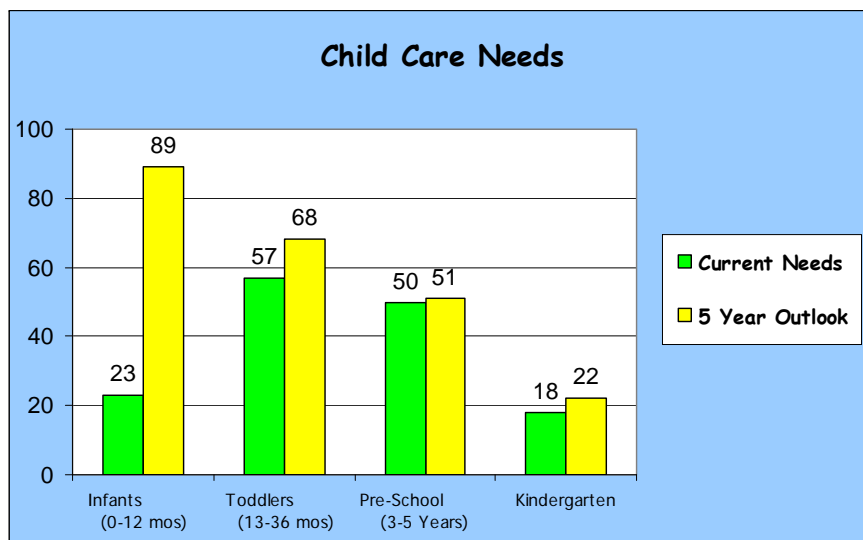
Determine the feasibility of establishing a full-service childcare center for faculty, staff, and students at NDSU.



### Project Team Deliverables

Documentation of:

- ❖ Current and future childcare needs.
- ❖ Location and funding sources.
- ❖ Recommendations for future projects.

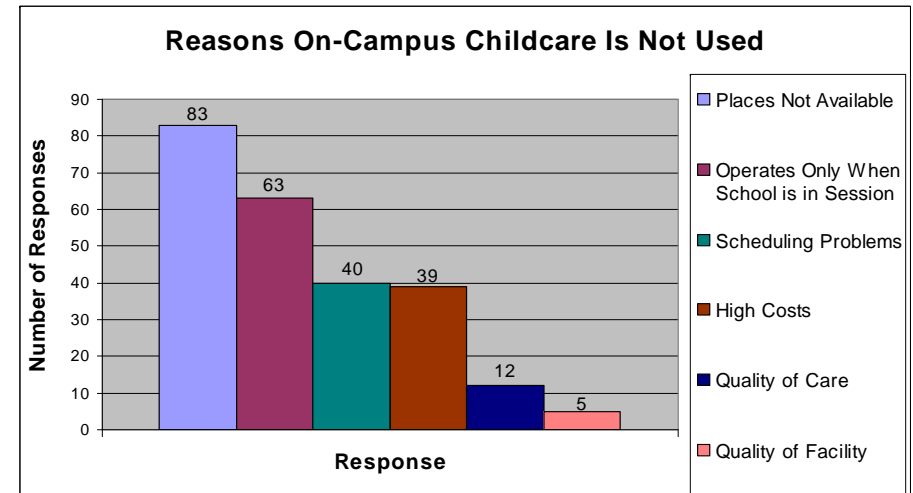


**Project Team Members:** Andrea Keller, Brad Andersen, Holly Stadstad, Heidi Rogahn .

**Faculty Advisor and Consultant:** Reza Maleki  
Email: [Reza.Maleki@ndsu.edu](mailto:Reza.Maleki@ndsu.edu).

**Department:** Industrial and Manufacturing Engineering

**Funding Source:** None



### Recommendations

- ❖ Build new on-site childcare facility to be managed by NDSU or a 3<sup>rd</sup> party.
- ❖ Partnership with YWCA to assist with the expansion and use of its current facilities.

### Project Benefits

- ❖ Provide child care services for NDSU faculty, staff & students.
- ❖ Increase employee satisfaction.
- ❖ Attractive benefit to recruit & retain young faculty and staff.

