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# Brake assembly bench part set up and part presentation

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# Creative Inquiry

## Meritor Brake Assembly Bench Part Setup and Part Presentation



# MERITOR

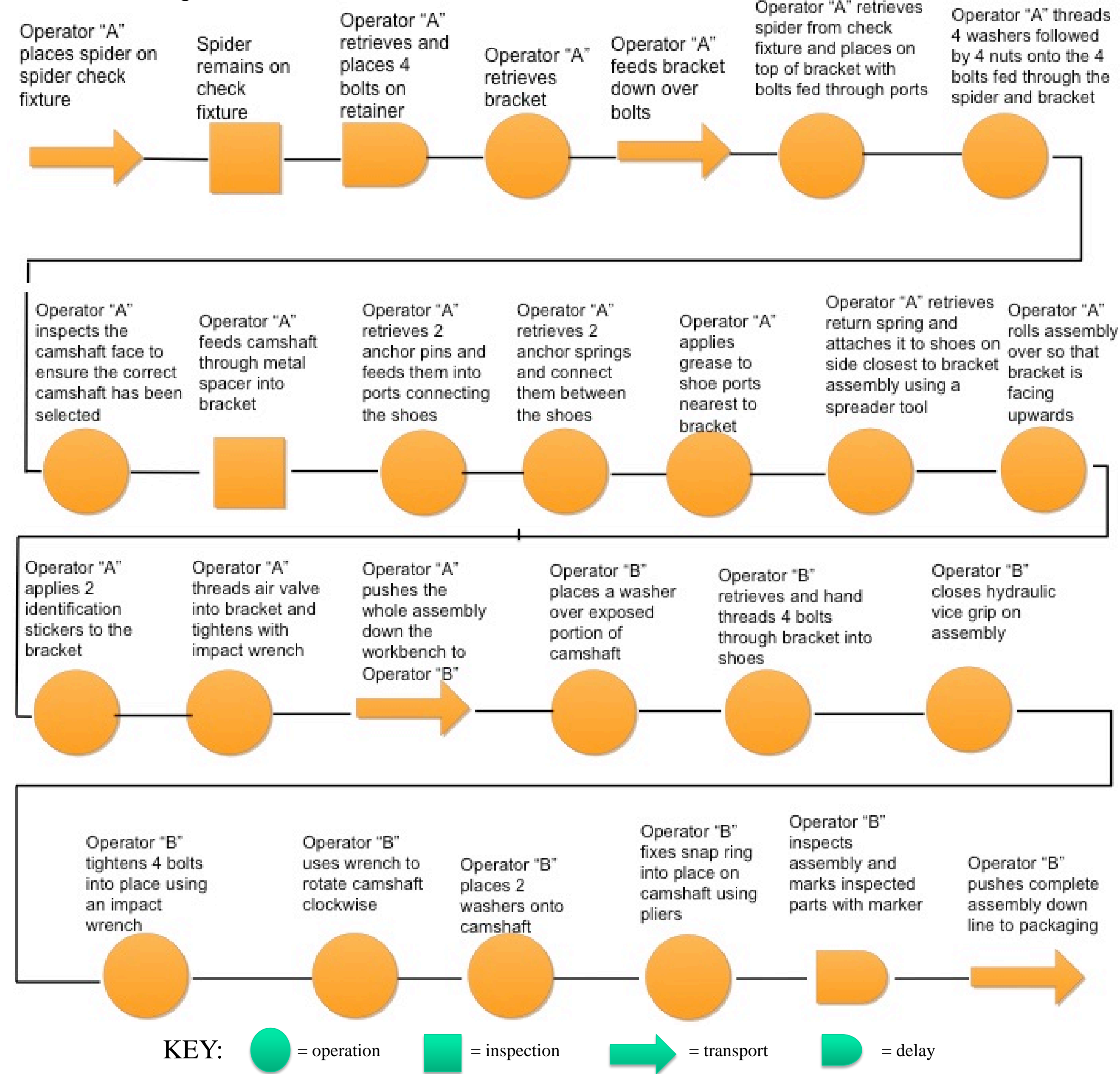
Brett Barry, William Rogers, Jacquelin Smolinski, Kristin Vanest

