IMPROVING THE EFFICIENCY OF MANUFACTURING CELLS

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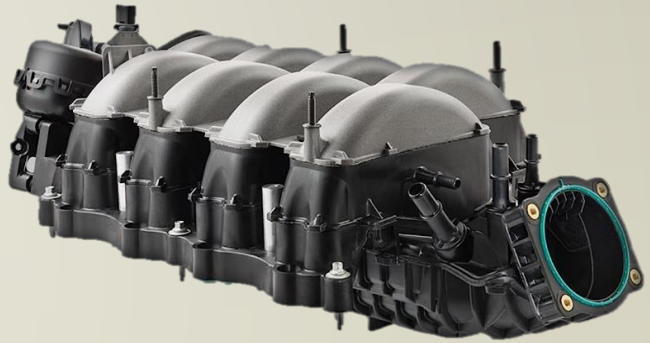
Agenda

- Company Background
- Cell Information
- Time Studies
- Stochastic Analysis
- Recommendations
- Conclusion
- Questions

Company Background

- Mann+Hummel
- Location: Portage, MI
- Tier 1 Automotive Supplier:
  - Ford, Toyota, GM, FCA
- Produces / Assembles:
  - Intake Manifolds
  - Air Induction Systems



Project Selection

Problems:

- Standard work is not frequently analyzed
- Processes change but times are not updated

Effects:

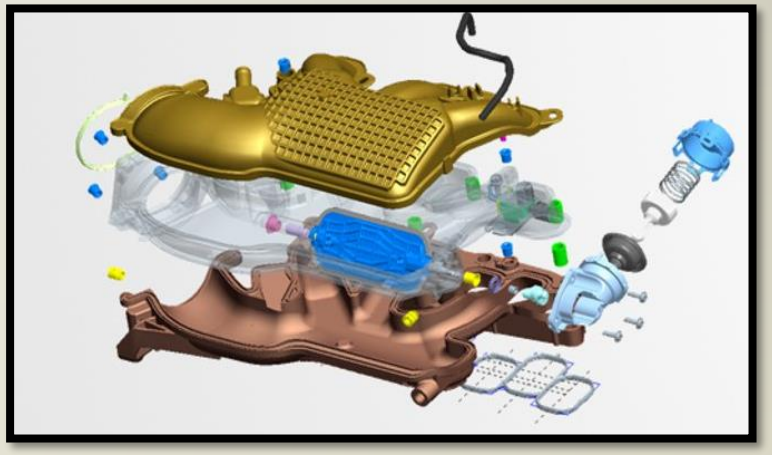
- Decreased production
- Increased labor costs
- Increased workplace stress

Cell Selection

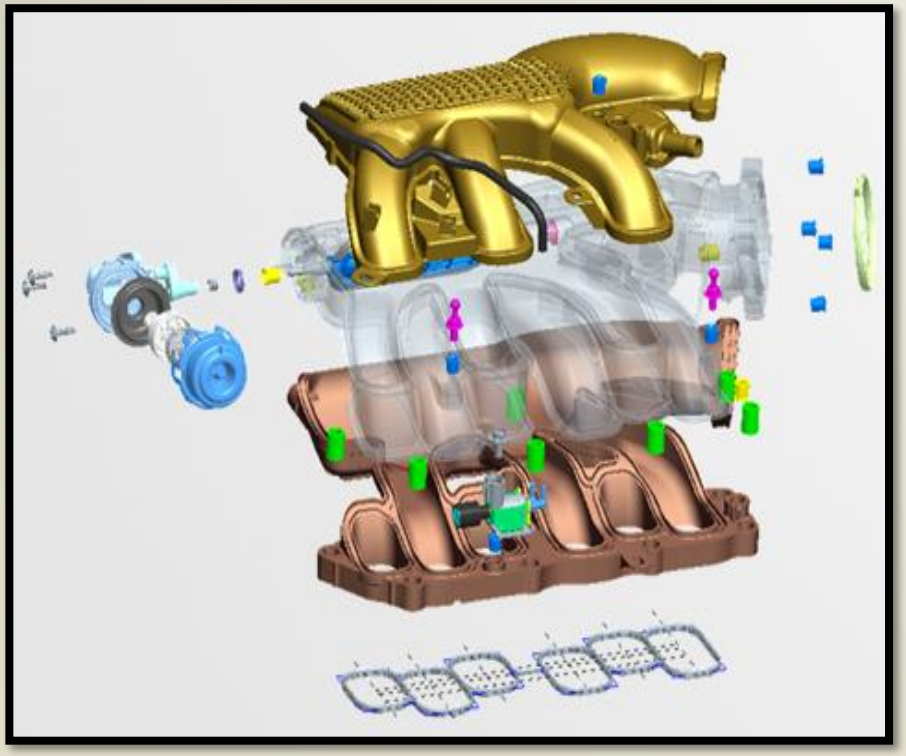
Cell	Program	Average OEE	Remainder Volume	Weighted Part %	Total Metric
301A	Program A	93.2%	958,800		$ 47,842,185
301B	Program A	83.3%			
	Average	88.2%			
311	Program B	93.5%	1,028,810	57.3%	$ 46,474,577
	Program B		698,350	38.9%	
	Program B		67,742	3.8%	
	Total Remainder Volume		1,794,902		
Cell G	Program C	79.3%	520,408	82.9%	$ 17,191,359
	Program C		107,358	17.1%	
	Total Remainder Volume		627,766		

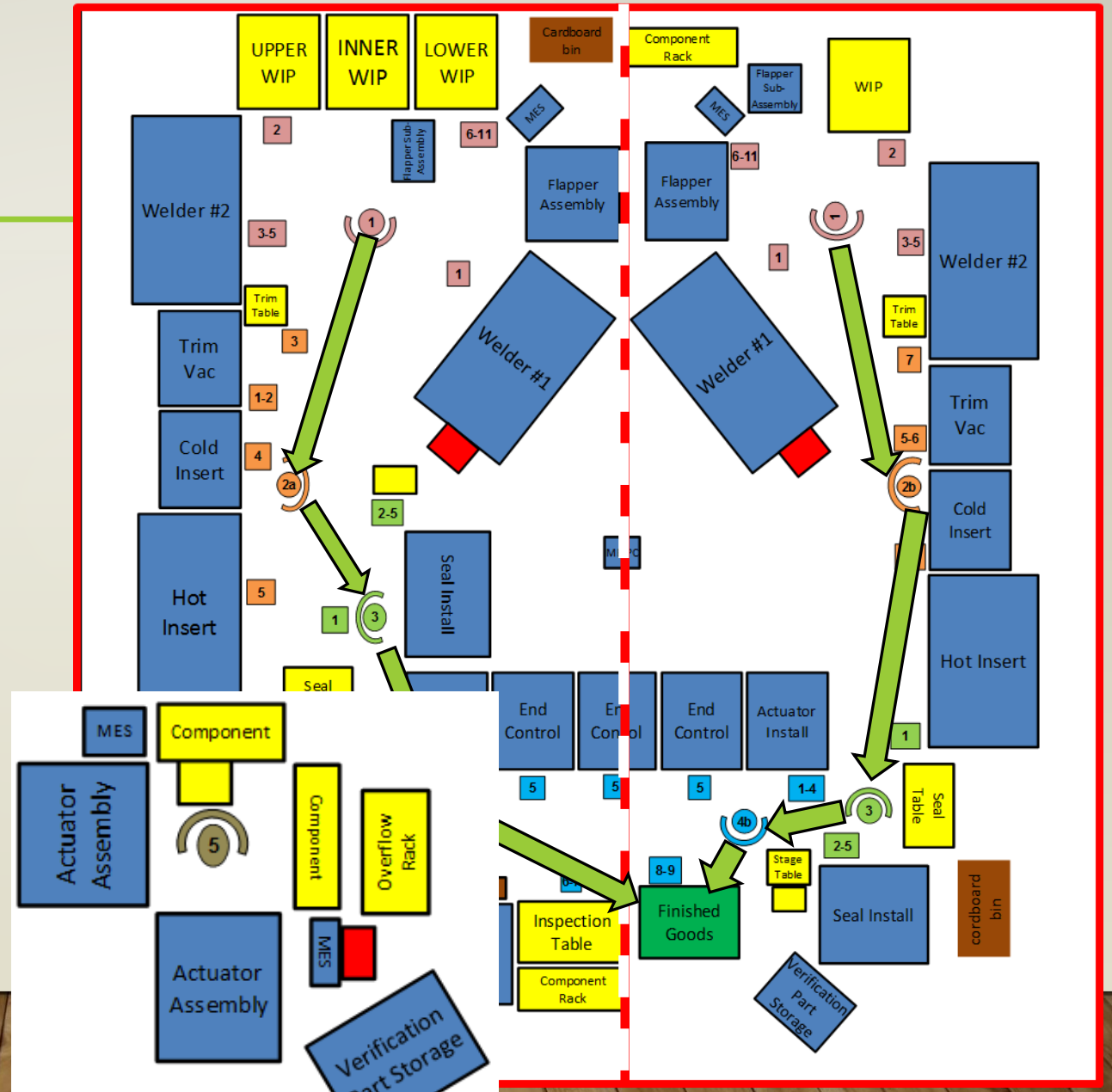
Cell 301

- Produces:
  - Air Intake Manifold
- Goes in:
  - Toyota Camry
  - Toyota Highlander



