Production System Implementation

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Vicente Reynal
AlliedSignal Inc.
(MS MIT ‘98

Background

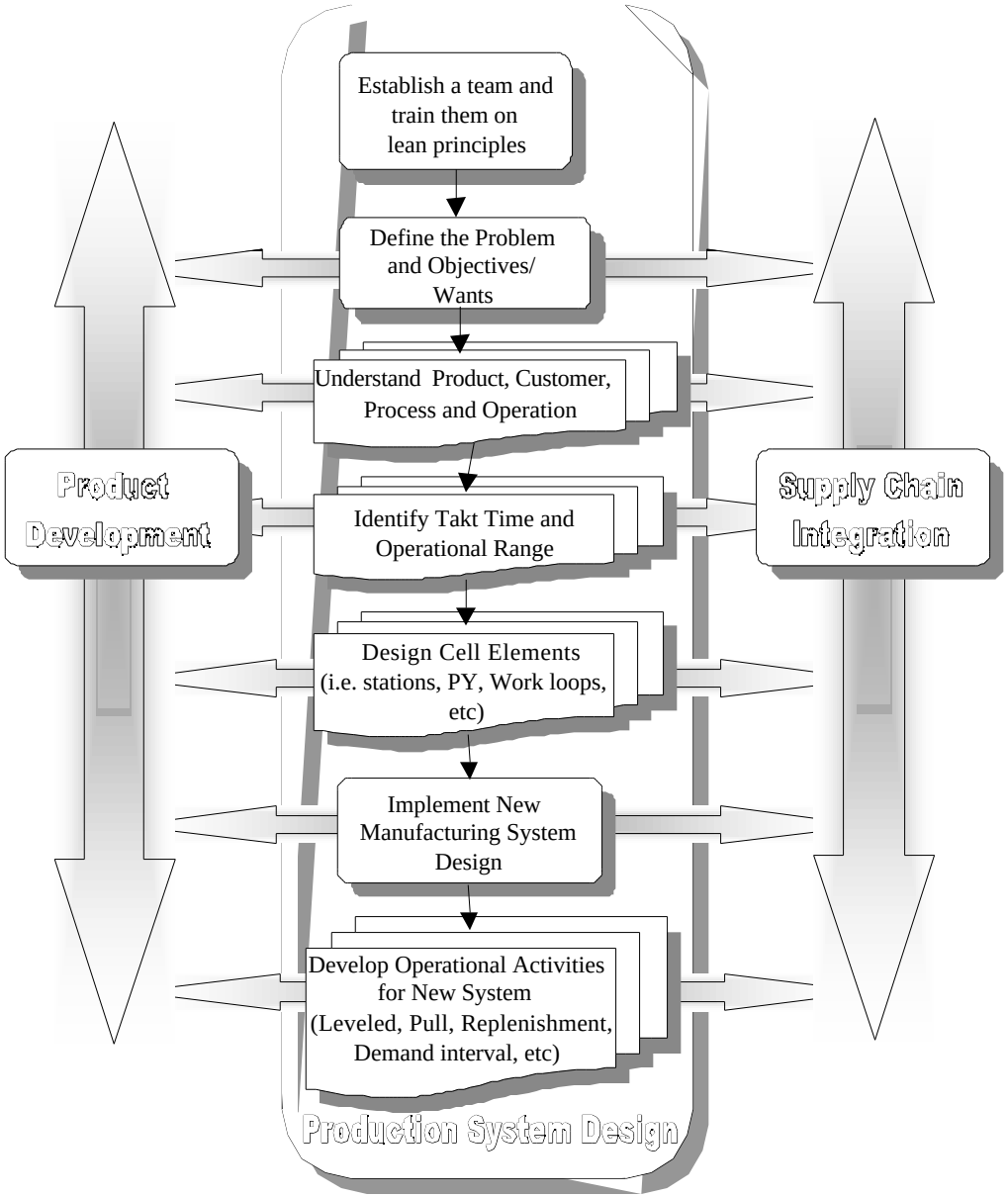
- Worked 3 years under the supervision of Prof. David Cochran (PSD) and Tom Shields (LAI)
- Thesis: “Production System Design and its application to the Automotive and Aircraft Industry”
- Working for AlliedSignal (Military Customer Support, Phoenix R&O Site)
  - Six Sigma/Lean Manufacturing Leader
  - Components Area Team Leader