### ABSTRACT

In partnership with Meritor, this project focused on improving the part presentation and downtime losses of the current brake assembly process. The way in which the parts are currently presented to an operator causes an ergonomic strain on the worker, which is not ideal for production, resulting in worker downtime losses and an inefficient build rate. The Rapid Upper Limb Assessment (RULA) was conducted to ensure the ergonomic strain on the worker remains at an acceptable level. As a result of performing two fishbone diagrams on the downtime and ergonomic strain, the team quantified the system losses by the amount of time lost and quantified harmful motions by conducting a RULA assessment. Based on the findings of the Pareto chart and utilizing various Industrial Engineering tools, the team was able to provide solutions to reduce the amount of downtime while also ensuring the motions of workers remain ergonomically safe.

### INTRODUCTION

Meritor manufactures automobile components for military, trucks, and trailers. The Meritor plant located in Manning, South Carolina is where the team will focus their attention. The Manning facility alone is responsible for supplying brake assemblies for 70% of class 8 vehicles (tractor trailer trucks) on the road in North America. The scope of the project deals with the brake assembly bench setup and part presentation. The team determined two quantifiable business goals in order to address the scope of the project, decrease downtime by 10% and reduce RULA scores to less than or equal to 4.

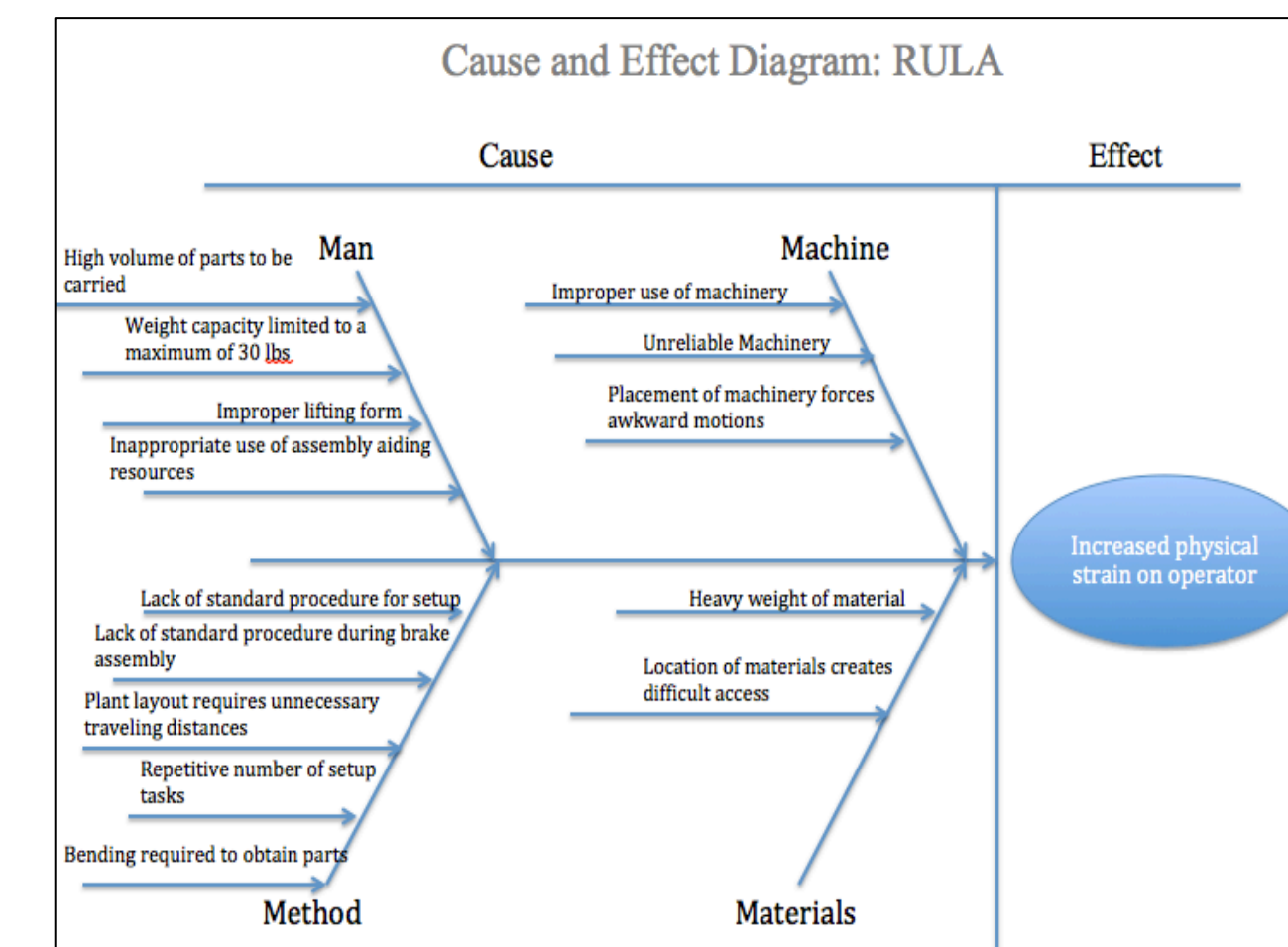
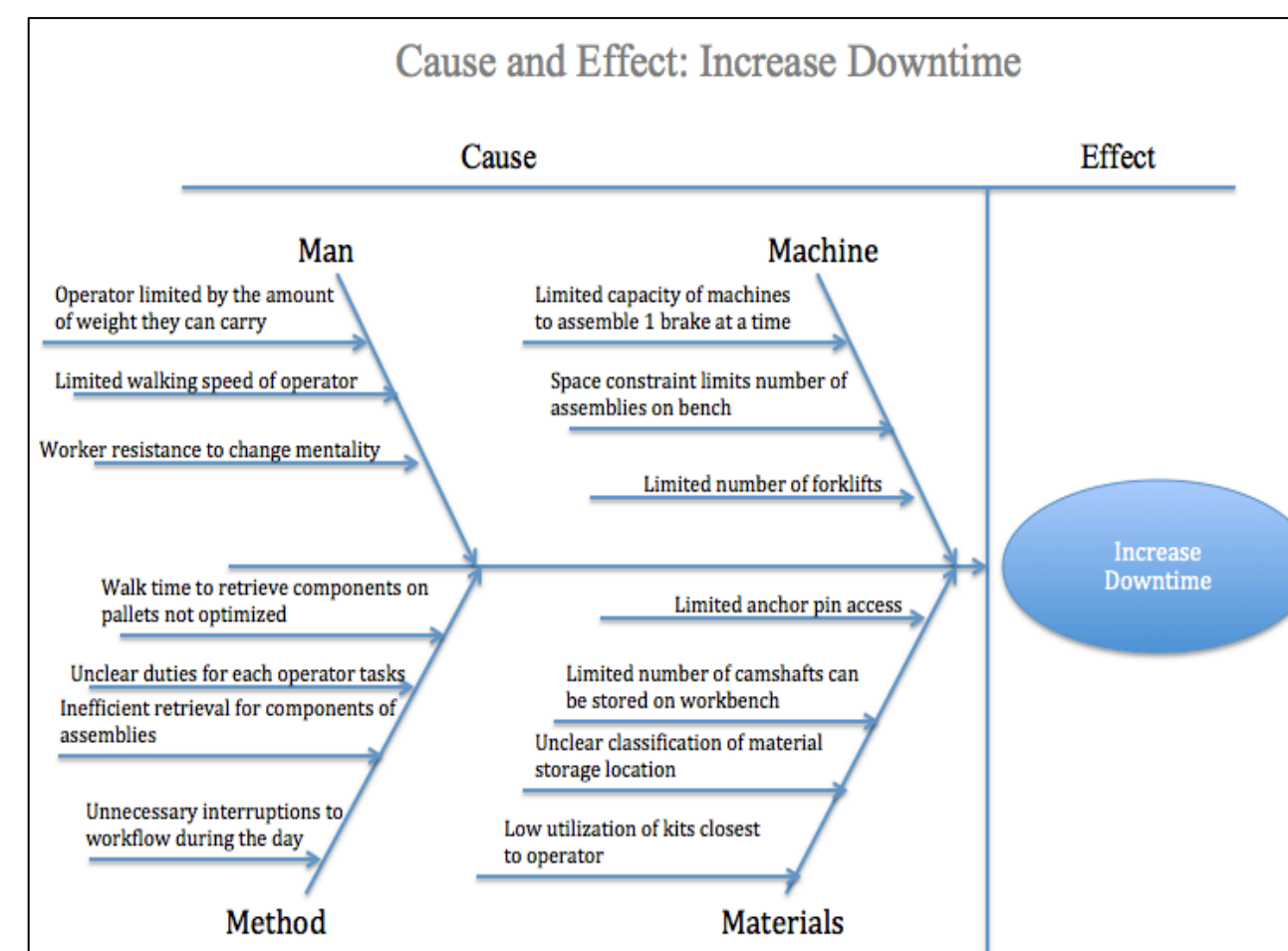