Cell 301

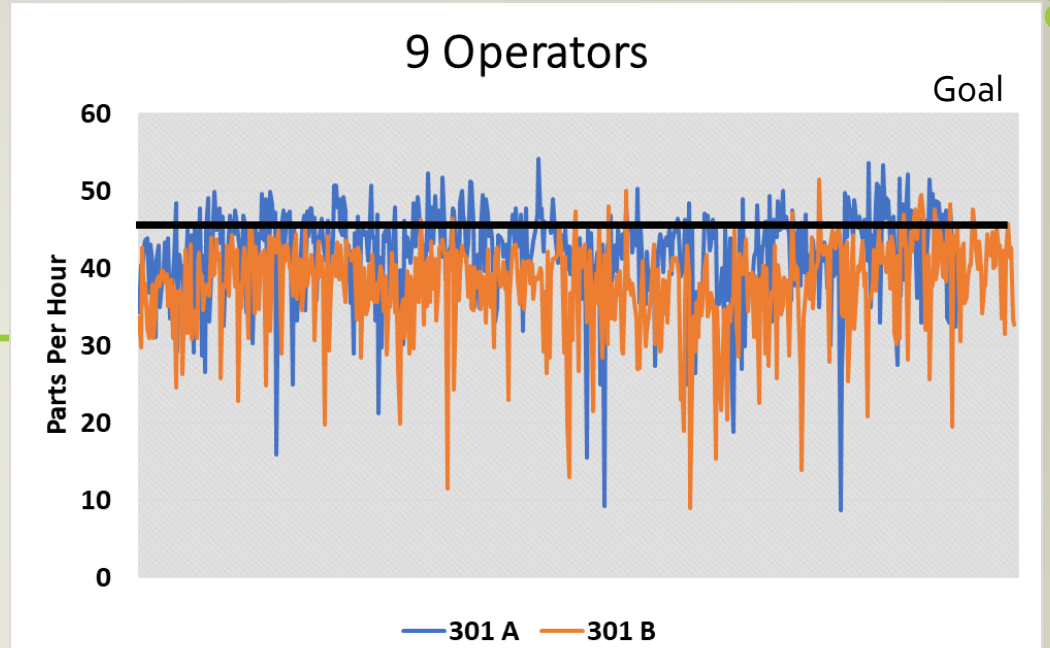


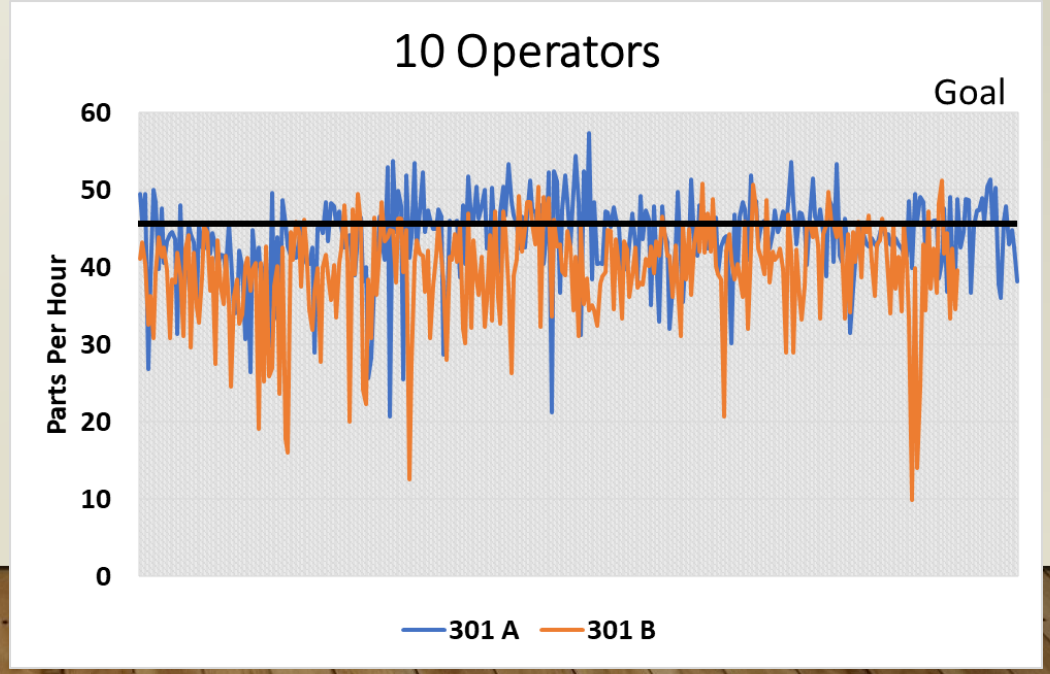

A-Side
B-Side
UPPER WIP
INNER WIP
LOWER WIP
Cardboard bin
Component Rack
Flapper Sub-Assembly
WIP
MES
Welder #2
Flapper Assembly
Welder #1
Trim Vac
Trim Table
Cold Insert
Hot Insert
Seal Install
Seal
End Control
Actuator Install
Inspection Table
Component Rack
Finished Goods
Seal Table
Stage Table
Verification Part Storage
cardboard bin
Actuator Assembly
Component
Overflow Rack

Historical Data Trends

2018/2019	Part Per Operator	
Operators	301A	301B
9	37	34
10	35	32

Hourly Goal: 45 Parts per Hour

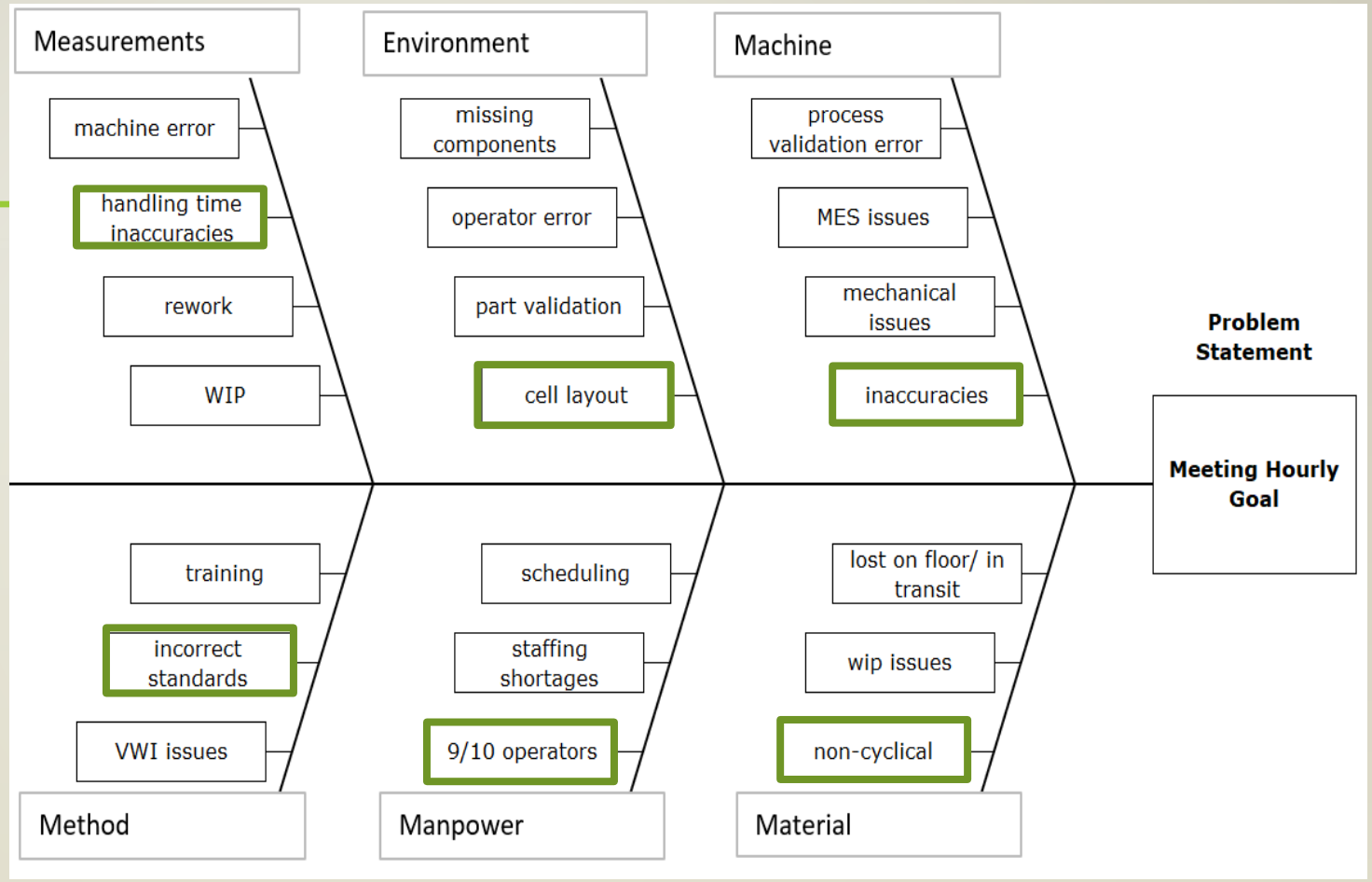




Project Goal

Increase profits through the reallocation of labor.

