

***Lean Six Sigma Green Belt
Final Project Report-Out***

Throttle Body Assembly Line Balancing

Duration of Project:

June 11, 2004 to September 27, 2004

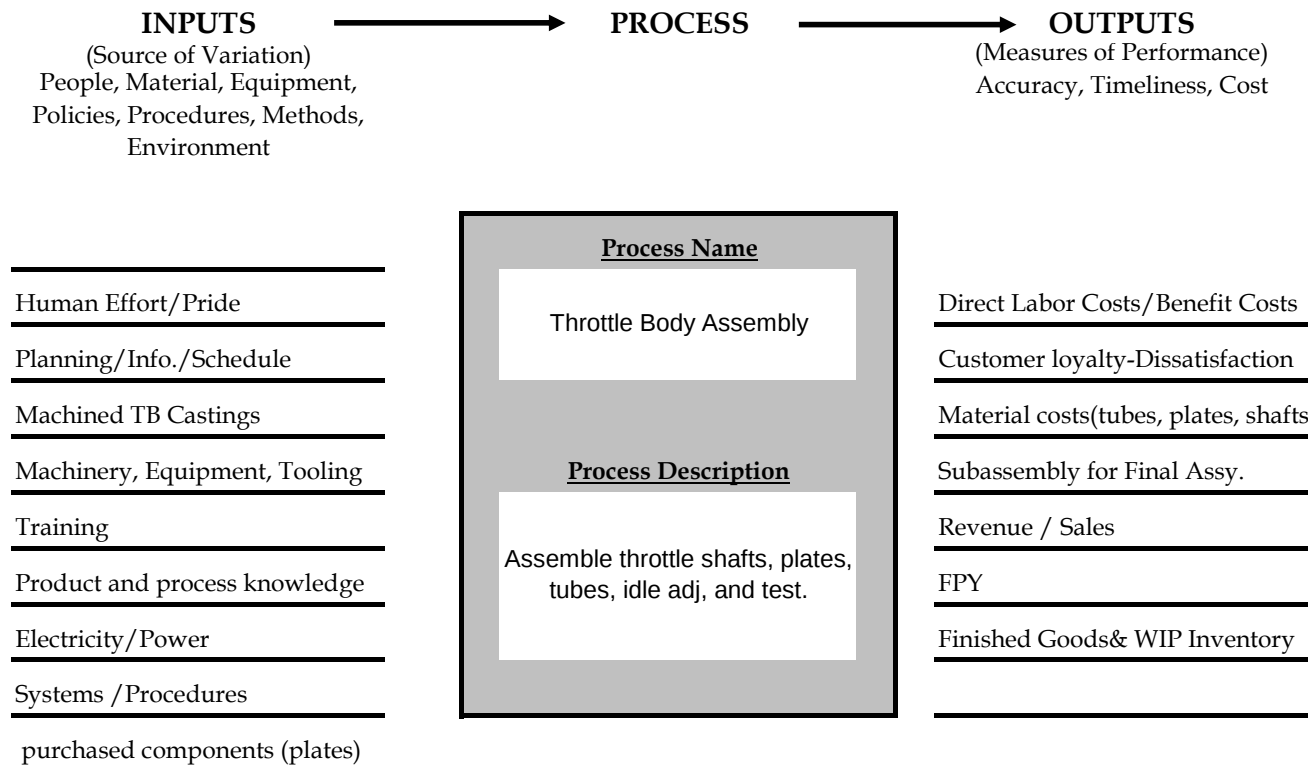
Team Membership

- **Business Unit Manager**
- **Shift Supervisor**
- **Scheduler/Planner**
- **Intern Engineer**
- **Process Owner**

Define

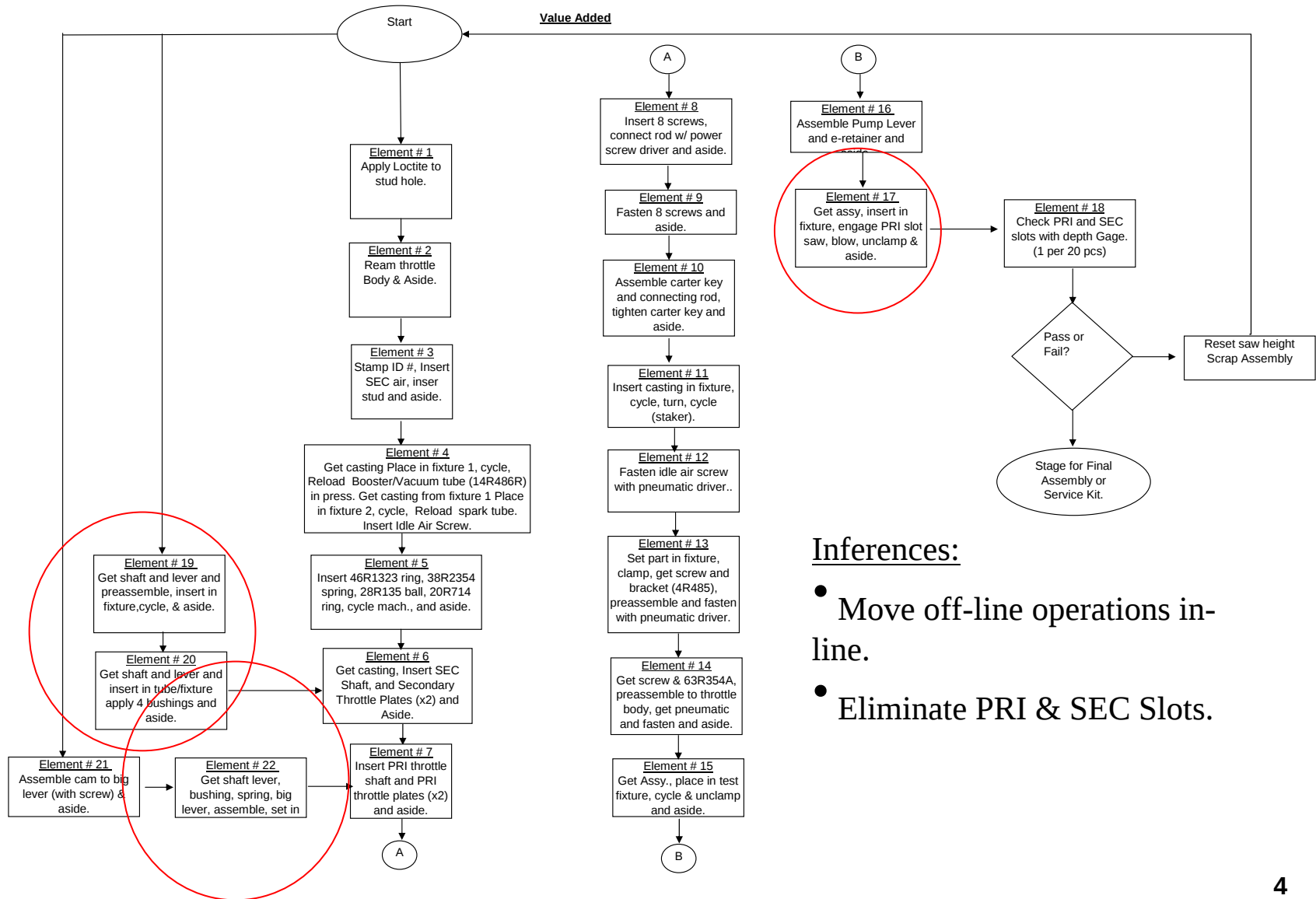
- The Throttle Body Assembly Process requires the assembly of various tubes, shafts, plates, springs, levers, and fasteners into machined castings.