The above flowchart displays the progression of the brake assembly throughout the system. The flowchart was necessary because it allowed the team to understand the system as a whole and identify where system losses were occurring.



### METHODOLOGY

- Created mission statement and determined the two quantifiable business goals:
- Determined operator likes and dislikes about the system
- Translated operator likes and dislikes into needs
  - Interviews, surveys, observations, time studies
  - Categorize needs into an affinity diagram
- Translated needs into metrics and determined marginal and ideal values
- Identified system losses and conducted time studies to quantify the losses
- Conducted root cause analysis of both quantifiable business goals using fishbone diagram to determine latent causes and categorize causes into 4 main categories for concept generation
- Created two Pareto diagrams to focus attention on top 80% of those responsible for losses
- Generated concepts to address system losses
- Selected concepts that improved the losses using concept screening matrices

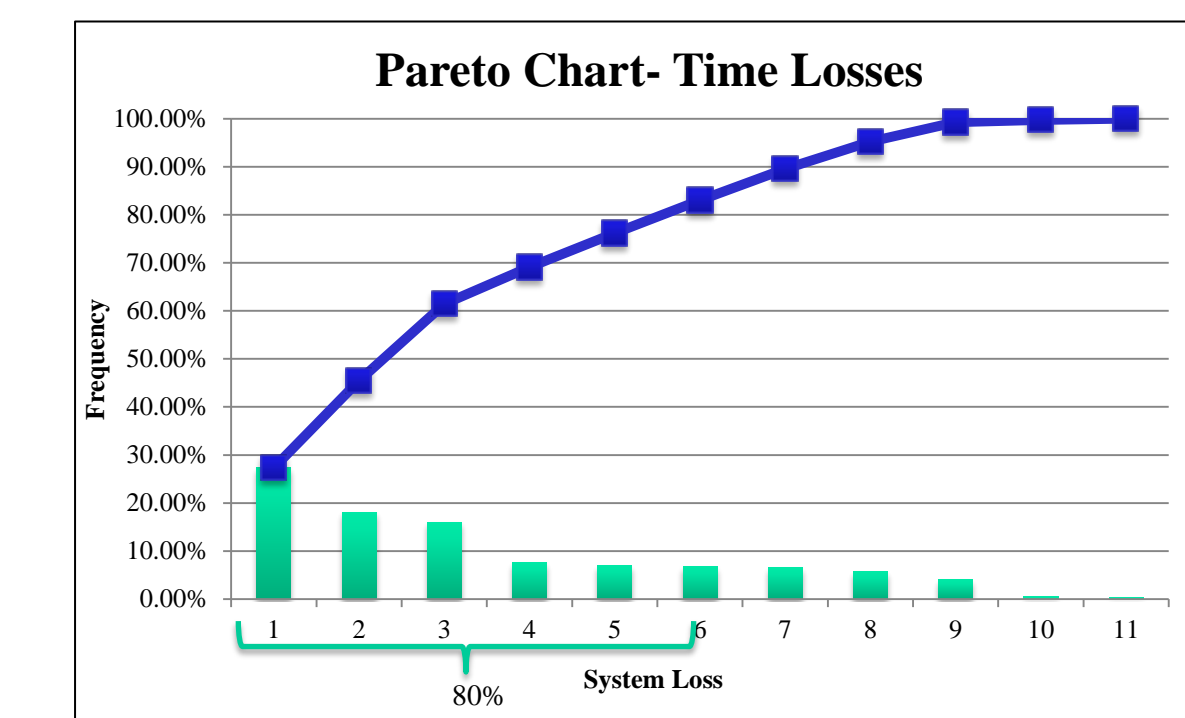