Root Cause Analysis



TIME STUDIES

Time Studies

Cyclical

- Handling Time (Assembly, Inspection, Packaging)
- Machine Time
- Wait Time

Non-Cyclical

- Moving Containers
- Refilling Component Bins

Existing Standard Work Charts

- Developed when the cell first launched (2015)
- are given as standard
- Validate element accuracy

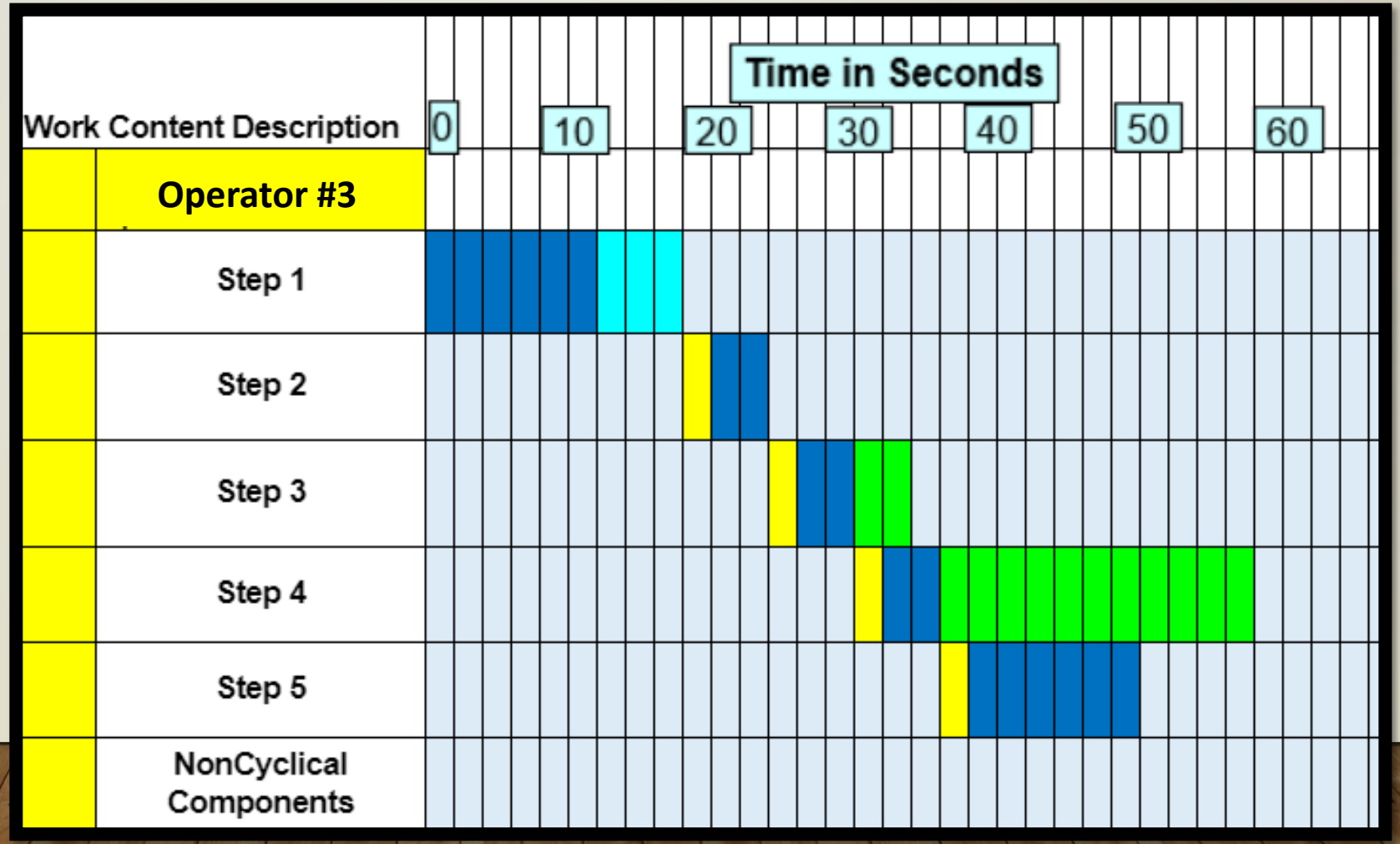
Steps	Process	Handling Time (sec)	Machine Time (sec)
	Operator # 1		
1	Unload welded shells from welder #1	6	
2	Retrieve upper shell. Preload upper onto welded inner/lower	6	
3	Unload welded manifold from welder #2. Stage part on staging table	5	
4	Load unwelded upper and welded inner/lower into welder #2 and cycle start	5	22
6	Unload inner and lower from flapper assembly station and load welder #1.	5	
7	Unload flapper sub-assembly station and load Load sleeve bearing	5	
8	Retrieve lower shell. Attach MES label. Load lower shell into right fixture	6	
9	Retrieve Inner shell	6	
10	Load inner shell into flapper sub-assembly station.	6	
11	Place part into oil nest to the left side of assembly station. Cycle start	6	15
	Operator # 2 Side A		
1	Load 7 cold limiters into limiter nests	10	
2	Load part from trim vac into cold limiter machine and cycle start machine.	6	8
3	Place part from stage table into trim vac machine (auto start)	5	6
4	Take part from cold insert machine and load into hot insert machine and cycle start	6	54
5	Remove part from hot insert station and place on stage table	5	