Input Process Output Diagram

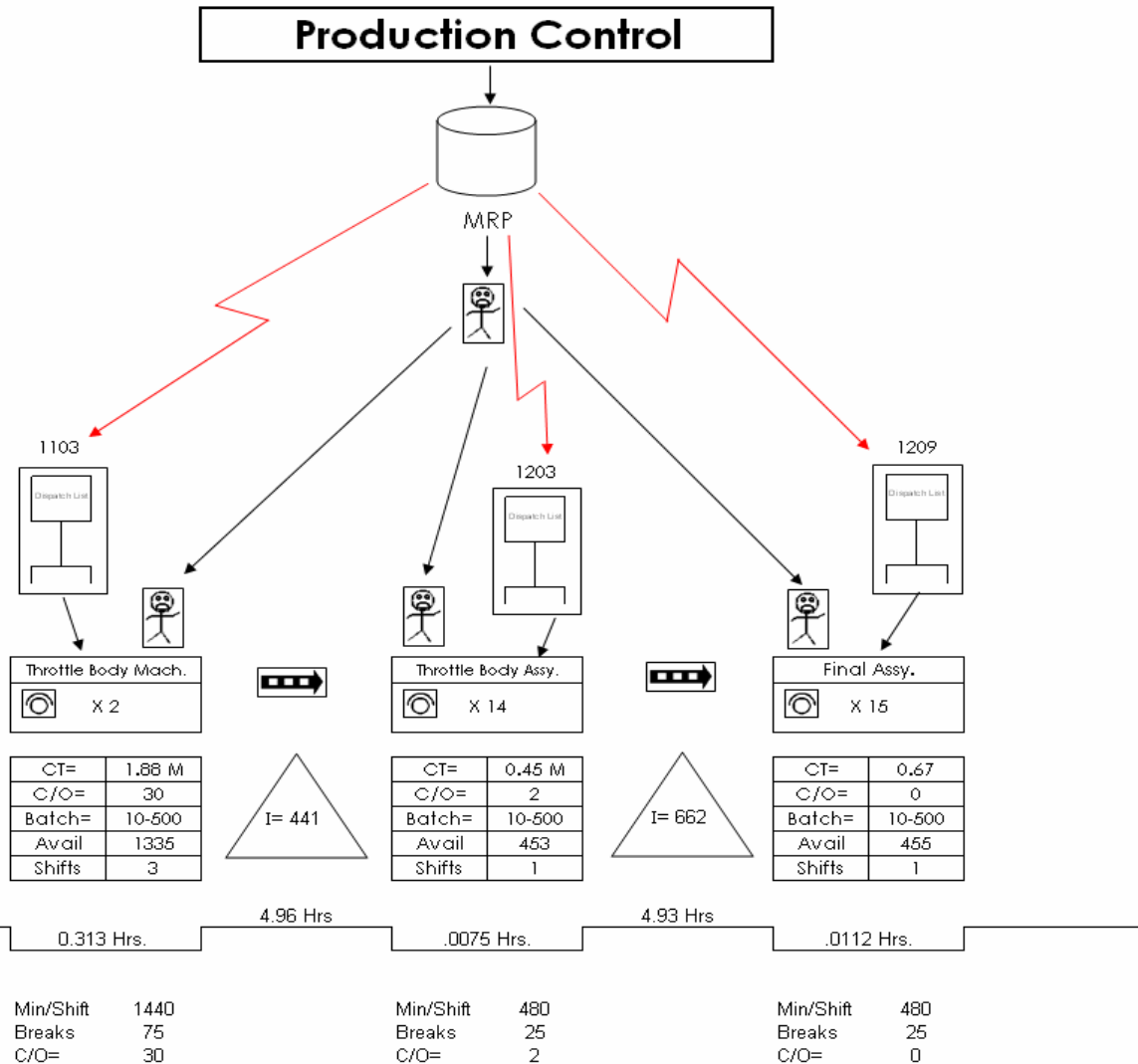


Define

- **Problem Statement (description)**
 - The current assembly process does not perform to acceptable cost levels.
- **Project Goals**
 - Reduce Labor Costs by 20%
 - Achieve 99 % FPY
 - Reduce WIP 20%



Measure - Value Stream Map



Inferences:

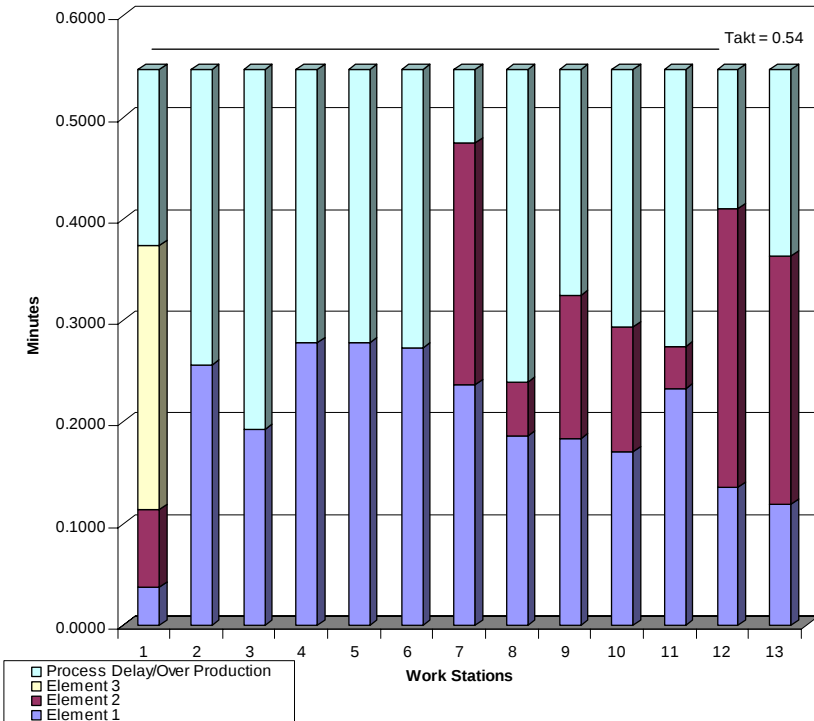
- The number of throttle body Assy. operators = the number of final Assy. Operators.
- Excessive WIP
- Low VA time.

NVA= 9.89
VA= 0.3317

Ratio= 3.35%

Measure - Current Work Load Distribution & Work Sampling

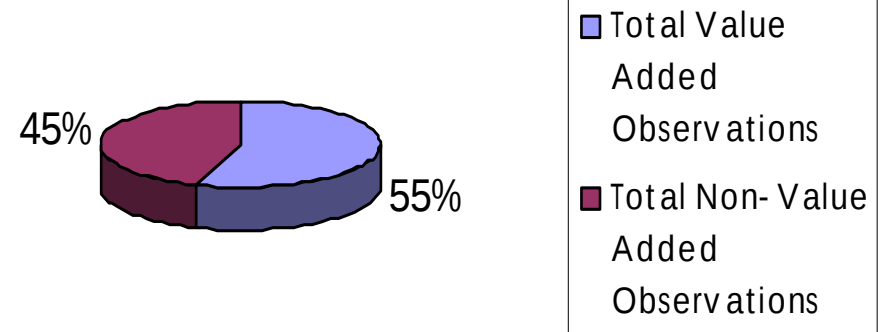
Current Throttle Body Assembly Load Leveling Chart
(13 Work Stations)



Inferences:

- Balance effort.
- Combine operations.

VA vs. NVA Observations



Inferences:

- Retrieve materials.
- Idle.
- Sorting.