The fishbone diagram allowed the team to use the knowledge gained through observing the to brainstorm contributing factors to system loss. By decomposing the process by broad categories the team was better able to identify factors that required improvement. The team determined that the most effective breakdown of the process would be based on man, machine, method, and materials.

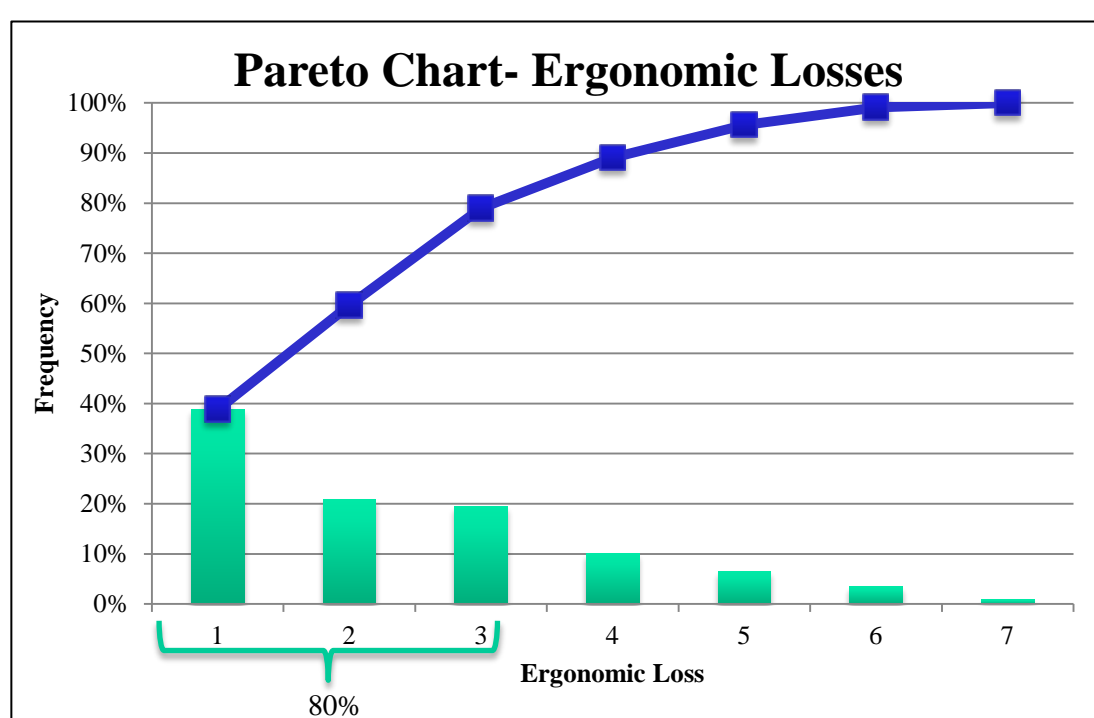
System Loss	Frequency/bench	Magnitude	Frequency*Magnitude
Set Up Camshaft Time	250/day	6.271 seconds	1567.75 seconds
Improperly packaged parts	118/day	8.78 seconds	1036.04 seconds
walk time for spiders	250/day	3.67 seconds	917.5 seconds
Leave cell to move plywood shelf	27/day	16.255 seconds	438.885 seconds
walk time for brackets	7/day	1.62 seconds	405 seconds
Retrieve Anchor Pins	250/day	55.797 seconds	390.579 seconds
reworks	2/day	188.26 seconds	376.52 seconds
downtime from line backup	22/day	14.68 seconds	322.96 seconds
Inspection of assembly	4/day	58.34 seconds	233.36 seconds
waiting for material handlers	1/day	26.22 seconds	26.22 seconds
refill grease bucket	0.20/day	72 seconds	14.4 seconds
<b>Total Time loss</b>			<b>5729.214 seconds</b>