**Spring Semester 2005**

**Integrated Program/Project Management and Capstone Experience**





# Sioux Manufacturing Plant Layout and Process Improvement

**Project Team Members:** Brian Dodd, Ryan Schwoch, Charles Sloan, Travis Olson.

**Faculty Advisor and Consultant:** Reza Maleki  
Email: [Reza.Maleki@ndsu.edu](mailto:Reza.Maleki@ndsu.edu).

**Department:** Industrial and Manufacturing Engineering

**Funding Source:** Sioux manufacturing

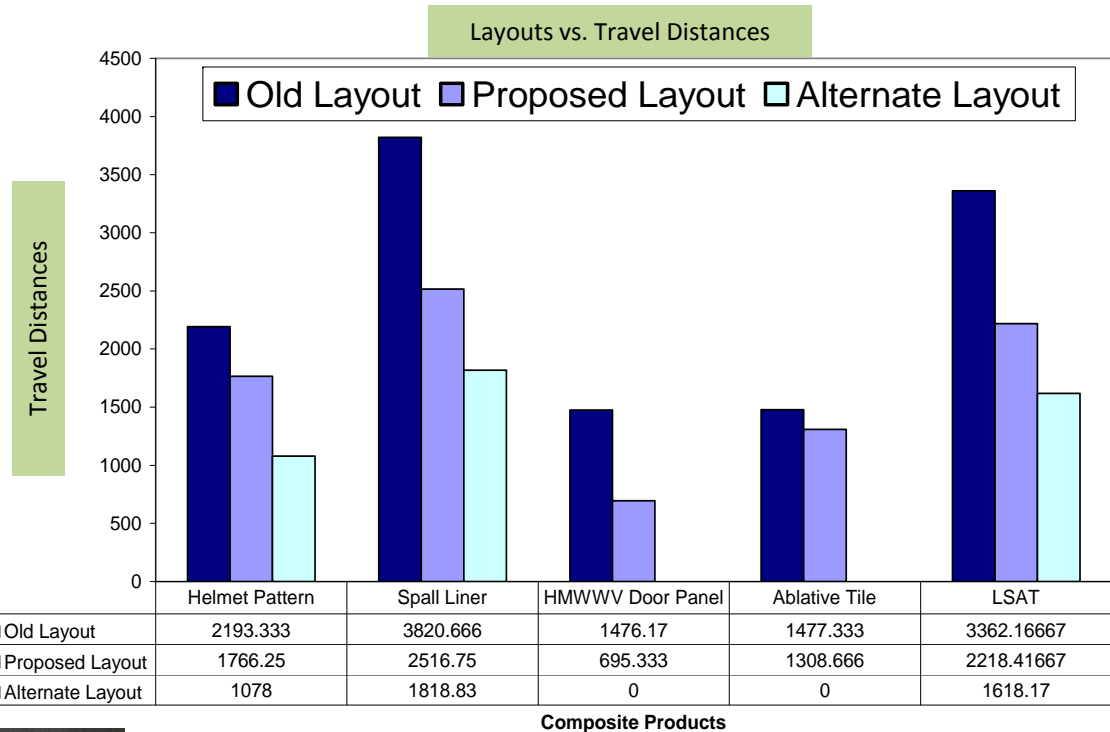
## RESEARCH PROJECT OBJECTIVE

To study, document and evaluate the current layout, material and process flow and propose an improved plant layout that can contribute to improved throughput.

## PROJECT TEAM DELIVERABLES

Documentations of:

- Current layout, material flow and processes
- Proposals for improved layout and processes
- Savings resulting from improvement proposals
- Recommendations for future projects



## POTENTIAL BENEFITS

- Improved productivity of some of the processes
- Improved quality
- Reduced travelling distances
- Increased throughput
- Improved safety and ergonomics

Spring Semester 2005

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# Bottling Operations Throughput Improvement

**Project Team Members:** Mike Rooks, John Rogstad, Phillip Gaugler, Brad Okonek.

**Faculty Advisor and Consultant:** Reza Maleki  
Email: [Reza.Maleki@ndsu.edu](mailto:Reza.Maleki@ndsu.edu).

**Department:** Industrial and Manufacturing Engineering

**Funding Source:** Swanson Health Products

## Research Project Objective

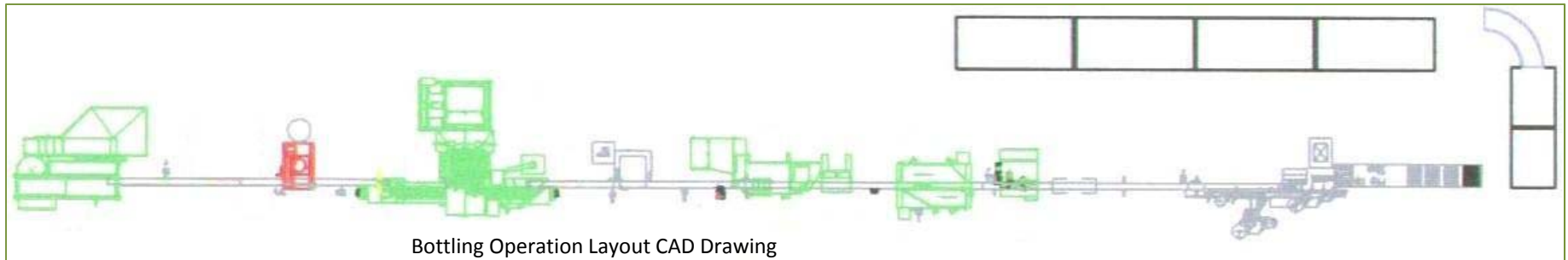
Develop and document a proposal that can help with increased bottling operations throughput.

## Team Deliverables

1. Documentation of current bottling process
2. Improving Bottling Operations throughput by use of setup reduction methodology
3. Economic justification of recommendations

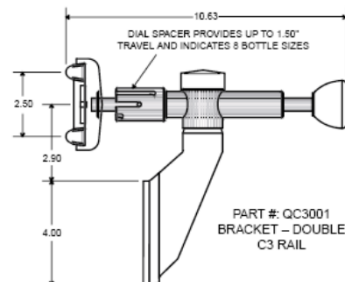
## Recommendations

1. Transfer Double Cremer cleaning operations from an internal setup to an external setup
2. Utilize Double Cremer Computer Programming capabilities to reduce setup time
3. Purchase Trackstar brackets to improve guide rail systems



Bottling Operation Layout CAD Drawing

Bottling Operations Throughput Increase			
	Cremer Cleaning	Cremer Standardization	TrackStar Brackets
Time saved	25 min	10 min	10 min
Setups Completed	4 per shift	4 per shift	0.333 per shift
Time saved per shift	100 min	40 min	3.33 min
Bottles filled per shift	2700	1080	90
Throughput Increase per Year	675,000	270,000	22,500
Total Throughput Increase Per Year: 967,500			