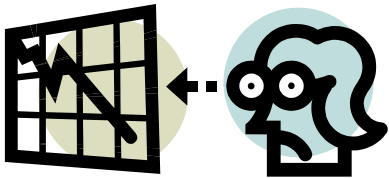
Measure

- **Baseline Data**
 - FPY and Sigma Capability

Throttle Body Assembly

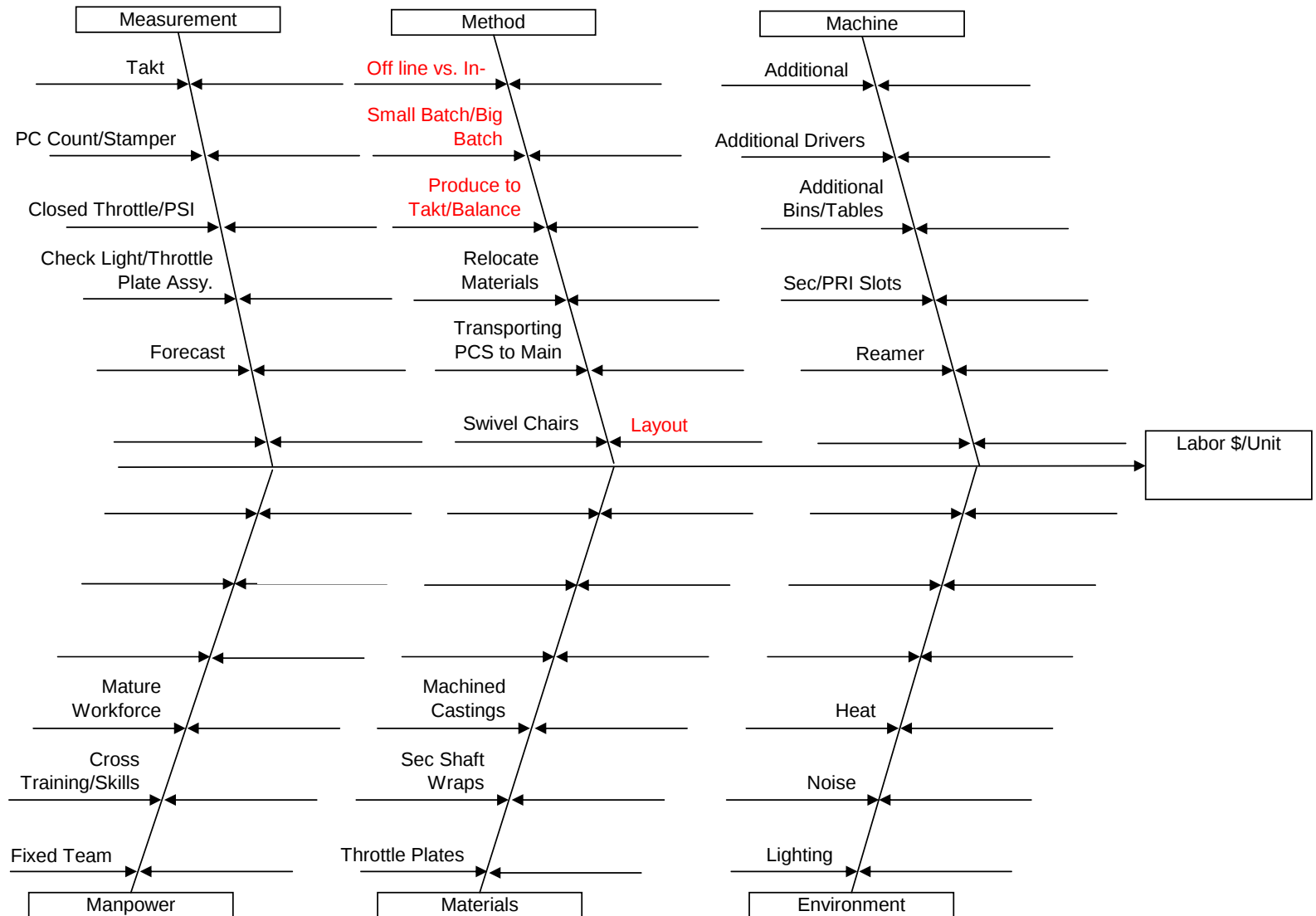
Product Summary Report

Characteristic	Defects	Units	Opportunities	Total Opportunities	DPU	DPO	DPMO	Sigma Capability	FPY
1	222	7895	1	7895	0.02812	0.02812	28119.063	3.4092	97%



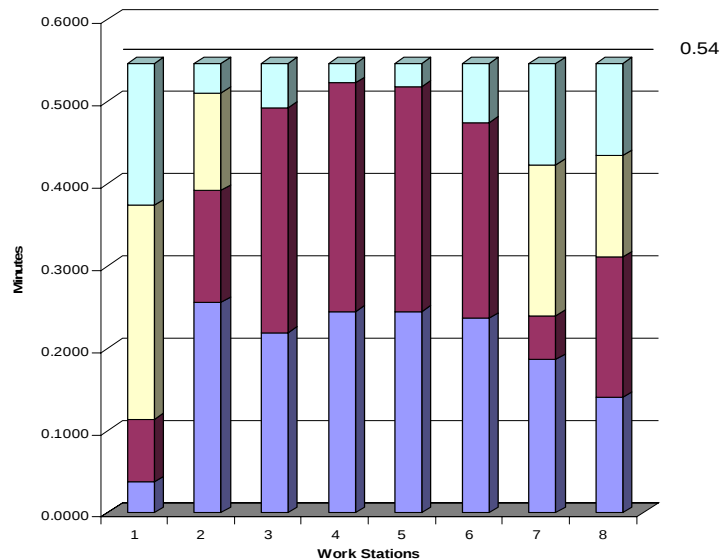
Analyze

Fishbone Diagrams



Improve – Work Load Distribution

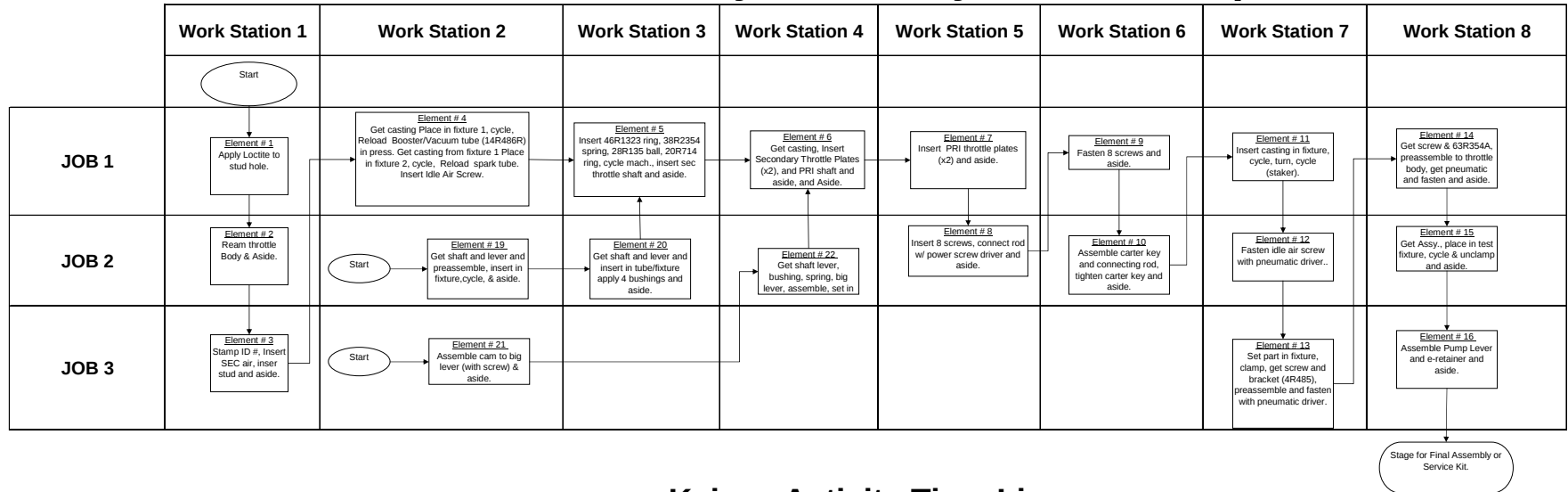
• Work Loading Based on Takt



Throttle Body Assembly Takt Time Calculation

Daily Requirements	
Final Assembly	650
Service	58
Total Daily Requirements	708
Hours Available/Shift	8
Minutes Available/Shift	480
Number of Shifts	1
Total Available Minutes/Day	480
Breaks & Clean-up/Day (Min.)	30
Change-Over Time (Min.)	20
Total Available Production Minutes/Day	430
Takt Time (Total Available Production Minutes/Daily Requirements)	0.60734
Leveled Takt Time (90%)	0.54661