TIME STUDIES

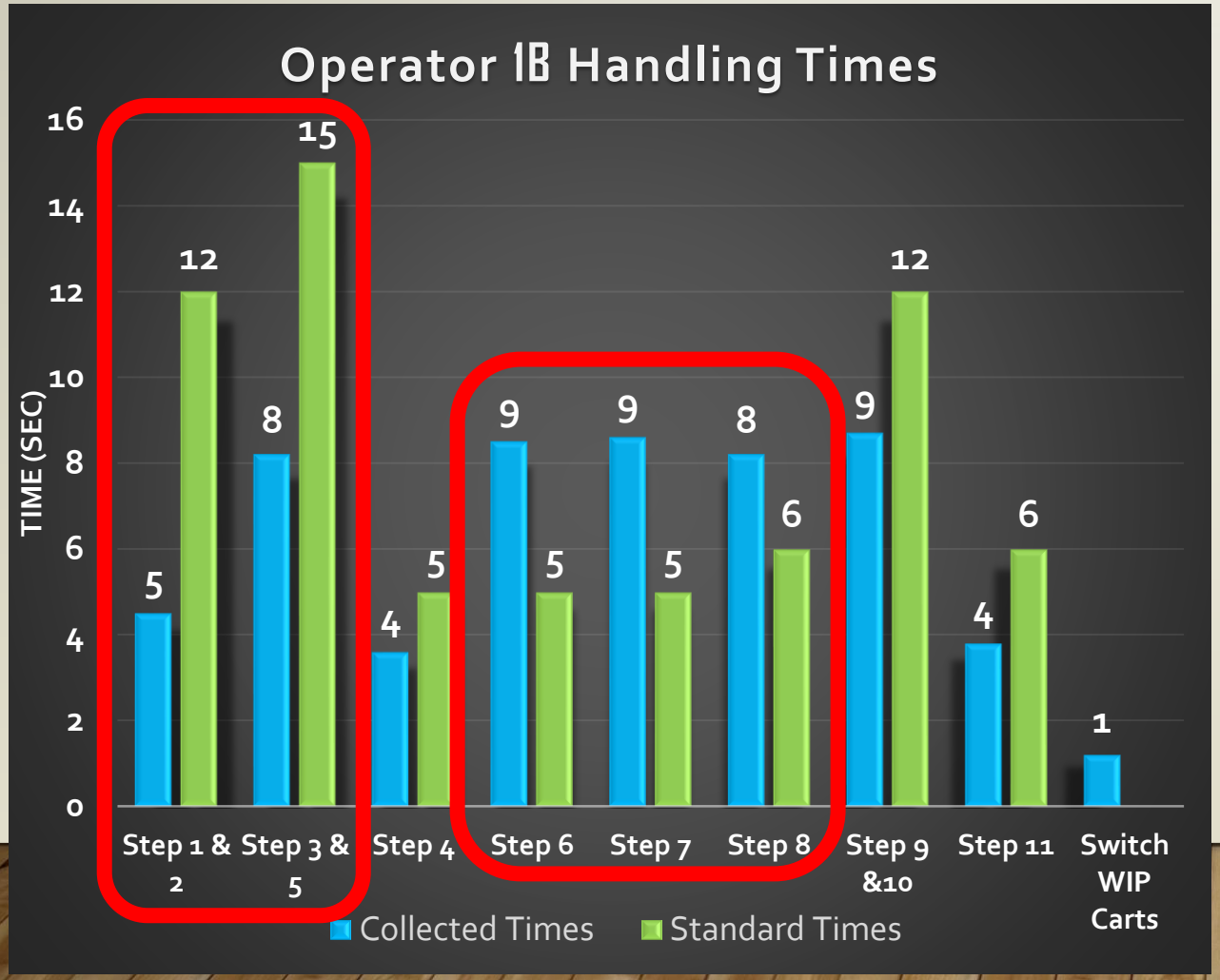
ELEMENT ACCURACY

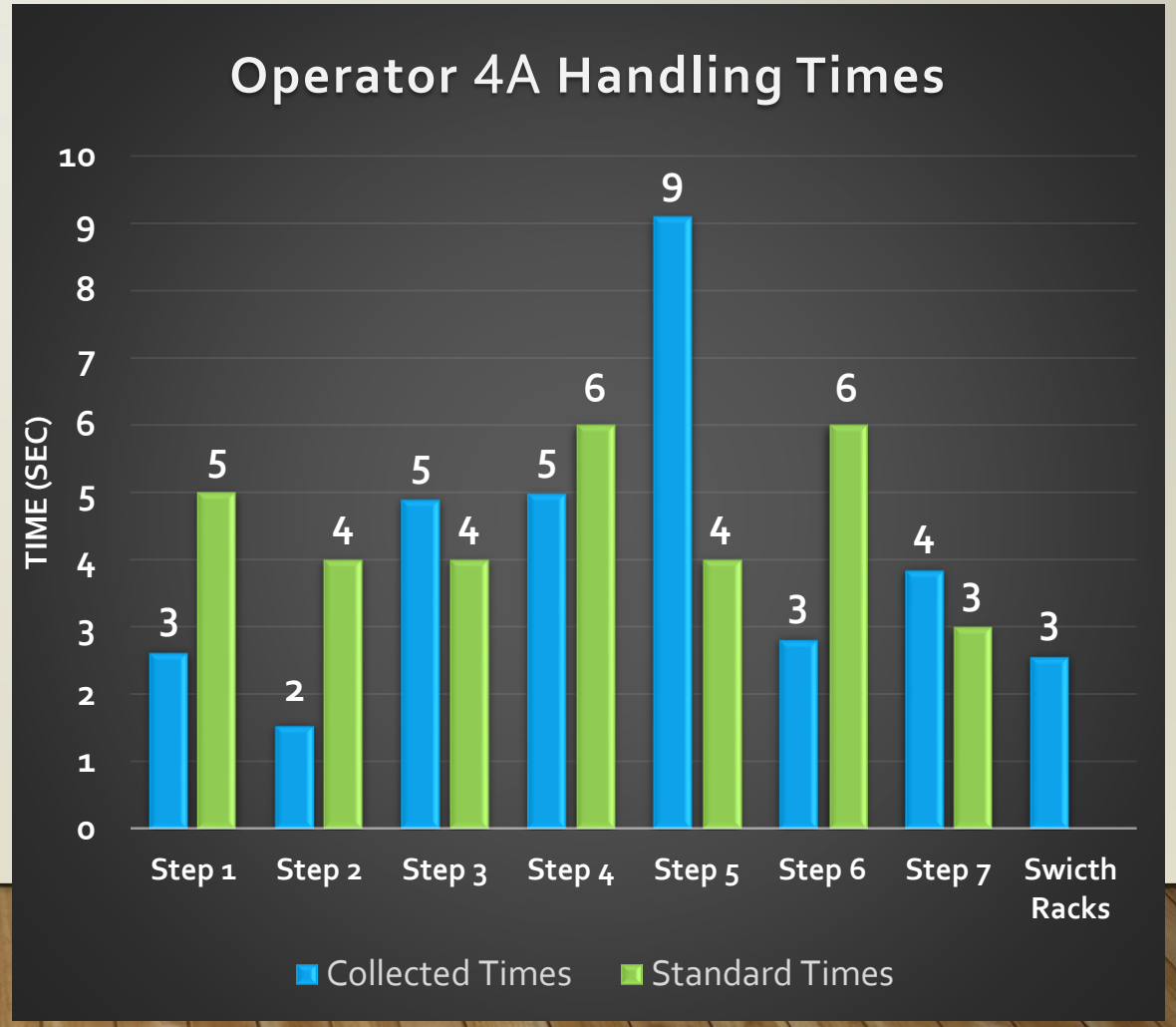
Man Machine Chart

Manual
Walking
Waiting
Automatic



Element Accuracy: Handling Times

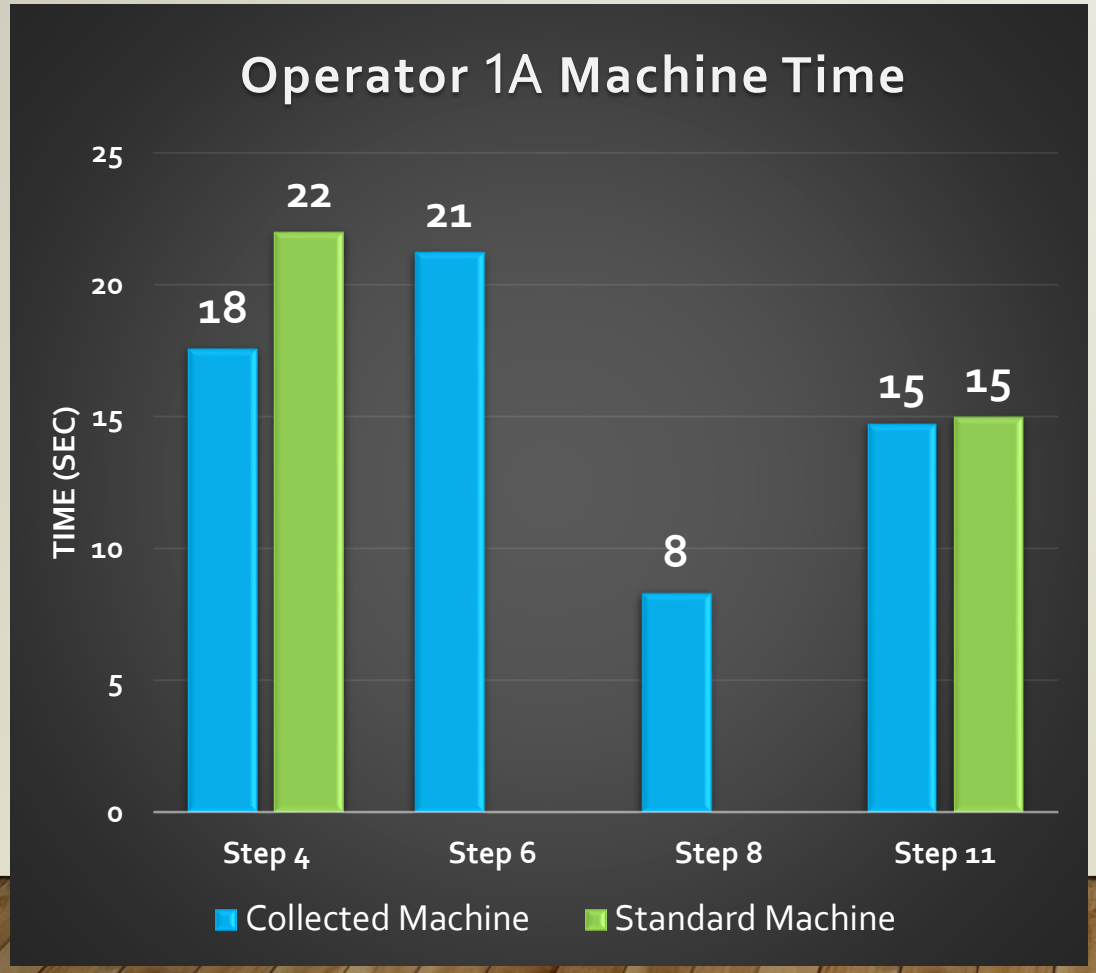


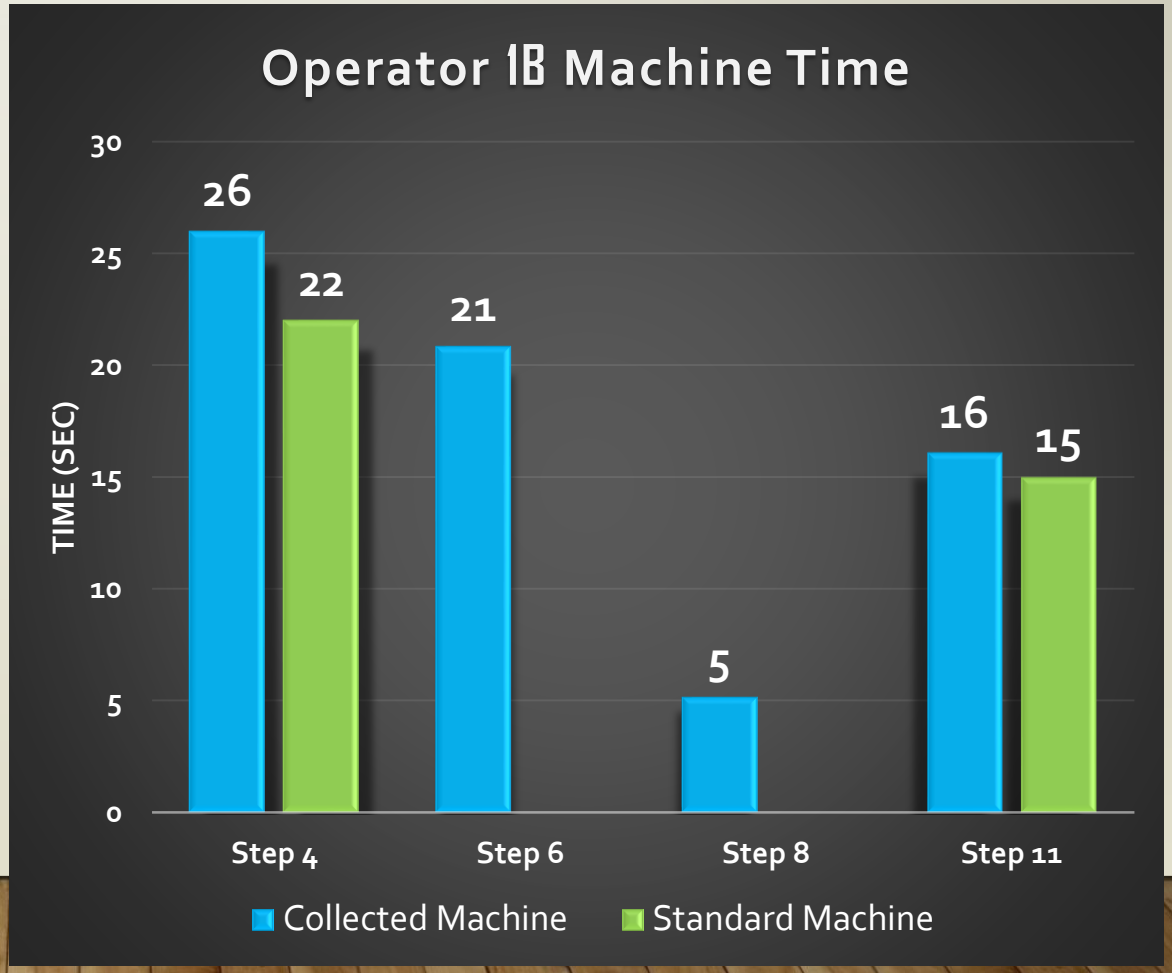


Element Accuracy: Handling Times

Standard Work Accuracy (Handling Times)			
	>20% Faster	Within 20% of Standard	>20% Slower
Number of Operations	25	10	11
Percentage of Operations	54%	22%	24%

Element Accuracy: Machine Times





Element Accuracy: Machine Times

Standard Work Accuracy (Machine Times)			
	>10% Faster	Within 10% of Standard	>10% Slower
Number of Machines	3	8	5
Percentage of Machines	19%	50%	31%

Number of Observations

$$N = \left(\frac{t_{a/2,n-1} \times s}{k \times x_{bar}} \right)^2$$

x_{bar}: sample mean

s: sample deviation

k: desired accuracy 90%

α: desired significance level 5%