Trackstar Brackets

Spring Semester 2005

Integrated Program/Project Management and Capstone Experience





# White Earth Health Center

## Improving Patient Access

**Project Team Members:** Audrey Rondeau, Nichole Haan, Alesia Schilke, Nick Zilka.

**Faculty Advisor and Consultant:** Reza Maleki  
Email: [Reza.Maleki@ndsu.edu](mailto:Reza.Maleki@ndsu.edu).

**Department:** Industrial and Manufacturing Engineering

**Funding Source:** White Earth Health Center

### RESEARCH PROJECT OBJECTIVE

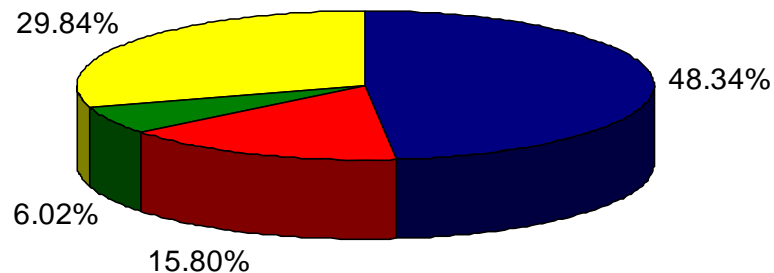
Determine and propose methods to improve patient access, by increasing the number of patients seen per provider through analysis, documentation, and recommendations.

### PROJECT DELIVERABLES

Documentations of:

- Current appointment scheduling process
- Recommendations for addressing scheduling problems
- Recommendations to increase patients seen per provider
- Recommendations for future projects and improvements

**Summary of Providers' Activities During the Study Period**



■ Total Time with patients    ■ Total No Show Time  
■ Total Cancellation Time    ■ Remaining Idle Time

### RECOMMENDATIONS

- Reduce number of “ruled” appointment slots
- Reduce number of carved appointment slots
- Require providers’ work availability three months in advance

Provider	Total Hours Currently Scheduled w/ Appointments	Total Hours Available for Appointments after Implementation of Recommendations	Additional Hours Available for Appointments after Implementation of Recommendations	Additional Patients after Implementation
1	68.00	86.65	18.65	36
2	78.75	98.88	20.13	39
3	82.50	88.27	5.77	11
4	60.50	74.21	13.71	26
5	39.00	53.74	14.74	28
6	15.75	22.93	7.18	13
7	0.00	0.00	0.00	0
8	34.00	42.15	8.15	15
9	32.50	39.19	6.69	12
10	63.31	92.77	29.46	58
TOTAL				238

### POTENTIAL BENEFITS

- Increase number of fifteen minute appointment slots able to be filled by general or follow-up appointments by 8.
- Help to reduce no show rates as patient’s appointment will be scheduled while they are still at the health center.

**Spring Semester 2005**

**Integrated Program/Project Management and Capstone Experience**





# Bobcat®

## Small Miscellaneous Parts (SMP) “Supermarket” Design

**Project Team Members:** Patrick Brandt, Tom Tveter,  
Josh Tysver, James Klein.

**Faculty Advisor and Consultant:** Reza Maleki  
Email: [Reza.Maleki@ndsu.edu](mailto:Reza.Maleki@ndsu.edu).

**Department:** Industrial and Manufacturing Engineering

**Funding Source:** Bobcat

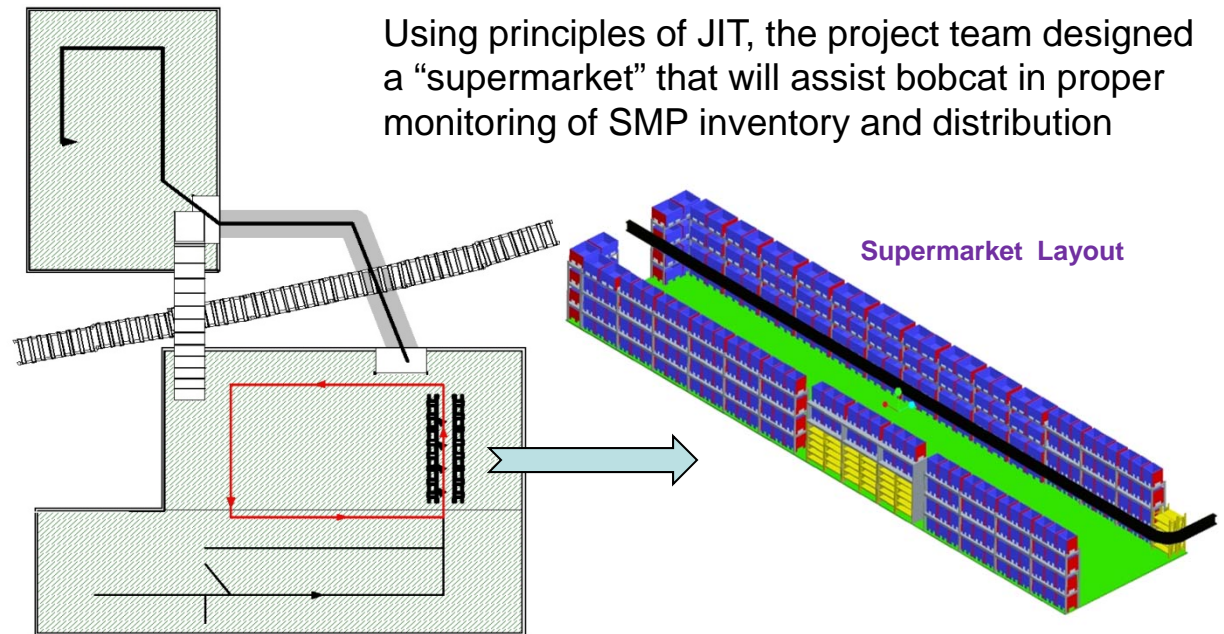
### Research Project Objective

Design a centralized “supermarket” facility to be used for the storage and distribution of small miscellaneous parts