Throttle Body Assembly Process Map



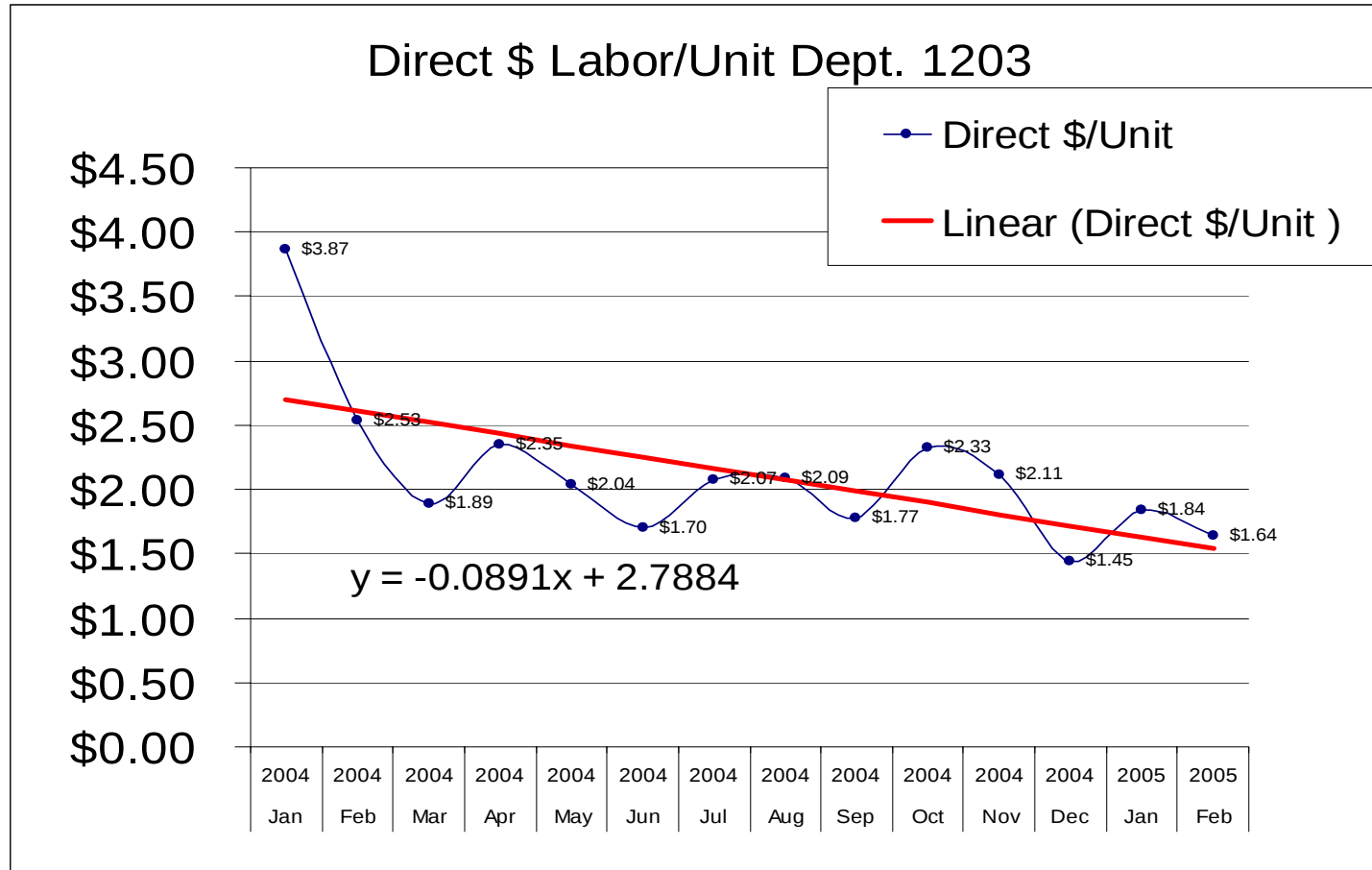
Kaizen Activity Time Line

Completion DATE	Event	Event	Event	Event	Event	Event	Event	Event
8/13/2004		Relocate-SEC Radial Bracker-To-Main-Line	Relocate-Bushing-Wrap-Fixture					
8/16/2004		Construct Cam/Lever Assembly Fixture.						
8/16/2004			Construct Gravity Bins to transport Throttle Shaft Assembly.					
8/18/2004	Eliminate Batch Ream, Blowing, and Loctite.			Construct Gravity Bins to transport Throttle Shaft Assembly.				
8/19/2004				Relocate PRI Radial Bracker To Main Line	Install Table to Accommodate PRI Throttle Plate Assembly.			
8/22/2004						Modify Fastening Station/Fixture to accommodate the Carter Key Assembly.		
8/23/2004							Reposition Staker and Lever (4R485) assembly fixture for one person workstation.	
8/24/2004							Construct Gravity Bins to transport Subassembly.	Construct and install fixture to Assemble SEC throttle Lever. Tool # 12R-10072A-3-F1)

Improve

- **Verification of Improvement**

- Labor Cost Unit:



Control

- Control plan

Control Plan

Process Name: Throttle Body Assembly Line

Process Owner: Bart Brashear

Customer:

Prepared by: Howell Hopper

Approved by:

Core Team:

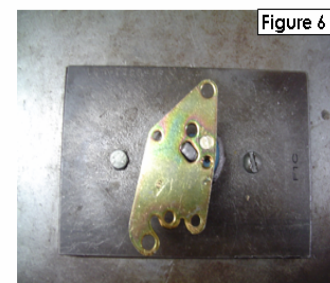
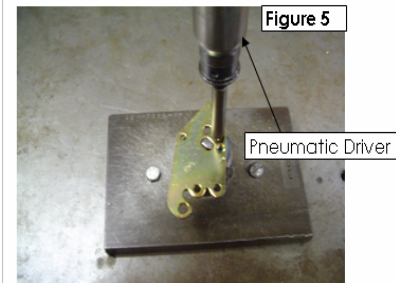
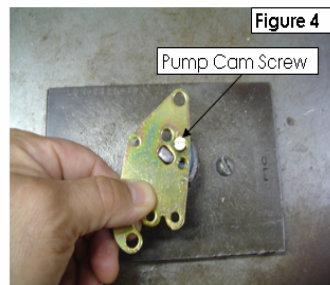
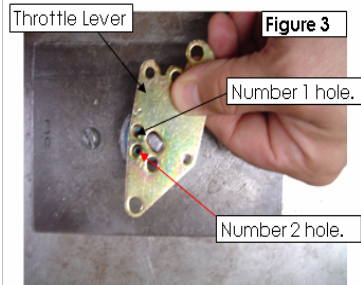
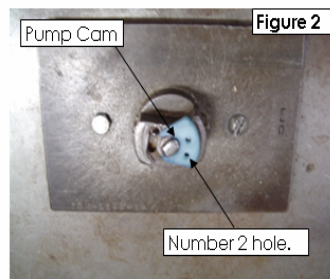
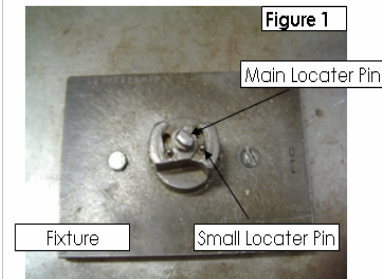
Orig Date: 9/13/2004

Revision Date:

Departments	Process Step (Description)	Performance Indicators KPIV KPOV		Requirements (Target, specs)	Msmt. Method Sample Size	Sample Size	Frequency	Who?	Record Location	Reaction Plan (corrective action)	SOP Ref.
1203	Assy.	Crew Size		9	Direct Hours	Days Production	Daily	Morris Rogers (1203 Sup.)	N:Drive	Re-balance	CP-2002
1203	Assy.		FPY	99%	Non Defective Units (Physical Count)	Days Production	Daily	Howell Hopper & Jerry Taylor (QC)	N:Drive	Define Problem/Pareto	PCI's

A.P.C. Change History							Part Number:	41R427	PCI # : 41R427 Pump Cam Assembly Process	
Change Level	Issued	A	B	C	D	E	Facility:	Bowling Green		
APC Number	80373-24						Department:	1203	Page 1 of 1	
Date/ Name	9/28/2004						Part Description:	Pump Cam to Throttle Lever Assembly		
Approved	H. Hopper						PCI Identification and Description			

Diagrams and Illustrations:



Procedure

Operation 10 : Make sure that the fixture is free from debris and the main locator pin is in the five o'clock position point towards the small locator pin as shown in figure 1.

Operation 20 : Locate the pump cam on the locator pins as shown with the flat surface of the pump cam facing up (figure 2). The number 2 hole should be positioned on the small locator pin.
(The hole number can be found on the back of the pump cam).

Operation 30 : Place the throttle lever on the main locator pin as show in figure 3. Make sure that the number 1 hole is positioned on the small locator pin and the number 2 hole is free to receive the pump cam lock screw.

Operation 40 : Insert the pump cam lock screw in the number 2 hole of the throttle lever as shown in figure 4.

Operation 50 : Apply pneumatic driver with flat head bit (figure 5) to screw and fasten until the head of the screw is flush with the surface of the throttle lever (figure 6).

Quality Characteristics:

Audit Torque Minimum Breakaway (to tighten) is 4 IN. LBS.

Audit Torque Maximum Breakaway (to tighten) is 10 IN. LBS.

Tools/Instructions:

Pneumatic Screwdriver (4-20 IN LBS)

Assembly Fixture F1C

Component/Materials	Quantity	Component/Materials	Quantity	Component/Materials	Quantity
10- Pump Cam (41R427)	1				
20-Throttle Lever (11R2476-1)	1				
30-Pump Cam Lock Screw (5R682)	1				

Project Summary Scorecard ... before and after

METRIC	BEFORE	AFTER	CHANGE (%)	ANNUAL SAVINGS
UNIT LABOR COST \$	\$2.78	\$1.53	44%	\$198,106
FPY	97%	99%	2%	\$20,603
WIP	662	513	23%	\$0
TOTAL	-	-	-	\$218,709

Project Summary

- **Problem**

- The current assembly process does not perform to acceptable cost levels.

- **Baseline and Target Performance**

- Reduce Labor unit cost 20% (Baseline: = \$2.78 Target : \$2.22)
- Improve FPY from 97% to 99%
- Reduce WIP 20% (Baseline WIP: 662 Target WIP:574)