Objective

- Present Methodology used to convert a Low Volume/Medium Mix Non-Aerospace Company

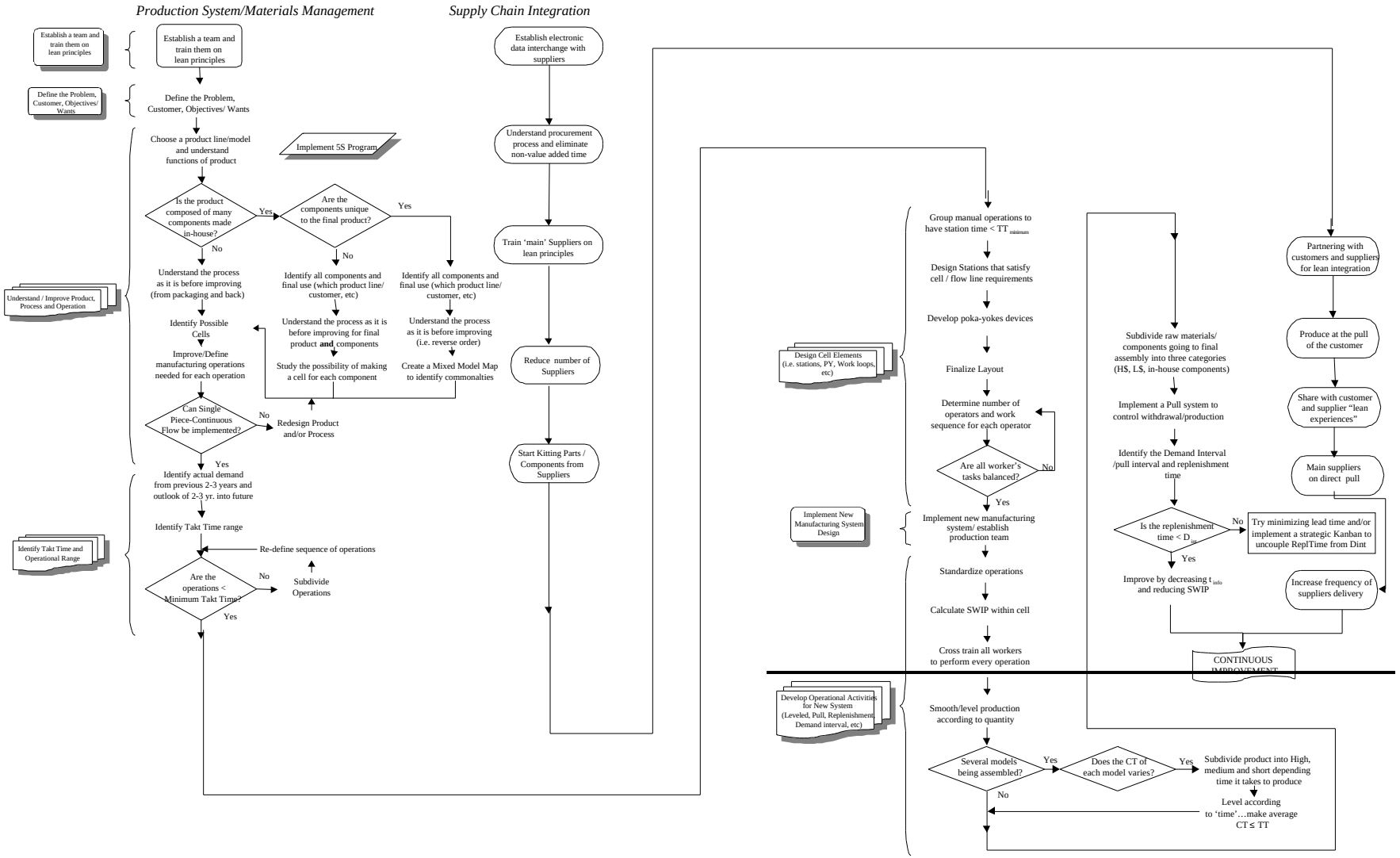
- Demonstrate how same methodology is been used to convert an Aerospace R&O Facility.