SMPs are produced and painted in Gwinner and used in the assembly of Bobcat skid-steer loaders

Using principles of JIT, the project team designed a “supermarket” that will assist bobcat in proper monitoring of SMP inventory and distribution



### Project Deliverables

Documentation of

- ☐ Layout and hardware requirements for the “supermarket”
- ☐ Inventory replenishment policies for the “supermarket”
- ☐ SMP delivery routes
- ☐ Recommendations for future projects

### Potential Benefits

- ☐ System for monitoring of both painted and unpainted parts
- ☐ A more reliable delivery system for SMPs to assembly
- ☐ Reduced lead time
- ☐ Higher number of inventory turns
- ☐ Decreased material handling

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## Design of a Flexible Assembly Device

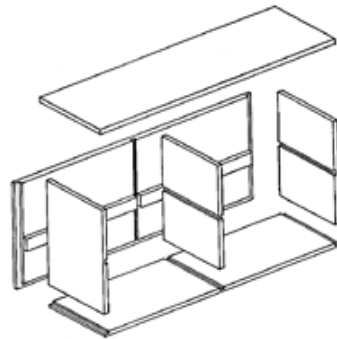
### Research Project Objectives

Design a flexible holding device that will aid in improving cabinet assembly processes.

### Project Deliverables

Documentation of:

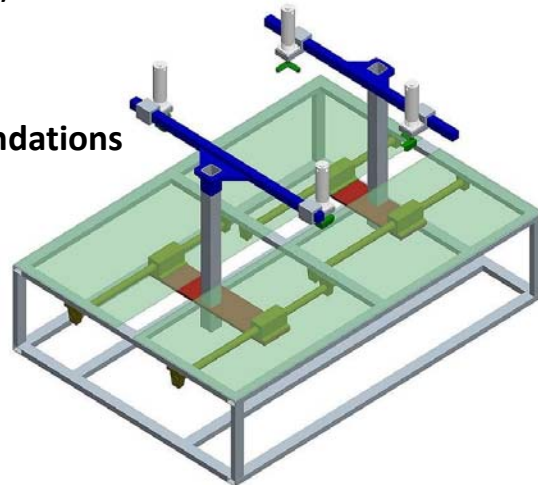
- Current Processes
- Proposed holding device
- Investment requirements
- Recommendations for Future Projects and Improvements



**The Team designed a device that had the potential to:**

- Reduce Assembly Time
- Improve Ergonomics
- Decrease Employee Turnover

### Design Recommendations



**Project Team Members:** Neil Anderson, Chris Knipfer, John Bonicelli, Brian Thompson.

**Faculty Advisor and Consultant:** Reza Maleki  
Email: [Reza.Maleki@ndsu.edu](mailto:Reza.Maleki@ndsu.edu).

**Department:** Industrial and Manufacturing Engineering

**Funding Source:** Braaten Cabinets

### Potential Savings and Payback Periods

		Time Savings (minutes)					
Cabinets Per Day	15	30	45	60	75	90	minutes saved/day
		374	562	749	937	1124	\$ saved/month
		31	21	16	13	11	payback period (months)
		638	424	319	255	212	payback period (days)
	18	36	54	72	90	180	minutes saved/day
		449	674	899	1124	2249	\$ saved/month
		26	17	13	11	6	payback period (months)
		531	354	266	212	106	payback period (days)
	24	48	72	96	120	240	minutes saved/day
		599	899	1199	1499	2999	\$ saved/month
		20	13	10	8	4	payback period (months)
		398	266	199	159	80	payback period (days)
	30	60	90	120	150	300	minutes saved/day
		749	1124	1499	1874	3749	\$ saved/month
		16	11	8	7	4	payback period (months)
		319	212	159	128	64	payback period (days)

Spring Semester 2004

Integrated Program/Project Management and Capstone Experience





# Material Handling & Ergonomics

**Project Team Members:** Greg Frey, Dan Anderson, Nathan Davis, Emily Ekeren.

**Faculty Advisor and Consultant:** Reza Maleki  
Email: [Reza.Maleki@ndsu.edu](mailto:Reza.Maleki@ndsu.edu).

**Department:** Industrial and Manufacturing Engineering

**Funding Source:** Dakota Growers Pasta Company

## Research Project Objective

To develop a proposal and make recommendations for improved ergonomics through utilizing improved methods and equipment for material handling and packaging equipment loading.

## Project Team Deliverables

Documentation of:

- ☐ Current procedures for material handling
- ☐ Detailed report on improved methods for material handling
- ☐ Cost benefit analysis for proposed solution
- ☐ Future project recommendations

## Recommendations

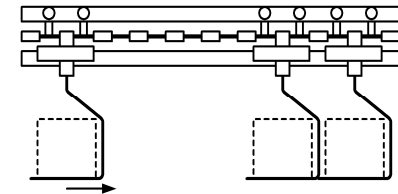


### Self-Leveling Cart

- ☐ Transports two or more loads at one time
- ☐ Relieves the operator of carrying the load
- ☐ Takes up minimal floor space

### Power & Free Conveyor System

- ☐ Transports two loads at one time
- ☐ Relieves the operator of carrying the load
- ☐ Basic
- ☐ Takes up minimal space



### Fork Lift

- ☐ Adjustable height
- ☐ Maneuvers easily
- ☐ No scissor arm



### Additional Recommendations

- ☐ Footwear
- ☐ Lifting Techniques - Training
- ☐ Stretching – Encouraged

Recommendations	Cost	Benefit
Lift Truck	\$12,200	Workers will not have to bend over.
Overhead Trolley	\$5,400	Workers will be able to move corrugate easily.
Spring Loaded Cart	\$500	Workers will be able to move corrugate easily.
Footwear	\$1,600	Reduce foot fatigue.