- **Analysis and Solution**

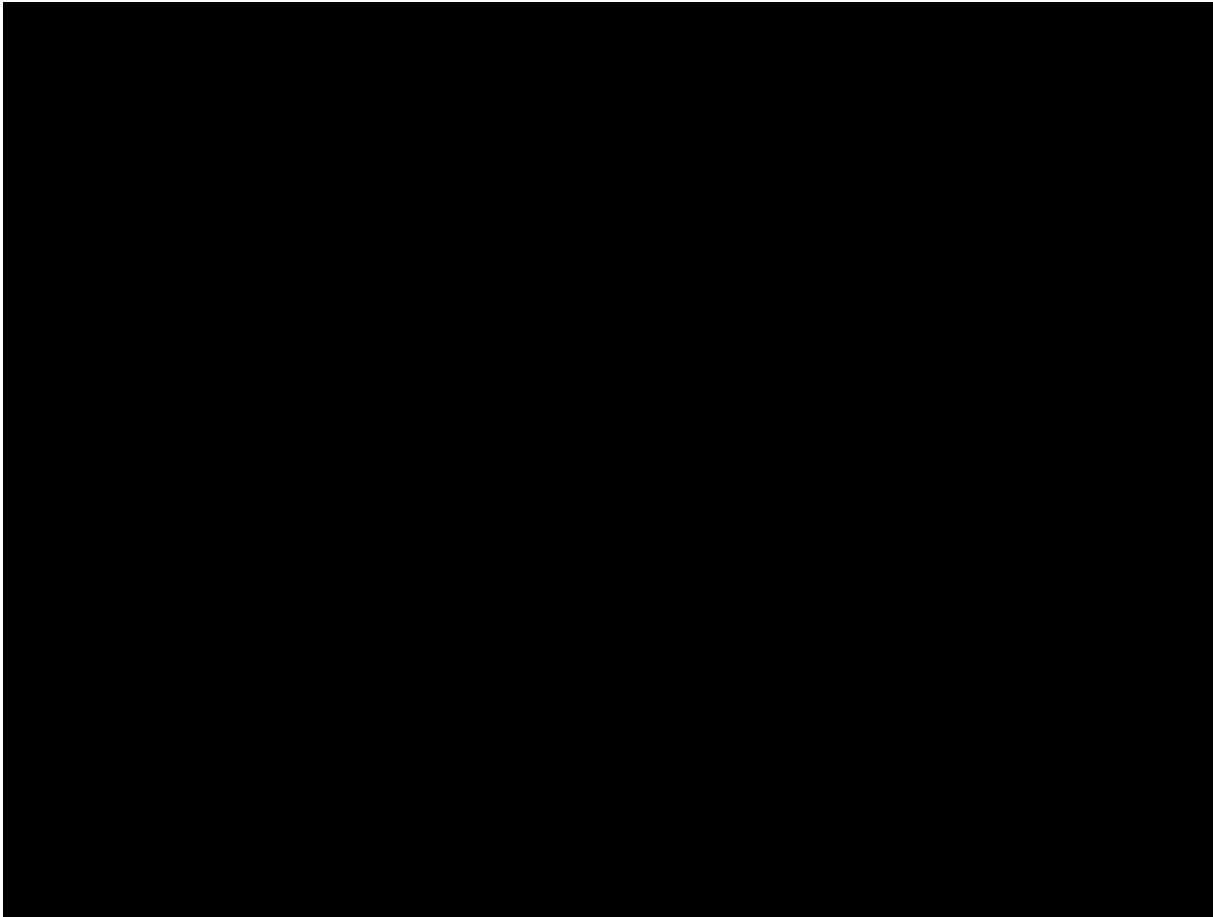
- Workstation loading analysis revealed that it was possible to compress 13 workstations into 8 (at 650 pcs/day).

- **Results and Business Benefit(s)**

- Unit Labor Cost was reduced from (\$2.78 to \$1.53) = 44%
- FPY was increased to 99%
- WIP was reduced from 662 to 531.
- Annual Savings \$218,709

Appendices ... Additional Supporting Material

- **Before Improvement Video**



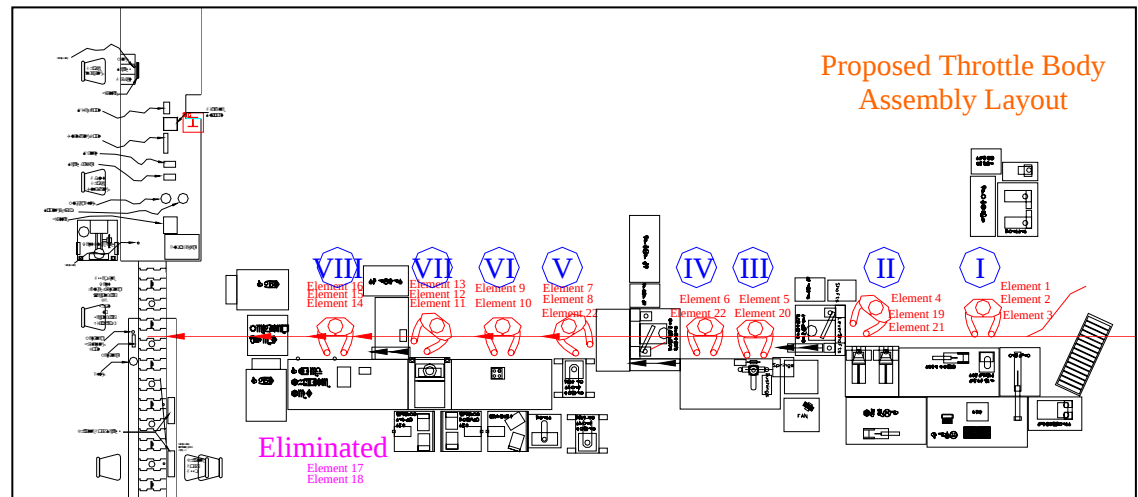
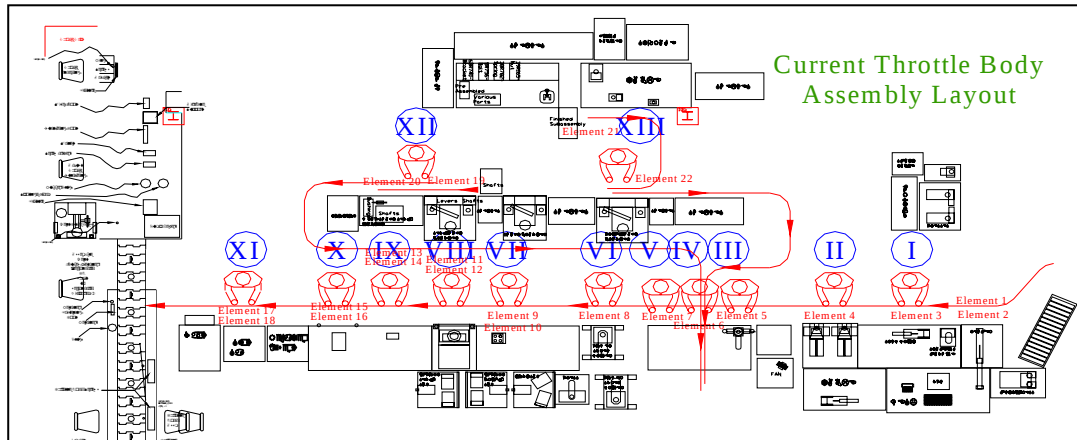
Appendices ... Additional Supporting Material