Macro Level of Methodology



Micro Level…

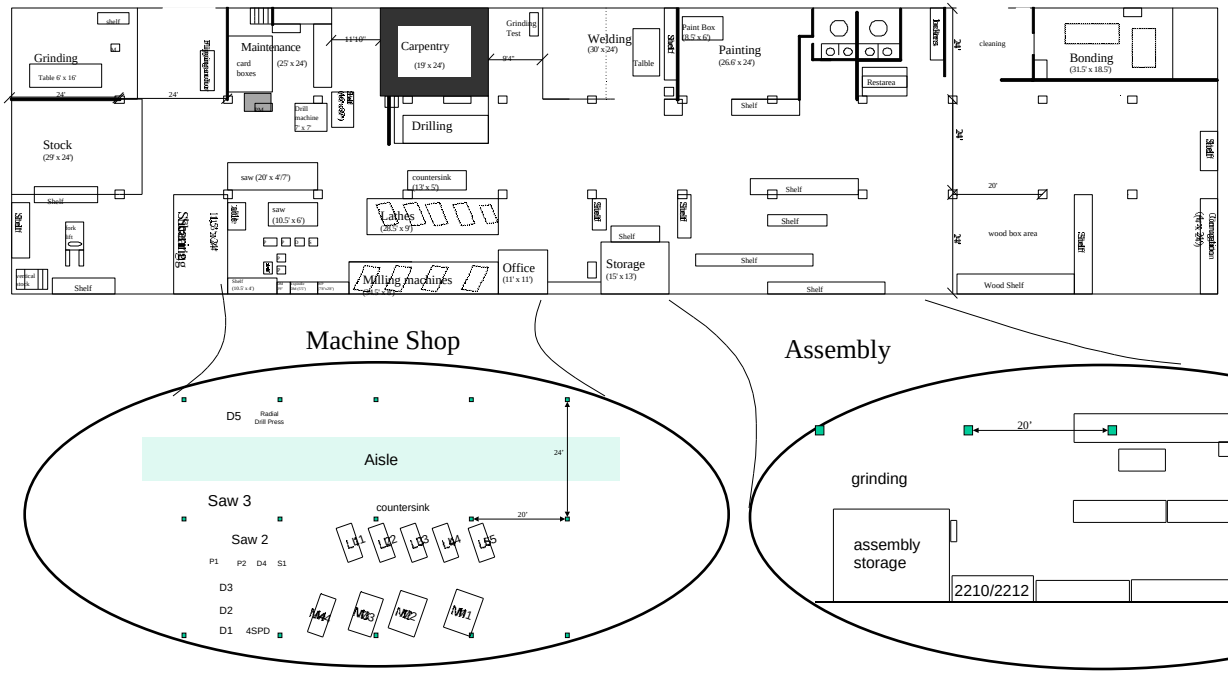
for more details please refer to thesis



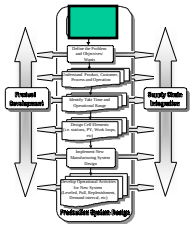
Low Volume/High Mix Non-Aerospace Company

a)

b)

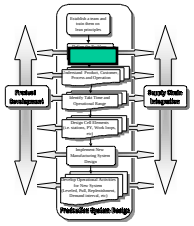


Step 1: Establish a team and train them on lean principles



- Pick people who have “high credibility”
- 6-8 Members per Team
  - 3-5 production operators, a supervisor, a quality expert, a manufacturing engineer, 1-2 management people and possibly a cost accountant.
- Lean Principles:
  - Balanced Production to customer demand
    - Cell design to achieve range of demand
    - Man-Machine separation
    - Machines/Stations designed for cells
  - Leveled Production
    - Setup Reduction (external vs. internal)
    - Pull System
  - Predictable Output and rapid response to undersired events
    - Quality (Mistake proofing devices)
    - Visual Controls (5s)
    - Time reliability and maintenance (TPM)