### Additional Potential Benefits of the Recommendations :

- ☐ Reduce worker injuries
- ☐ Reduce time loading magazine
- ☐ Reduce travel distances
- ☐ Labor time for load/unload

Spring Semester 2004

Integrated Program/Project Management and Capstone Experience



# Paint Line Productivity Improvements

**Project Team Members:** Dustin Jung, Chad McNea ,  
Nathan Kent, Bo Hicks.

**Faculty Advisor and Consultant:** Reza Maleki  
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**Department:** Industrial and Manufacturing Engineering

**Funding Source:** Integrity Windows and Doors

## RESEARCH PROJECT OBJECTIVE

To develop a proposal and make recommendations for the material handling methods for loading, transferring, and unloading of wood parts to improve the overall productivity and quality of the paint line.

## PROJECT TEAM DELIVERABLES

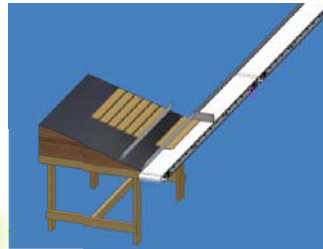
- ❑ Documentation of current processes
- ❑ Documents proposing improved material handling methods
- ❑ Cost justification for improvements
- ❑ Recommendations for future projects

## RECOMMENDATIONS

- ❑ Automated in-feed loading system for Primer line
- ❑ Transfer with robotics from Primer line to Paint line
- ❑ Installation of ring wrapper in the unloading area of the paint line

## RING WRAPPER

- ❑ Reduces amount of material handling for wrapping of pallets
- ❑ Decreases the amount of distance traveled for this process



## AUTOMATED IN-FEED SYSTEM

- ❑ Allows for operator to concentrate on inspection
- ❑ Consistency in the loading process and the release of parts
- ❑ Creates even spacing of product on the oven belt
- ❑ Increases the overall utilization of the oven belt

## ROBOTIC TRANSFER

- ❑ Relieves operator from repetitive motions
- ❑ Reliable system for consistency in transfer
- ❑ Maintains the utilization from the priming process
- ❑ Minimal defects due to part handling



## Recommendations have potential to help with:

- ❑ Improved throughput
- ❑ Decrease in labor input

## Potential additional improvements in:

- ❑ Quality
- ❑ Ergonomics
- ❑ Employee morale
- ❑ Turnover rate



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# Lake Agassiz Regional Library

Lake Agassiz Regional Library

## Improving Methods for Processing Library Materials

**Project Team Members:** Amy Paul, Derrick Tuma, Jonathan Auel.

**Faculty Advisor and Consultant:** Reza Maleki

Email: [Reza.Maleki@nds.u.edu](mailto:Reza.Maleki@nds.u.edu).

**Department:** Industrial and Manufacturing Engineering

**Funding Source:** Lake Agassiz Regional Library

### Research Project Objective

to study, document, and analyze the existing methods for processing library materials and propose a streamlined process and workplace layout.

### Project Team Deliverables

- Documents for:
  - Current layout and methods
  - Improved layout and methods
  - Furniture and equipment specifications
  - Budget and cost benefits analysis
- Document of Recommendations for:
  - Material handling equipment
  - Future projects
  - Further improvements

#### Some Facts

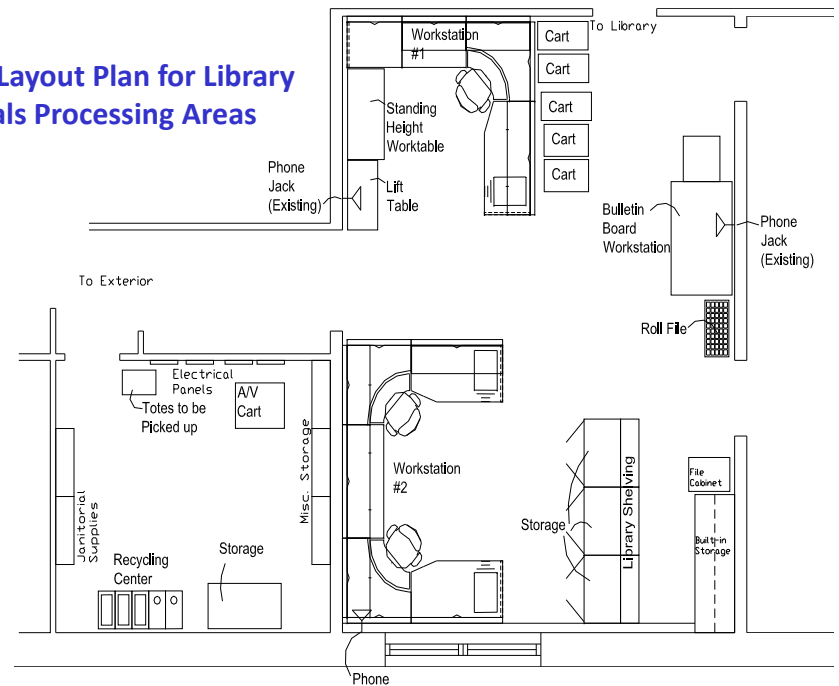
The library processes books, magazines, CD's, DVD's and donated items

2003: the library processed 163,000 materials

The work room where processing takes place is not designed to accommodate large numbers of materials efficiently

The number of materials processed is continuing to grow

### Proposed Layout Plan for Library Materials Processing Areas



#### Problems Identified

- Material handling issues
- Cluttered work areas
- Inefficient process/workflow
- Outdated furniture and equipment
- Storage spaces not being utilized effectively

#### Proposed Solutions

New ergonomically correct furniture, up to date equipment, a more efficient process and a new layout with better usage of space was proposed.