System Loss (RULA)	Frequency/bench	Magnitude (RULA scale)	Magnitude* Frequency
Bending for camshaft setup	36/day	7	1500
Reaching for camshaft on shelf	250/day	3	805
Retrieving Spider from kit	130/day	3	750
Retrieving Spider from Bulk Bin	115/day	7	390
Picking up Shoes from pallet	250/day	6	252
Removing pallet sheet	27/day	5	135
Carrying anchor pins	7/day	5	35

The above charts are system losses for our two quantifiable business goals. The first pertains to the downtime system losses. The second chart pertains to the system losses according to RULA. The frequency refers to how often the loss occurs per day per bench. There are 12 benches at the Meritor plant pertaining to brake assembly process.



- KEY**
- Set Up Camshaft Time
  - Improperly Packaged Parts
  - Walk Time for Spiders
  - Leave Cell to Move Plywood Shelf
  - Walk Time for Brackets
  - Retrieving Anchor Pins
  - Reworks
  - Downtime From Line Backup
  - Inspection of Assembly
  - Waiting for Material Handlers
  - Refill grease bucket

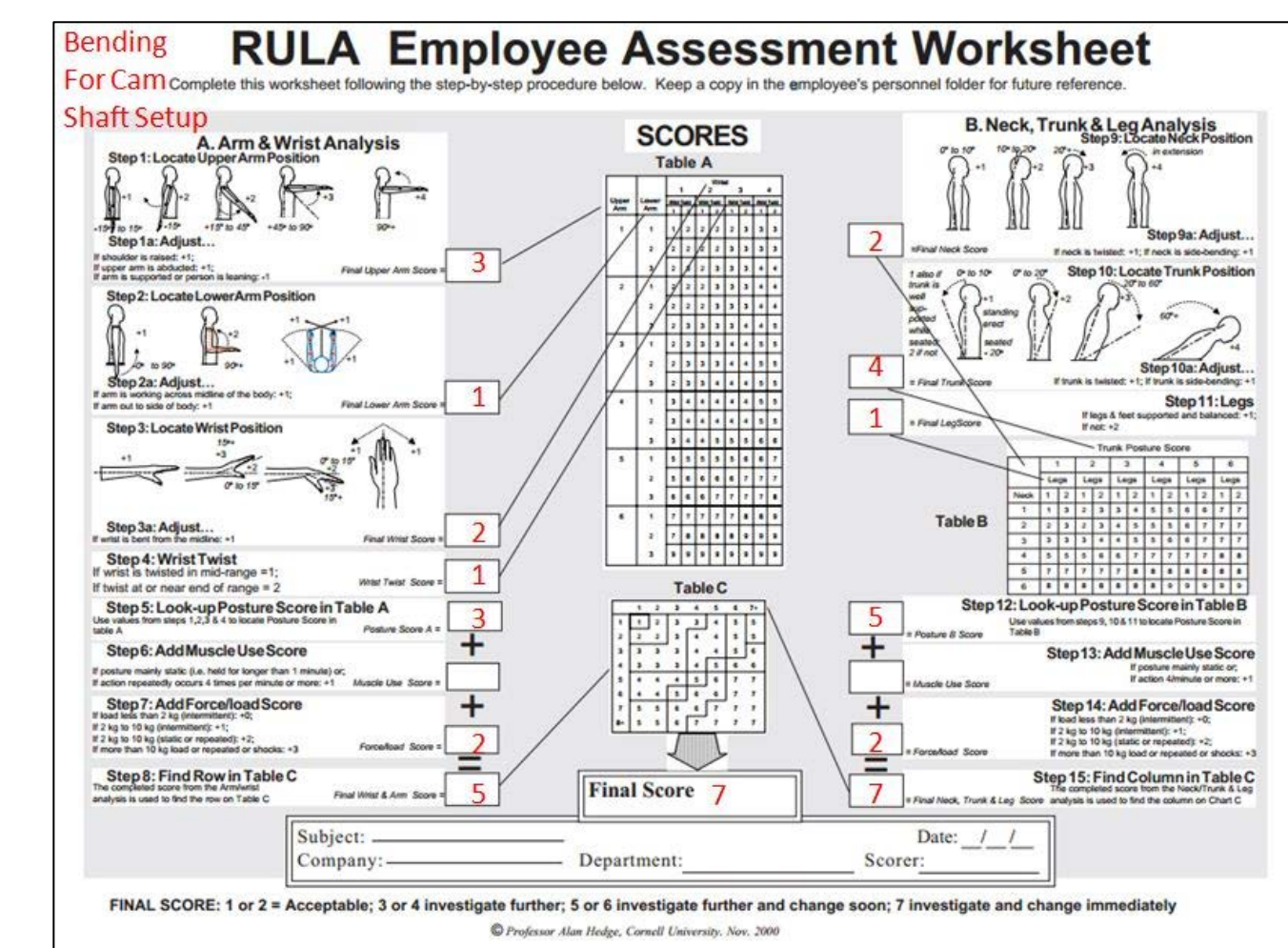


- KEY**
- Picking Up Shoes from Pallet
  - Retrieving Spider from Bulk Bin
  - Reaching for Camshaft on Shelf
  - Retrieving Spider from Kit
  - Bending for Camshaft Setup
  - Removing Pallet Sheet
  - Carrying Anchor Pins

The Pareto chart displays the system losses in a bar graph form in order from the highest percentage loss to the lowest. The Pareto chart allows for the accumulation of loss to be correlated with each individual factor. The magnitude and frequency of each system loss is multiplied and the percent effect of each loss is then compared. Typically the factors contributing to a cumulative of 80% loss are identified as necessary for focusing on throughout concept generation.