Step 2: Define Problem, Objectives/Wants



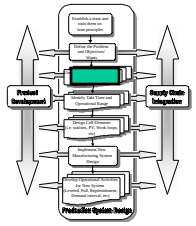
Problems

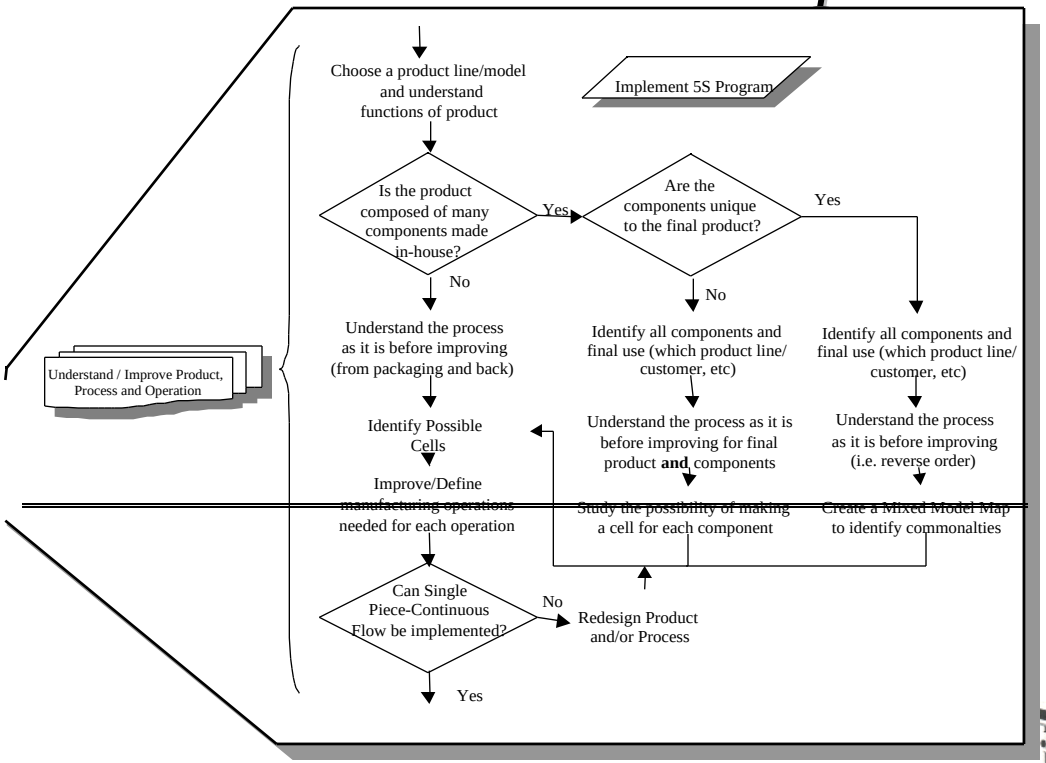
Operator turnover of 40%
Customer orders always late
Unpredictable lead times
Inconsistency of material flow and availability
Administrative inefficiencies (> 3 weeks to process)
High levels of inventories
Quality Problems (e.g. 25/37 parts returned from customer)
Competitors gaining market share
No traceability of Cost

Goals

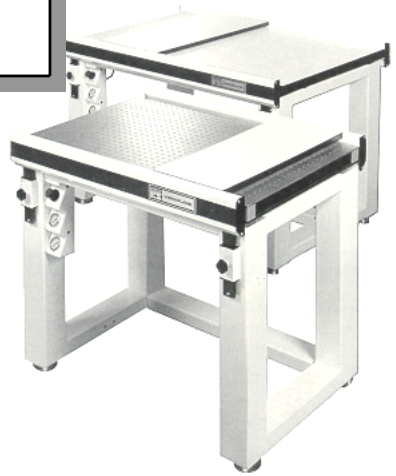
Increase morale of workers
Increase on time delivery from 5% to 80-90%
Reduce lead time by 50% (from 12 wks to 4-6 wks)
Inventory reduction
Reduction of space to introduce new products
Reduce customer returns from 35% to < 10%
Create a more predictable output