#### Implementing proposed changes will:

- Accommodate future processing needs
- Utilize space more effectively
- Save processing time
- Increase safety
- Improve staff morale

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# Operating Room Turnover Efficiency

**Investigators:** Chris Phillips, Melissa Kram,  
Chris Opskar, Randy Merkle.

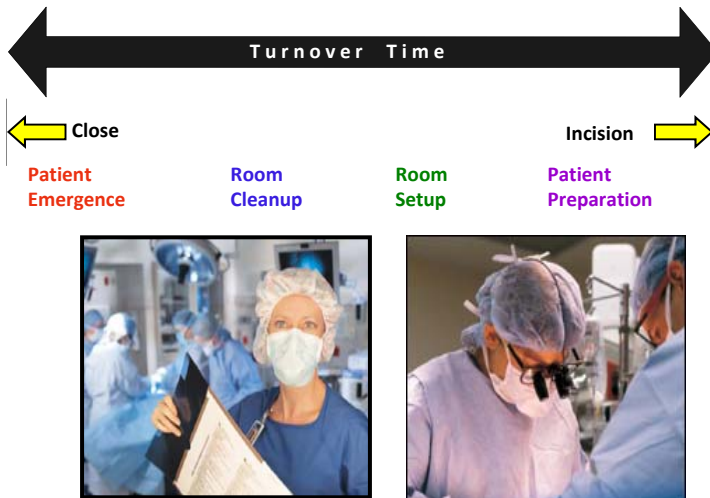
**Faculty Advisor and Consultant:** Reza Maleki  
Email: [Reza.Maleki@ndsu.edu](mailto:Reza.Maleki@ndsu.edu).

**Department:** Industrial and Manufacturing Engineering

**Funding Source:** MeritCare

## RESEARCH PROJECT OBJECTIVE

To determine and propose methods to minimize the operating room downtime and recommend ways to improve efficiency and turnover rates.



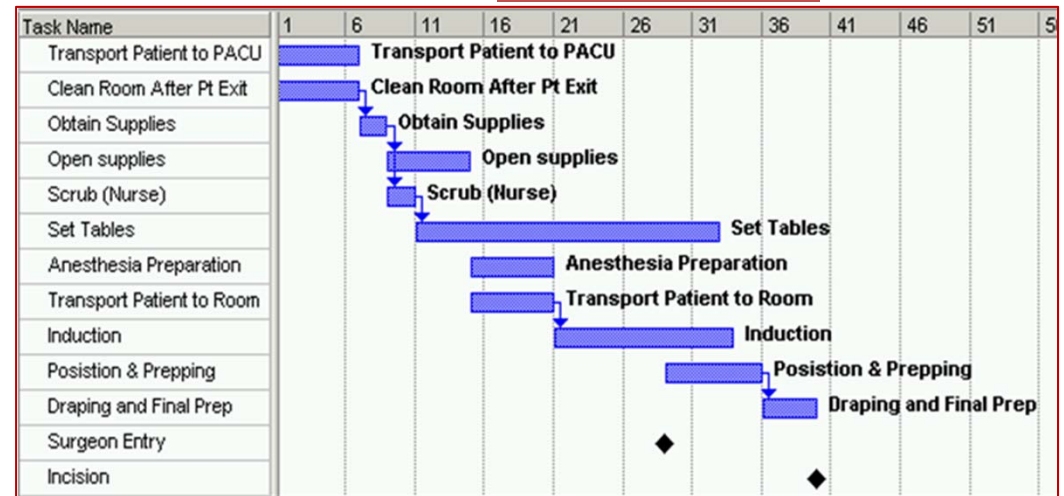
## RECOMMENDATIONS:

- Early Patient Entry
- Local Certified Registered Nurse Anesthetist (CRNA)
- Front Loaded Anesthesia
- Redefining Patient Transportation

## RECOMMENDATIONS INVOLVE:

- Parallel processing
- Reducing wait time and wasted time
- Redefining staff roles

## Proposed Process



## PROJECT TEAM DELIVERABLES

- Documentation of the current turnover process of the operation room suites
- Document with recommendations for improving operating room suites
- Documentation providing cost benefit analysis for the proposed improvements
- An outline of recommendations for future projects and further improvements

## PROJECT BENEFITS:

- Implementation costs negligible
- Possible additional cases & revenue
- Increased surgeon satisfaction

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## Error Rate Reduction in Order Picking

**Project Team Members:** Andrea McGhan,  
Ben Ostarello, Adam Jones, Sun Ho Nam.

**Faculty Advisor and Consultant:** Reza Maleki  
Email: [Reza.Maleki@ndsu.edu](mailto:Reza.Maleki@ndsu.edu).

**Department:** Industrial and Manufacturing Engineering

**Funding Source:** Swanson Health Products

### Research Project Objective

The objective of this project was to improve the quality inspection process for order picking.