n: size of sample

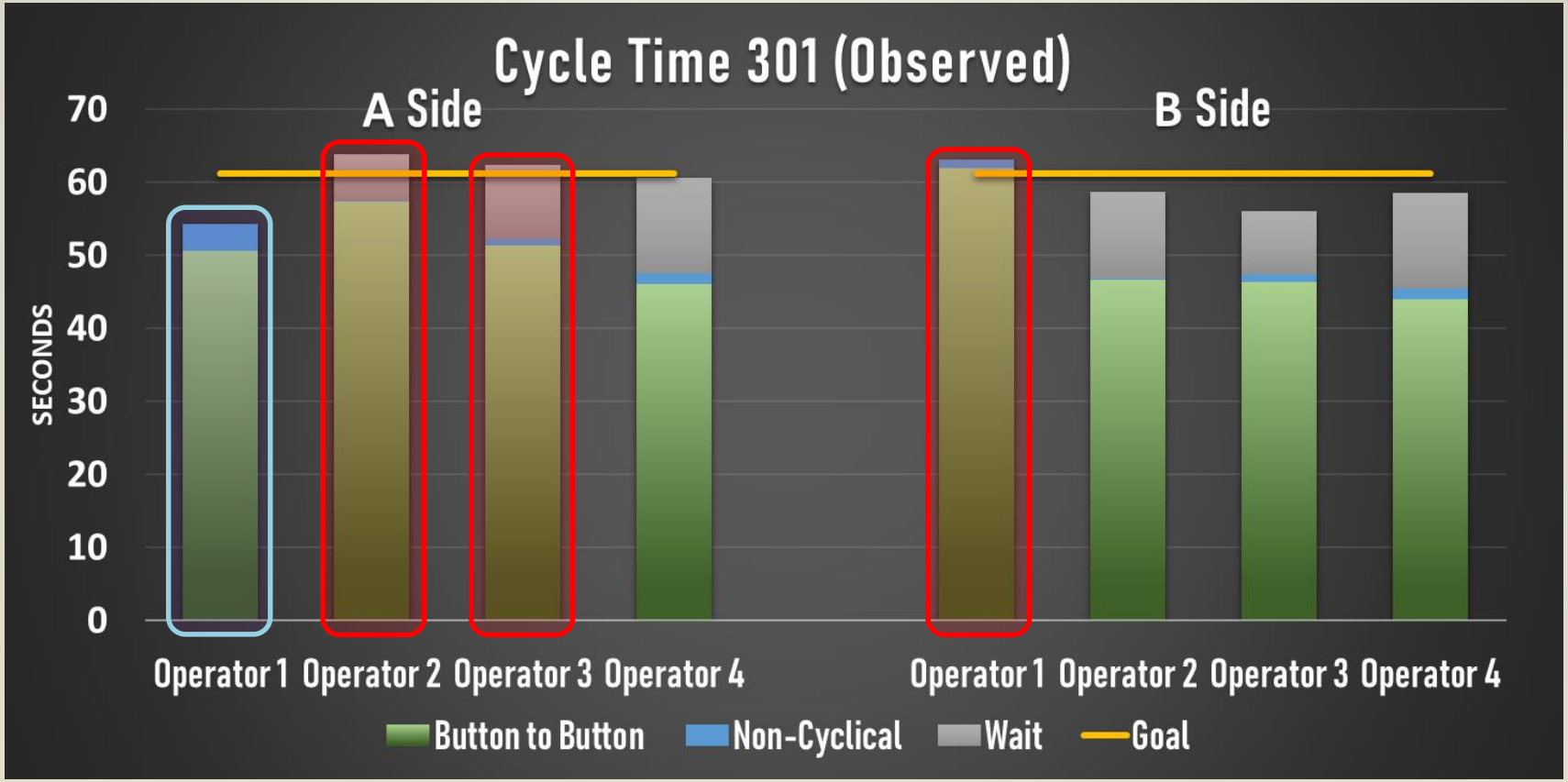
Cell 301 A Side	Operator 1	Operator 2	Operator 3	Operator 4
Observations Taken	22	14	12	19
Calc. Observations Needed	18	2	7	13

Cell 301 B Side	Operator 1	Operator 2	Operator 3	Operator 4
Observations Taken	9	15	14	13
Calc. Observations Needed	6	3	2	7

TIME STUDIES

CYCLE TIMES

Cycle Times


Cycle Time 301 (Observed)
A Side
B Side
SECONDS
70
60
50
40
30
20
10
0
Operator 1
Operator 2
Operator 3
Operator 4
Operator 1
Operator 2
Operator 3
Operator 4
Button to Button
Non-Cyclical
Wait
Goal

STOCHASTIC ANALYSIS

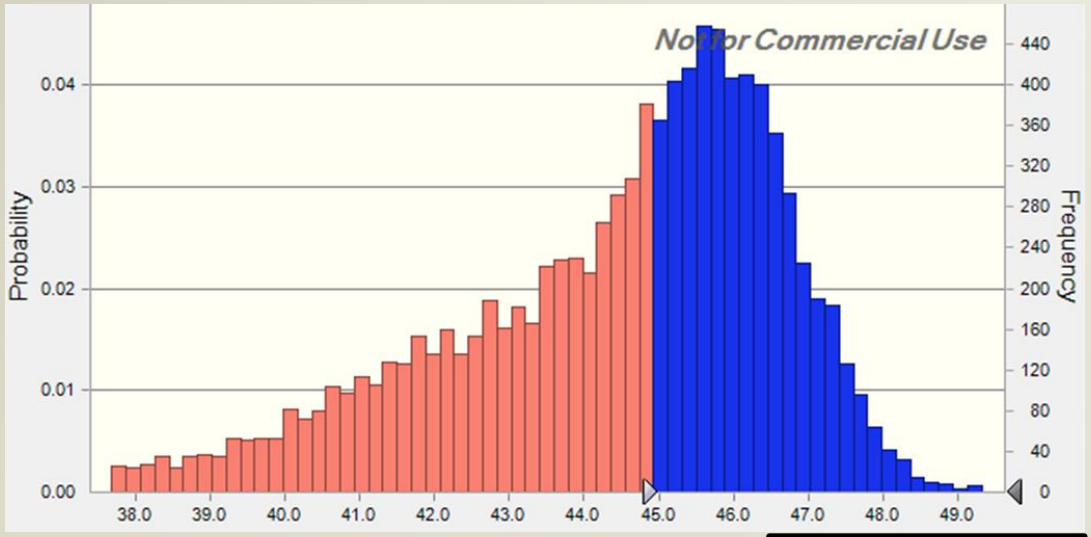
Parts Per Hour - Stochastic

Cycle Times	Normal Time		Standard Dev.
	Standard	Collected	
Operator 1	61.2	54.30	5.58
Operator 2	61.2	63.89	1.39
Operator 3	61.2	62.40	5.60
Operator 4	61.2	60.58	7.65

Max NT	61.2	63.9
Standard Time	69.2	72.3
Target PPH	52.0	49.8
Actual OEE PPH	48.4	46.3