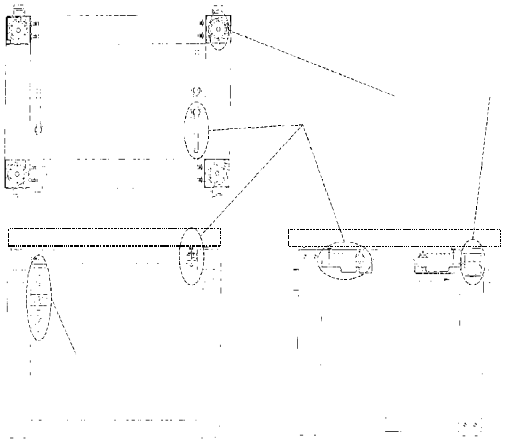
Step 3: Understand/Improve Product, Process and Operation



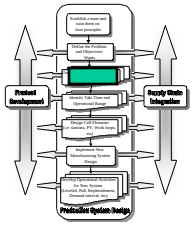


1. Level Valve
2. Air-mount (for 9100)
3. Control Panel
4. Piston (for 1200)
5. Table-top
6. Left-Side Weldment (two legs welded to a brace)
7. Right-Side Weldment (two legs welded to a brace)



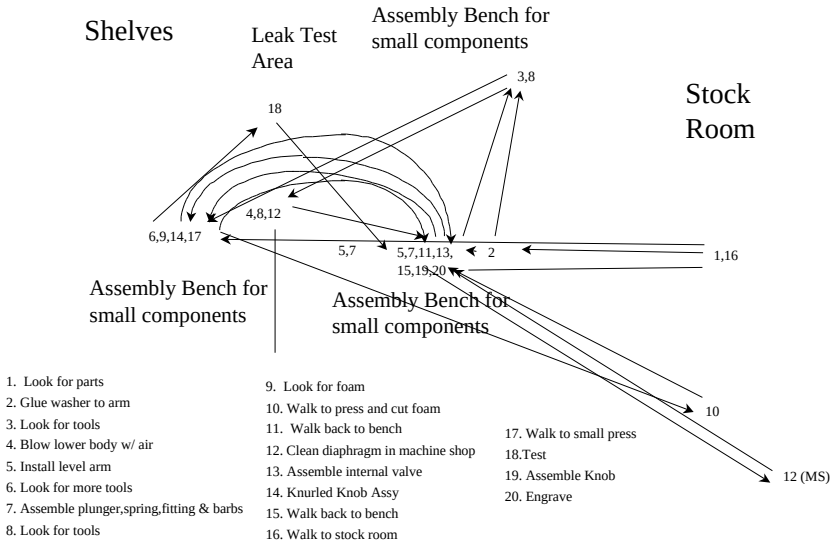


Understanding Processes "as-is" before improving

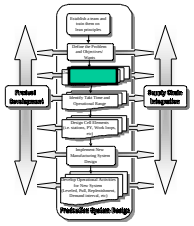


Step	Operation Element	Non-value added time	1	2	3	4	5	6
1	Look for Parts	540						
2	Prepare for first operation (Glue washers)	117						
3	Glue washers on arms		26	26	26	26	26	26
4	Prepare for second operation (inspection & cleaning of L.B.)	15						
5	Cleaning/inspect lower body		3	2	4	4	5	5
	⋮		⋮		⋮			
44	Test valves		230	148	227	117	97	311
45	Fix defect valve (#3)				636			
46	Assemble knurled knobs into level arm. Insert plastic tip into knob		41	44	45	40	37	42
47	Walk/look around for valve's notebook and engraver machine	240						
48	Write down in notebook part # and valve #	95						
49	Engrave part # & valve #		38	29	32	32	29	30
	END							