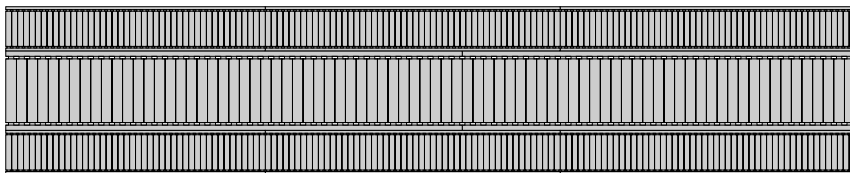
### Project Team Deliverables

Provide Documentation for:

- ❑ Current process used for picking orders and quality inspection
- ❑ Recommendations for improving picking order process and quality inspection
- ❑ Recommendations for an improved order picking layout
- ❑ Cost benefits analysis for the proposed improvements
- ❑ Recommendations for future projects and further improvements

B1	B2	B3	B4	B5	B6	B7	B8	B9	B10	B11	B12	B13	B14	B15	B16	B17
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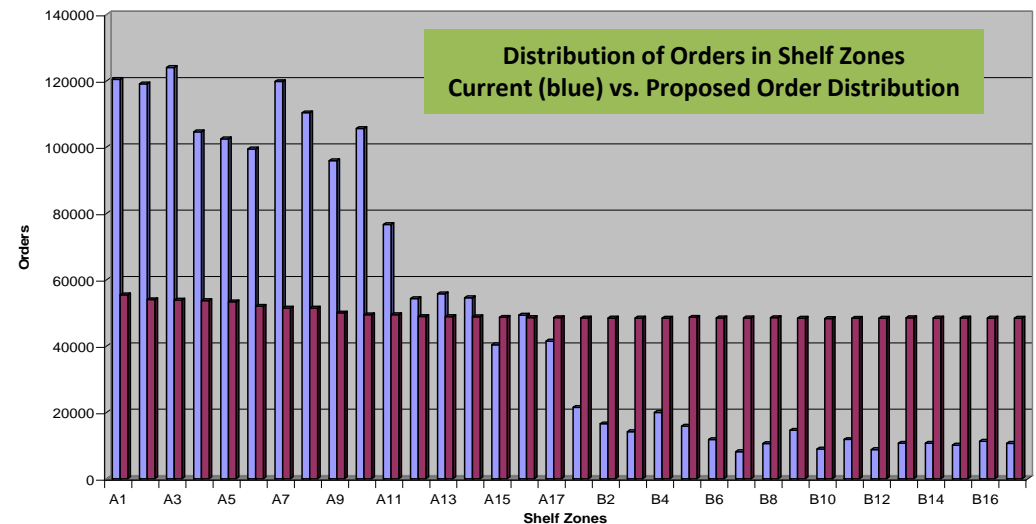
### Order Picking Layout



A1	A2	A3	A4	A5	A6	A7	A8	A9	A10	A11	A12	A13	A14	A15	A16	A17
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### Quality Assurance Alternatives

- ❑ Solution sought to replace current quality assurance methods and process
- ❑ Weight Scale is not best solution
- ❑ Alternatives:
  - Keep current inspection process but use fixed scanners
  - Begin eliminating inspection process
  - Best Solution: **Place quality into order picking process**



### Potential Benefits

- ❑ Implementing the proposed layout will decrease error rate by reducing operator fatigue and separating similar sized products.
- ❑ An in-line scanning system will put quality into the process and eliminate the existing quality inspection area.

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**WCCO Belting, Inc.**

## Improving Press Department Throughput

### Research Project Objective

Develop a proposals for improving the throughput of the press department while optimizing the number or operators through improved setup and operator interaction with the press equipment.

### Project Team Deliverables

Documentation of:

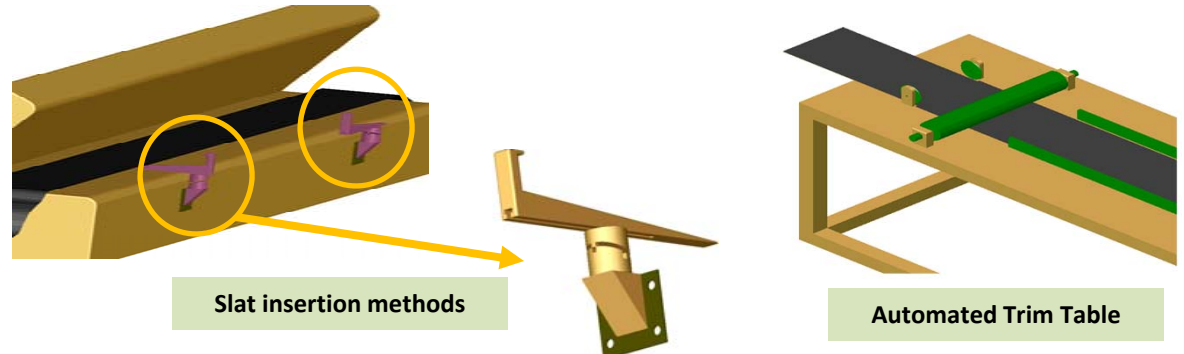
- Current methods of operations
- Improved methods and operator interface with press equipment
- Effective mix of products, people, and work-centers
- Economic analysis
- Recommendations for future projects

### The recommendations made included proposals for improving the following:

- Storage and retrieval of press plates.
- Slat insertion methods
- Trim operations
- Product/worker matrix

### Potential Benefits

- Reduce worker movement and time to perform operations. In turn, this can help with:
  - reduce employee turnover rate
  - reduce worker fatigue
  - reduce insurance premiums
- Increase press uptime
- Improve employee and production scheduling