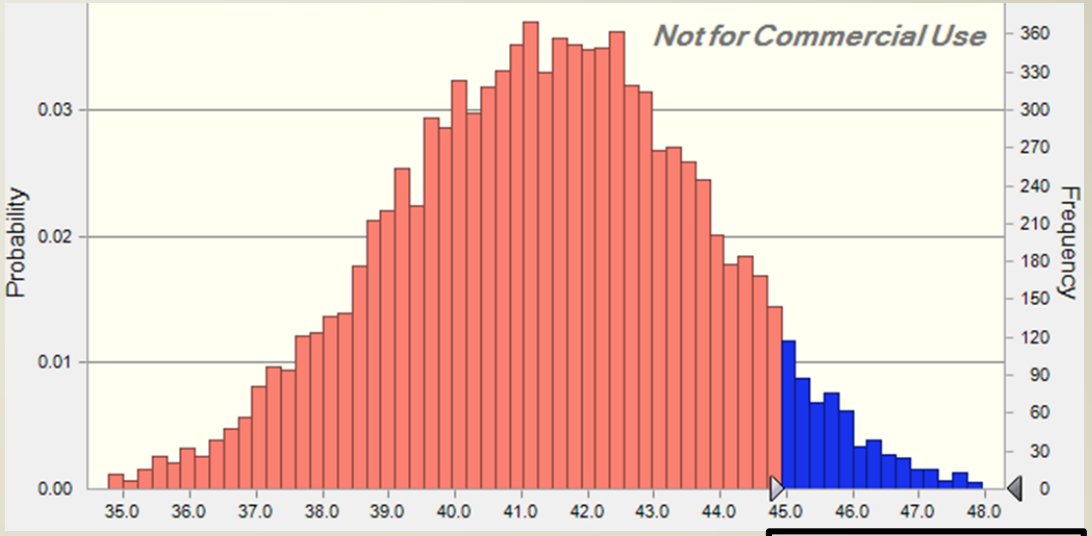
Parts Per Hour - Stochastic Cont.

A- Side



48.5%

B- Side

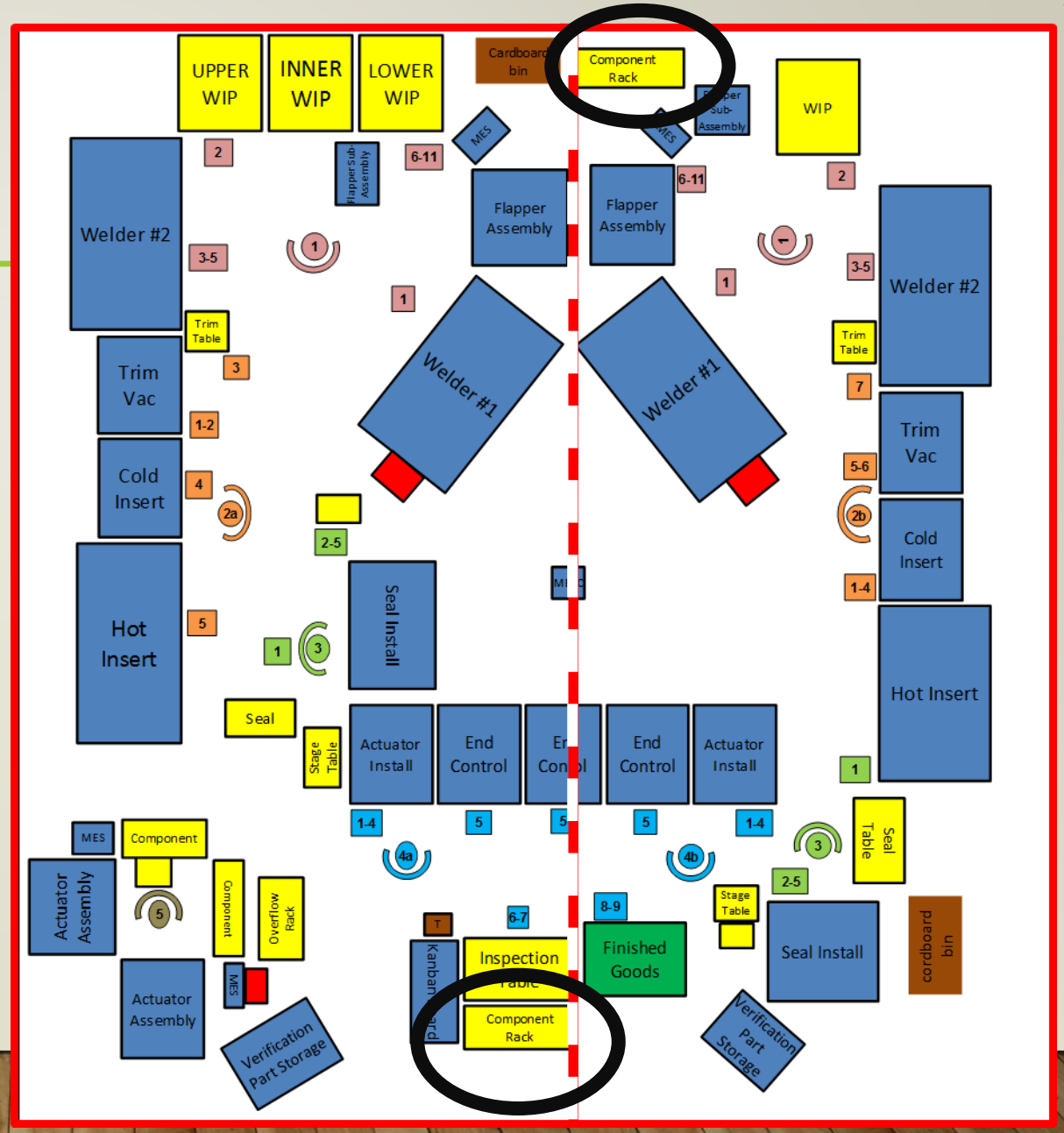


5.5%

RECOMMENDATIONS

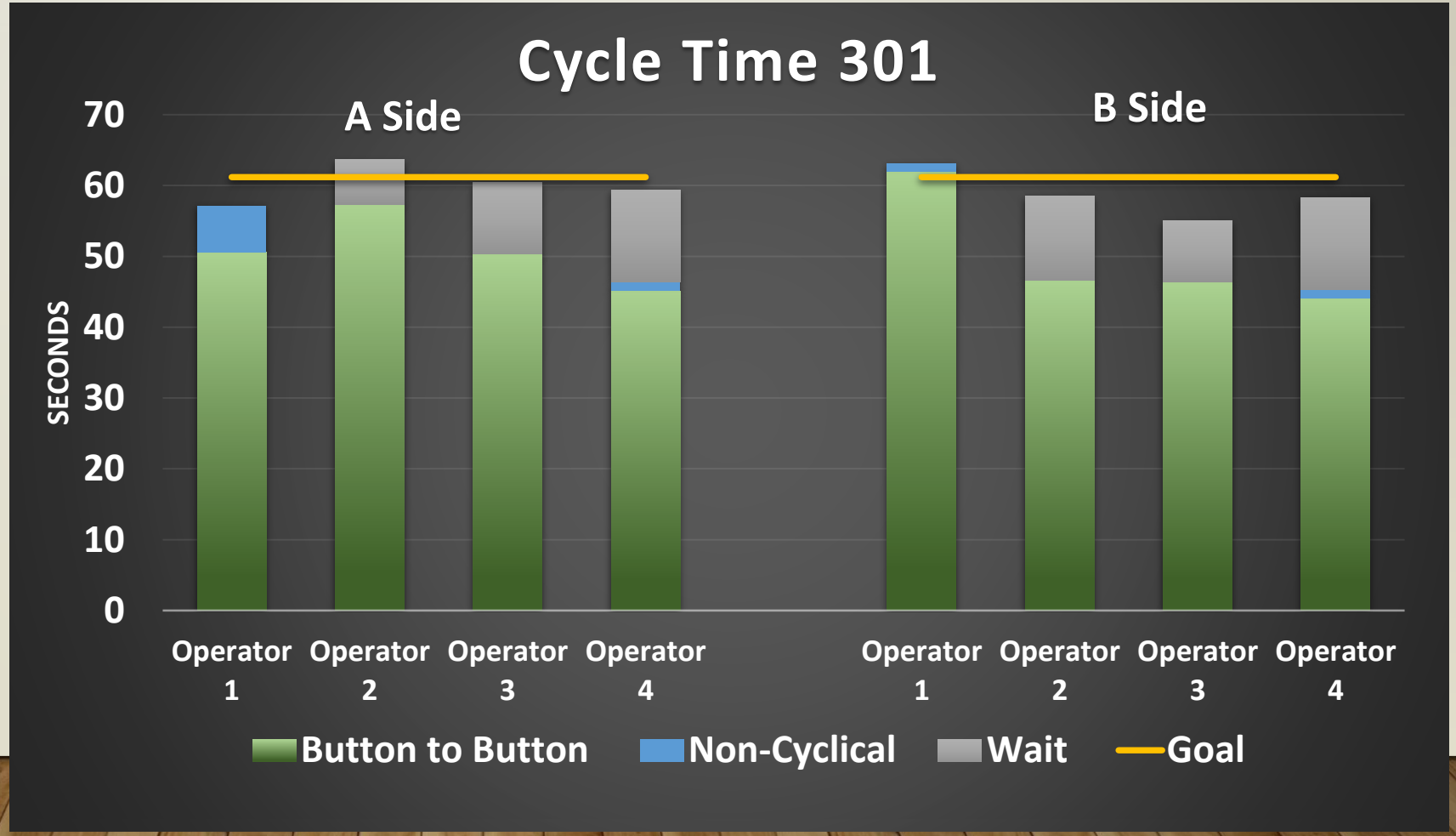
1st Iteration

- Operator 1A refills components for both cells
- Decrease total walking distance
- Increase utilization of 1A