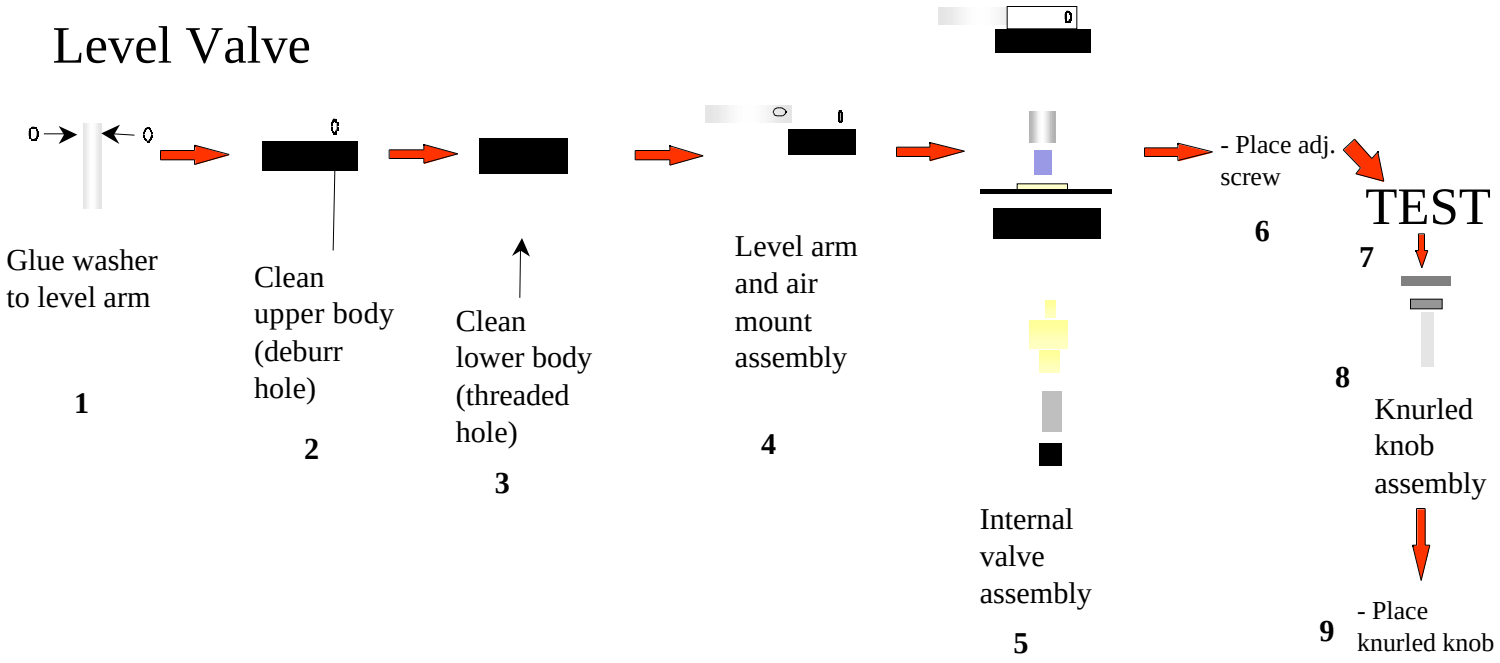
- 65% of the time is non-value added
- Valve traveled ~ 300 ft in order to be assembled



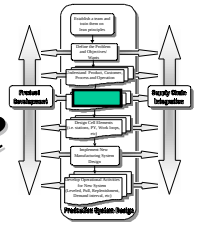
Improving the assembly process of level valves



- 40 out of 49 operations were eliminated.
- The other 9 operations were explicitly defined and standard procedures were created

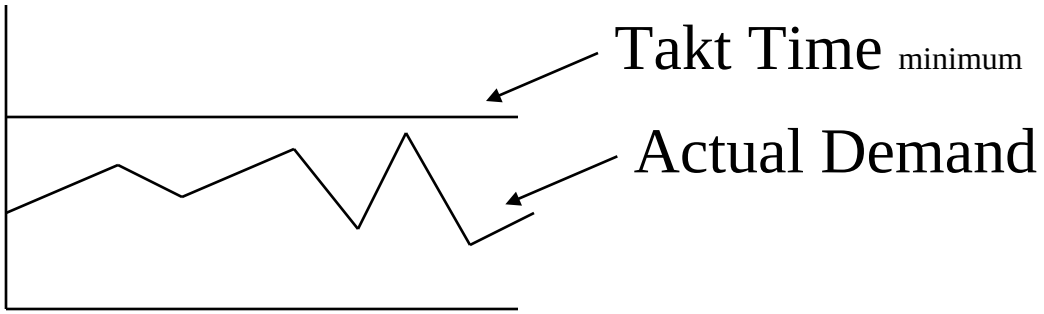


Step 4: Identify Takt Time and Operational Range



$$\text{TAKT TIME}_{\text{minimum}} = \frac{\text{AVAILABLE TIME}}{\text{AVERAGE DAILY DEMAND}_{\text{with X\%}}} * (1-\alpha)$$