- After Improvement Video



Appendices ... Additional Supporting Material

- Before and After Physical Process Maps



Appendices

FMEA

Product or Process	Failure Mode	Failure Effects	S E V	Causes	O C C	Controls	D E T	R P N	Actions	Plans	P S	P O	P D	P r p n
Apply Loctite to Stud Hole	Loose or Backed out Stud	No Pump, Pump Lever Binding.	2	Oper. missed stud hole (batch). Not enough loctite.	1		1	2						
Ream Throttle Body & Aside.	Hole not Reamed	No SEC Shaft opening. Shaft Binds. NCT.	2	Oper. missed part. Manual alignment.	2		1	4						
Stamp ID #, Stamp SEC air, insert stud and aside.	No SEC air.	Poor Idle	2	Oper. missed operation.	1		1	2						
	No Stud	Closed Idle	2	Missed. No Loctite.	1		1	2						
	Incorrect Assy. ID	Assy. Rework.	2	Missed. Die Dull.	1		1	2						
Get casting place in fixture, cycle, Reload Booster/Vacuum tube in press. Get casting from fixture 1 place in fixture 2, cycle, Reload spark tube. Insert idle air tube.	No Tubes	Vacuum Leak/No Flow	2	Oper. missed or improperly inserted.	3		3	18						
	No idle air screw.	can't set curb idle.	2	Oper. missed or improperly inserted.	2		2	8						
Insert ring, spring, ball, ring, cycle mach. and aside.	Wrong parts/No parts.	Back Fire/Blow out power valve.	4	Oper. missed or improperly inserted.	1		3	12						
Get casting insert SEC shaft and SEC throttle plates (x2) and aside.	Wrong shaft or damaged shaft. Wrong plate or damaged plate.	Shaft Binds. NCT.	2	Damaged a vendor or during shipping/handling.	3		2	12						
Insert PRI throttle shaft and PRI throttle plates (x2) and aside.	Wrong shaft or damaged shaft. Wrong plate or damaged plate.	Shaft Binds. NCT.	2	Damaged a vendor or during shipping/handling.	3		2	12						
Insert 8 screws with power screw driver and aside.	No screws.	Plates fall out.	2	Oper. missed or improperly inserted screw.	1		1	2						
Fasten 8 screws.	Screws too tight or too loose.	Fast Idle lever.	2	Insufficient Torque/too much Torque.	3		2	12						
Assemble cotter key and connecting rod key and aside.	Wrong connector.	NCT/SEC wide open.	2	Part mis-identified or improperly referenced.	3		3	18						
	Damaged connector.	NCT/SEC wide open.	2	Not inspected or damaged during handling.	2		2	8						
	Missing connector.	NCT/SEC wide open.	2	Oper. missed or improperly inserted.	2		2	8						
Insert casting in fixture, cycle, turn, cycle staker.	Miss staking operation.	Screws fall out and drop in engine.	5	Oper. missed or improperly inserted.	1		1	5						
Fasten idle air screw with pneumatic.	Improper setting.	NCT binding.	2	Oper. missed or poorly fastened.	1		2	4						
Get part in fixture, clamp, get screw and bracket, pre- assemble, fasten with pneumatic.	Damaged Bracket.	NCT binding.	2	Not inspected or damaged during handling.	3		1	6						
	Missing Bracket.	NCT binding.	2	Oper. missed or poorly fastened.	3		1	6						
Get screw, pre-assemble to throttle body, get pneumatic, and fasten, and aside.	Damaged Bracket.	NCT binding.	2	Not inspected or damaged during handling.	3		1	6						
	Missing Bracket.	NCT binding.	2	Oper. missed or poorly fastened.	3		1	6						
Get assembly, cycle in test fixture, cycle and undamp.	Defect not detected.	NCT.	2	Improper sealing, bad throttle plates, bend shaft, etc.	1		5	10						
Remove assembly pump lever and e-retainer and aside.	Damaged Lever.	No conformity to flow spec.	2	Shipping/Handling not properly inspected.	2		2	8						
	Wrong Lever.	No conformity to flow spec.	2	Part mis-identified or improperly referenced.	3		2	12						
	Missing Pump lever and sub assembly component.	No conformity to flow spec.	2	Oper. missed or poorly fastened. Not inspected before assembly.	3		2	12						
Get assembly, insert in fixture, cycle and aside.	Too deep, too shallow, too long, too short. Burr slots.	Poor idle. Poor Flow.	2	Manual location for sawing. Poor fixture/machine/method.	3		3	18						
Check PRI and SEC slots with depth gage (1/20).	Defect not detected.	Poor idle. Poor Flow.	2	Random Testing.	3		5	30						
Get shaft and lever and preassemble, insert in fixture, cycle, and aside.	Wrong Lever.	NCT.	2	Part mis-identified or improperly referenced.	4		2	16						
	Damaged Lever.	NCT.	2	Material handling method. Not inspected before assembly.	2		1	4						
	Insufficient brackering.	Lever comes loose in field. Warranty.	3	Improper Set-up.	2		2	12						
Get shaft/lever and insert in tube/fixture, apply 4 bushings, and aside.	Bad Bushings (too thick or split)	Loose bushings. Rework.	2	Poor quality from vendor.	1		1	2						
	Insufficient brackering.	Lever comes loose in field. Warranty.	3	Improper Set-up.	2		2	12						
Assemble CAM to big lever (with screw).	Wrong parts.	Insufficient pump.	2	Part mis-identified or improperly referenced.	2		2	8						
	Mislocated Screw.	Insufficient pump.	2	Oper. Improperly located/inserted.	2		2	8						
Get shaft, lever, bushing, spring, big lever, assy, set in fixture, cycle, and aside.	Wrong Lever	NCT.	2	Part mis-identified or improperly referenced.	4		2	16						
	Damaged Lever	NCT.	2	Material handling method. Not inspected before assembly.	2		1	4						
	Insufficient brackering.	Lever comes loose in field. Warranty.	3	Improper set-up.	2		2	12						
Assemble CAM to big lever (with screw).														

Dept 1203 FPY Pareto Analysis