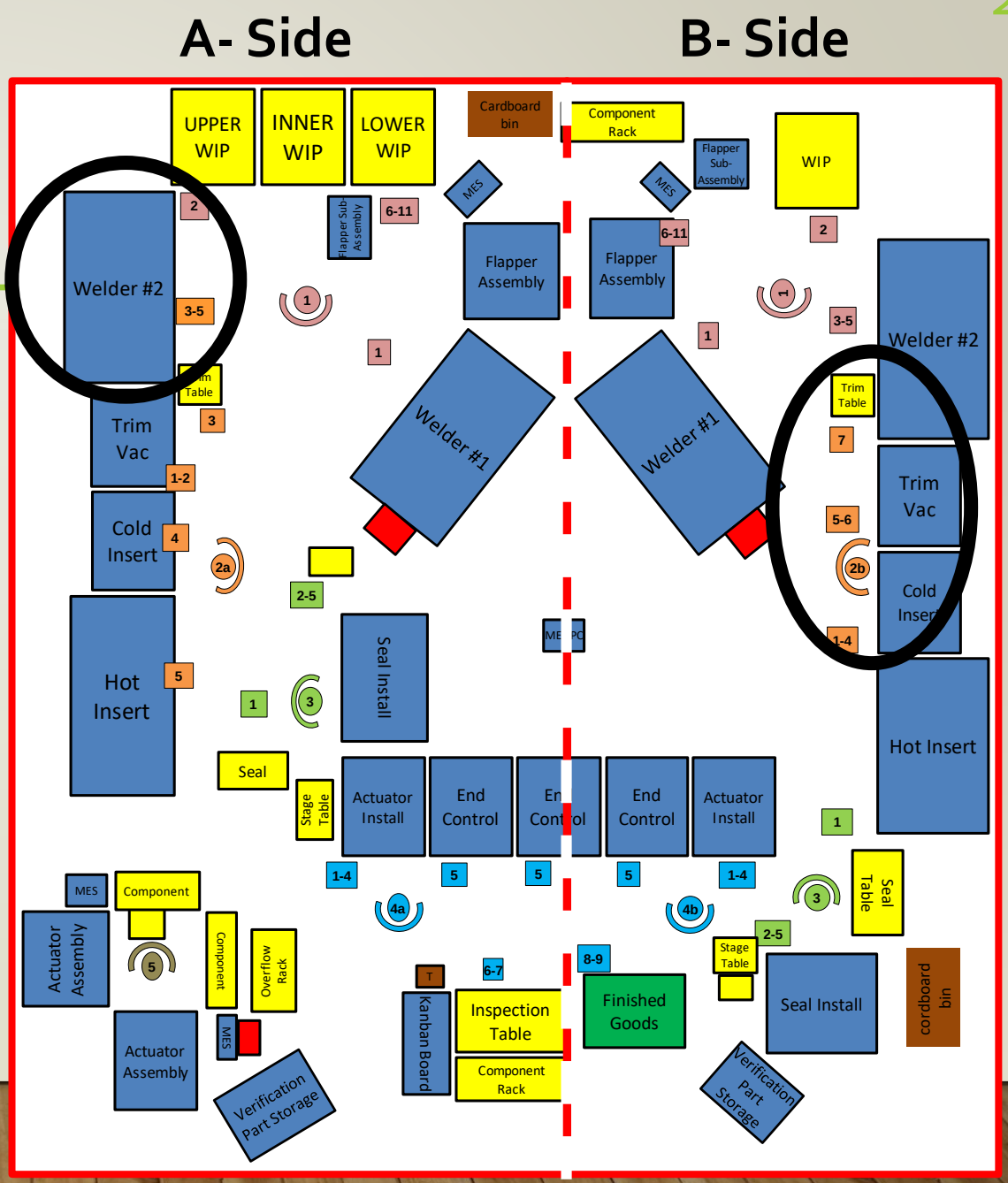
Line Balancing: 1st Iteration

Parts Per Hour		
Cell 301	A Side	B Side
Current	42	38
Operator 1A refills components for both A and B	44	41



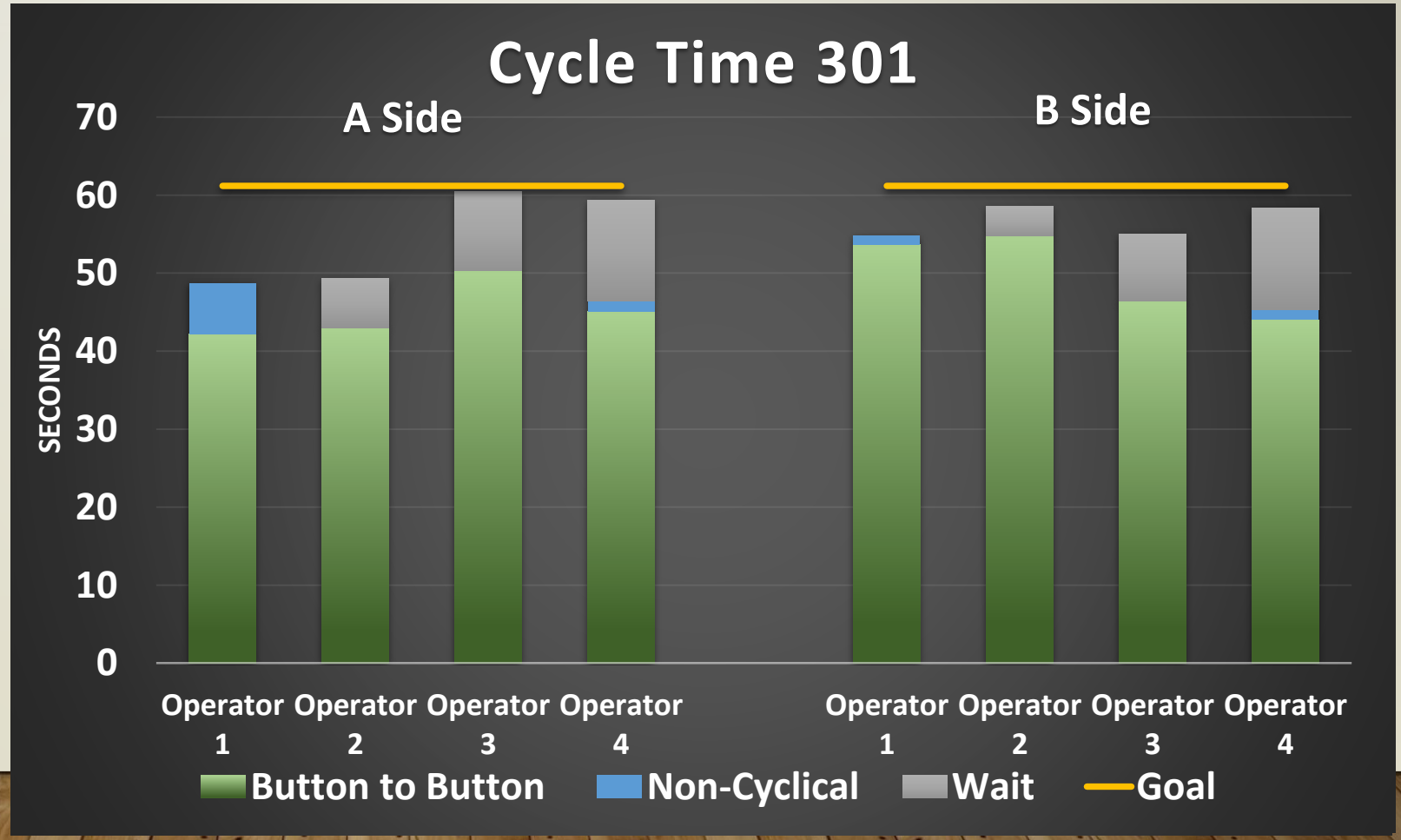
2nd Iteration

- Operator 2A and 1B are bottle necks
- Decrease wait time
- Reallocate flow of labor