Where α is the allowance of the system, (85% as a goal for $1-\alpha$) and X is 20-30%



Step 4: Identify Takt Time and Operational Range

- Takt Time of Final assembly based on historical demand and extra 20% of capacity to allow for growth

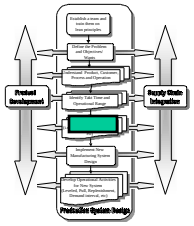
	Model	1995	1996	+ 20%
1200 Series	1201	174	145	174
	1202	18	25	30
9100 Series	9101	206	155	186
	9102	57	93	112
	9211	45	90	108
		500	508	610

Takt Time with 85% efficiency 147.24 min per table
2.45 hours per table

- The same was performed for the components and the following TT were found

Possible Cell	Minimum Takt time (85% eff) [min.]
Level Valve + T.W.	25
Air-mount + Piston	30
C. Panel + Regulator + Delco Valve	30

Step 5: Design Cell Elements (station, PY, work Loops, etc)



Since all operations manual, the number of stations is obtained by

$$\text{Number of Stations} = \frac{\text{Manual Time to Assemble}}{\text{Takt Time}_{\text{minimum}}}$$

Every Station was designed based on the following guidelines:

Material fed from the back of the stations or from some position that does not disrupt production.

Tools required for the operations conveniently located for the operator. If possible spring-loaded cable returns, so that the operator can simply let go of the tool when done with it.

Height adjustable station (if possible).

Stations on wheels for easy relocation.

Operations posted on the stations.

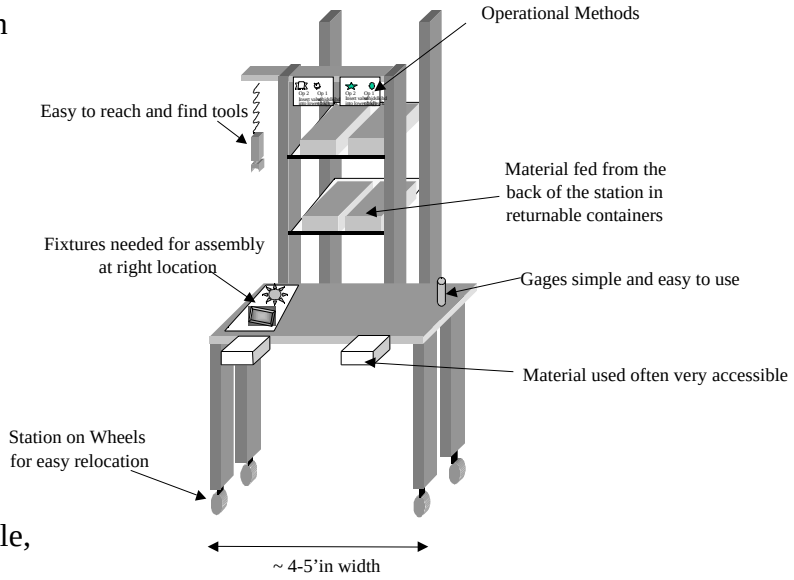
Place materials and tools in a given area and in the same sequence as the work.