**Project Team Members:** Phil Langevin , Karl Anderson, Josh Payne, Peter Ajo.

**Faculty Advisor and Consultant:** Reza Maleki  
Email: [Reza.Maleki@ndsu.edu](mailto:Reza.Maleki@ndsu.edu).

**Department:** Industrial and Manufacturing Engineering

**Funding Source:** Not Funded

Time available per shift (min)		420	<< excludes breaks and cleanup		
Product	Flat Stock, 14 oz Press 8	MRT 1003541 Press 8	Swather belt, rubber slat 1001551 Press 1	Swather belt, rubber slat 1001551 Press 6	Totals (Averages)
Annual demand	500	800	1200	2000	4500.0
Monthly demand	42	67	100	167	375.0
Weekly demand	10	15	23	38	
Daily demand	2.1	3.3	5.0	8.3	18.8
Percent of total sales	11%	18%	27%	44%	
Takt time (min/unit)	201.6	126.0	84.0	50.4	89.6
Operator cycle time	154.3	154.6	151.4	161.2	156.6
<b>Ideal # of operators</b>	<b>0.8</b>	<b>1.2</b>	<b>1.8</b>	<b>3.2</b>	<b>2.2</b>

\*Based on 5 section belts

**Product / Worker Matrix**

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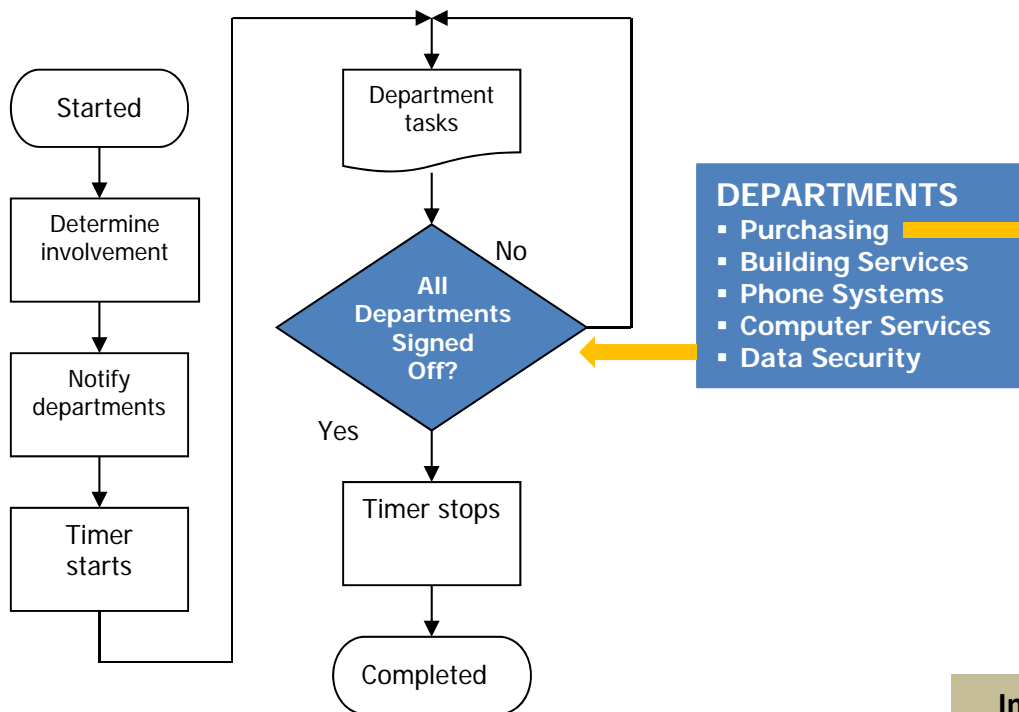
## Analysis of Service Work Order System

### RESEARCH PROJECT OBJECTIVE

The objective of this project was to document the current service work order (SWO) system's process, any employee concerns discovered during the interview process, and a formal submission of any potential improvements the group recommends.

### PROJECT TEAM DELIVERABLES

- ☐ Document describing existing SWO System process.
- ☐ Document detailing user feedback obtained during department interviews.
- ☐ Document detailing group recommendations.



**Project Team Members:** Deb Longtine, Bekki Majerus, Lucas Graunke, Tasha Hoffman.

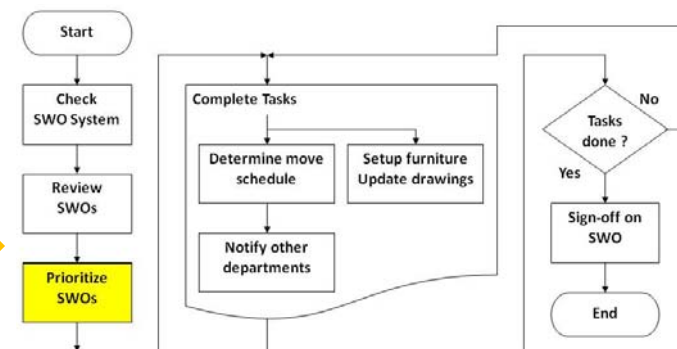
**Faculty Advisor and Consultant:** Reza Maleki  
Email: [Reza.Maleki@ndsu.edu](mailto:Reza.Maleki@ndsu.edu).

**Department:** Industrial and Manufacturing Engineering

**Funding Source:** Noridian Administrative Services

### RECOMMENDATIONS

- ☐ Hire SWO System Coordinator
  - ✓ Coordinate department schedules
  - ✓ Minimize overtime
  - ✓ Quality management
  - ✓ Avenue for voicing concerns
- ☐ Only notify involved departments
- ☐ Improve communication between departments
  - ✓ SWO team attitude



### Potential Benefits

The recommendations should:

- ☐ Contribute to boosting employee moral and satisfaction with the current SWO System
- ☐ Better departmental coordination
- ☐ Minimizing overtime due to imperfect scheduling

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