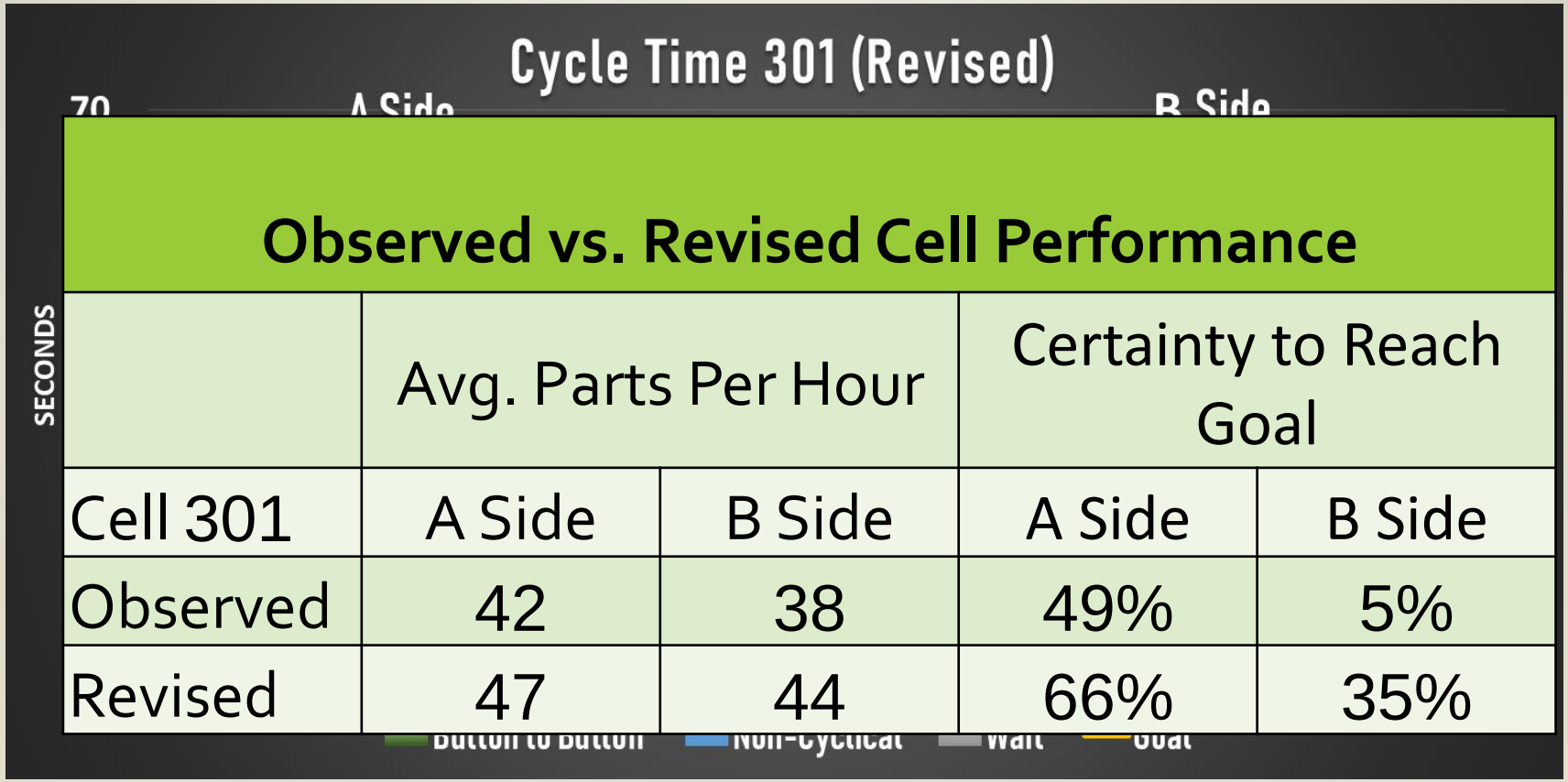


Line Balancing: 2nd Iteration

Parts Per Hour		
Cell 301	A Side	B Side
1st Iteration	44	41
Operator 2A takes steps 1,2,3,4 from Operator 1A	47	44
Operator 2B takes steps 3,5 from Operator 1B		



Comparison



Observed vs. Revised Cell Performance

	Avg. Parts Per Hour		Certainty to Reach Goal	
Cell 301	A Side	B Side	A Side	B Side
Observed	42	38	49%	5%
Revised	47	44	66%	35%

COST ANALYSIS

Labor Cost Per Part		
State	Regular Time	Over Time
Current	$2.81	$4.21
Revised	$2.62	$3.94
Difference	$0.19	$0.28
Savings	$84,267	$40,554
Total Labor Cost Saved for Remainder Volume		
$124,821		

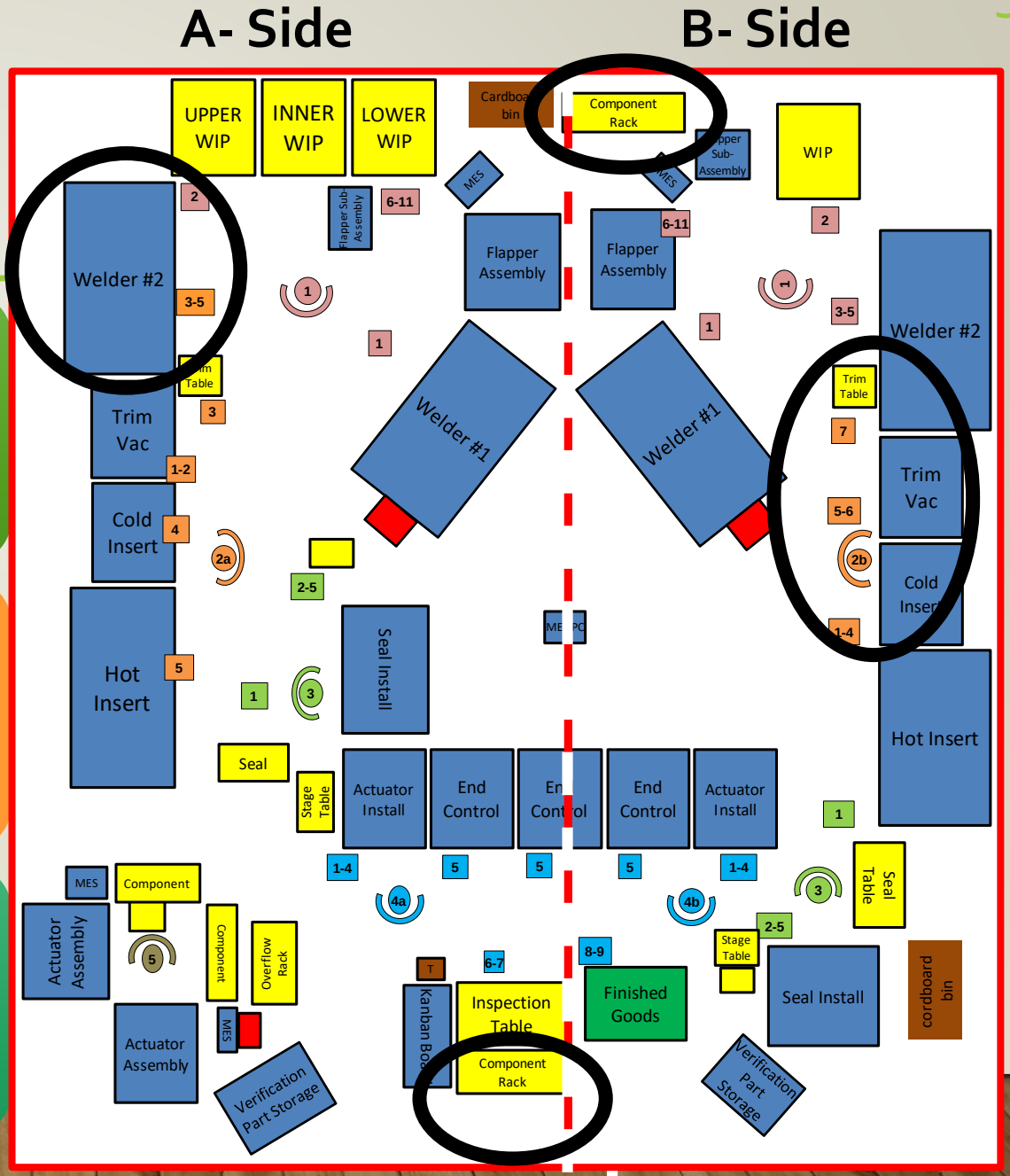
CONCLUSION

Short Term Recommendations

Operator 1A refills all components for both A and B

Operator 2A takes steps 1,2,3,4 from Operator 1A

Operator 2B takes steps 3,5 from Operator 1B



Short Term Recommendations
Updated Standard Work Chart

Steps	Operator # 1	Handling Time (sec)	Machine Time (sec)
1	Unload welded shells from welder #1	6	
2	Retrieve upper shell. Preload upper onto welded inner/lower	6	
3	Unload welded manifold from welder #2. Stage part on staging table	5	
4	Load unwelded upper and welded inner/lower into welder #2 and cycle start	5	22
5	Inspect welded part for excessive weld extrusion using snake light, and trim if needed.	10	
6	Unload inner and lower from flapper assembly station and load welder #1.	5	
7	Unload flapper sub-assembly station and load Load sleeve bearing	5	
8	Retrieve lower shell. Attach MES label. Load lower shell into right fixture	6	
9	Retrieve Inner shell	6	
10	Load inner shell into flapper sub-assembly station.	6	
11	Place part into oil nest to the left side of assembly station. Cycle start	6	15

Existing

Steps	Operator # 1 Side A+B	Handling Time (sec)	Machine Time (sec)
1	Unload welded shells from welder #1 and retrieve upper shell. Preload upper onto welded inner/lower.	4	
2	Unload welded manifold from welder #2. Stage part on staging table	3	
3	Load unwelded upper and welded inner/lower into welder #2 and cycle start	3	21
4	Unload inner and lower from flapper assembly station and load welder #1.	7	26
5	Unload flapper sub-assembly station and load Load sleeve bearing	7	
6	Retrieve lower shell. Attach MES label. Load lower shell into right fixture	7	5
7	Retrieve Inner shell, load inner shell into flapper sub-assembly station.	8	
8	Place part into oil nest to the left side of assembly station. Cycle start	3	16

Updated

Long Term Recommendations

Develop a standard work audit system

Implement the use of Man Machine charts

Acknowledgements

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Questions?