### RESULTS

The Pareto charts, fishbone diagrams, as well as the RULA worksheet, and performance evaluation matrix seen below helped the team narrow the scope prior to final concept generation. The RULA assessment helped the team identify motions such as the picking up shoes from pallet that pose a risk to the operator and need correction in any concept introduced. The performance evaluation matrix allowed the team to compare the projected performances of all of the concepts on a single matrix. The results of our concept generation and initial cost analysis were the elimination of solutions that fell outside of our budget of a return of investment within one year. These concepts ranged from the addition of a part prep station prior to assembly as well as the introduction of a conveyor belt to transport parts to the workbench.



KEY BUSINESS GOALS	CONCEPTS							
	A	B	C	D	E	F	G	H
Decrease Downtime by 10%	✓ +	✓ +	✓ +	✓ +	✓ +	✓ +	✓ +	✓ +
RULA score maintained	✓ +	✓ +	✓ +	✓ +	✓ +	✓ +	✓ +	✓ +
METRICS								
Number of Rotations	X	X	X	X	X	X	X	X
Workbench locations identifiable	X	✓	✓	X	✓	✓	✓	✓
Operator Satisfied with instructions	X	✓	✓	✓	✓	✓	✓	✓
Number of employees with assembly information	X	X	X	X	X	X	X	X
Minimize distance traveled in assembly area	✓ +	✓ +	✓ +	✓ +	✓ +	✓ +	✓ +	✓ +
CONCEPTS								
Hand cart for camshaft setup	X	X	X	X	X	X	X	X
Fix packaging software	X	X	X	X	X	X	X	X
Temporary storage location for plywood shelves	X	X	X	X	X	X	X	X
Hand carts for brackets	X	X	X	X	X	X	X	X
Hand cart and storage on bench	X	X	X	X	X	X	X	X
Pneumatic lift tables	X	X	X	X	X	X	X	X
Shelves on carts	X	X	X	X	X	X	X	X

### CONCLUSION

Quantifiable business goals: Decrease downtime by 10% and RULA score ≤ 4

8 Concepts:

- Hand cart for camshaft setup
- Fix packaging software
- Place spider bins closer and use pneumatic lift table
- Temporary storage location for plywood shelves
- Hand carts for brackets
- Handcart and storage on bench
- Pneumatic lift tables
- Shelves on carts

There is no one concept that will satisfy all of the metrics and product specifications. Several concepts will be combined in order to meet the quantifiable business goals.

### ACKNOWLEDGEMENTS

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