Integral Frame

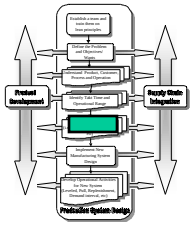
Flexible utility drops

Simple Leveling System

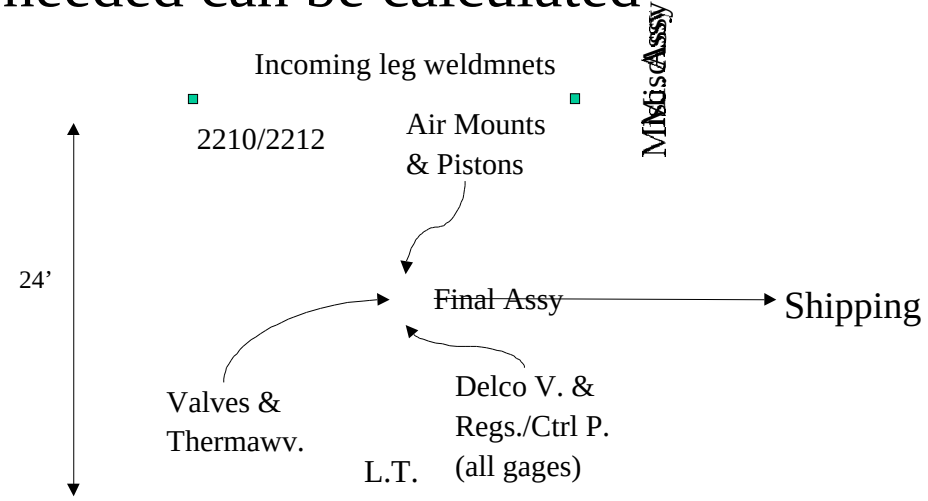
General simplicity designed into the entire station. Make it inexpensive and simple, so that the work team is not afraid of making changes.



Determine Number of Operators based on Takt Time



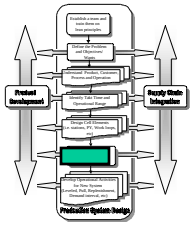
- Once the station and operations are well defined, the layout of the cells can be finalized and the number of operators needed can be calculated.



$$\text{Number of Operators} = \frac{\text{Manual time + Walking Time}}{\text{Takt Time}}$$

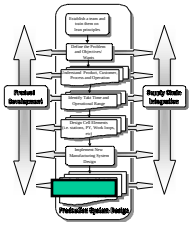
Cell	Average Manual Work Time (min)	Actual Takt Time (min)	# of Operators
Final Assembly	120	160	0.8
Valve + T.W.	20	30	0.7
Air-Mt + Piston	20	36	0.6
C. Panel + Regulator + Delco	30	35	0.9
2210/2212	100	181	0.6
		Total	3.6 → 4

Step 6: Implement Manufacturing System Design

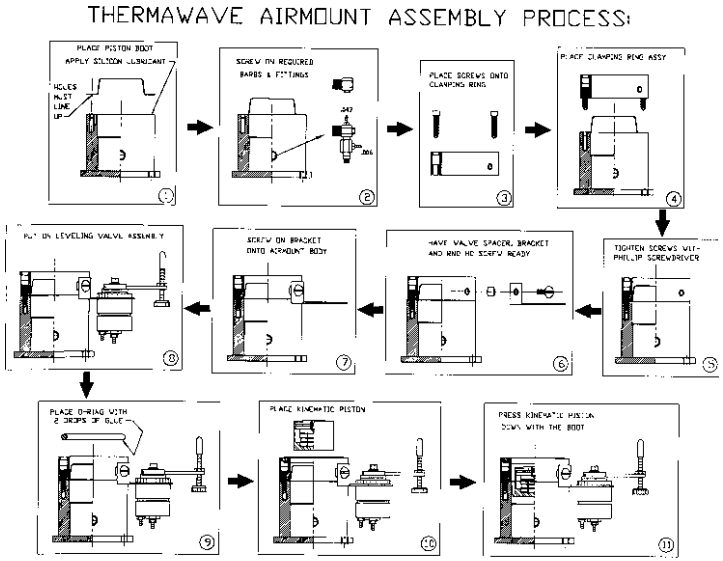


- Very important to improve the morale of the workers
  - Paint the new area and equipment if possible
  - Record issues/concerns from operators and make sure those are resolved !!
  - Communicate
- Make them feel that they are working in a completely new environment
- Create a new worker organization
  - Team leader that can create a team workplace and a high performance work organization
  - Re-structure work responsibilities

Step 7: Implement operational activities for new system (level, pull, replenishment time, demand interval, etc)



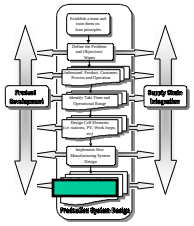
- Operational Method Sheets were created to standardized operations



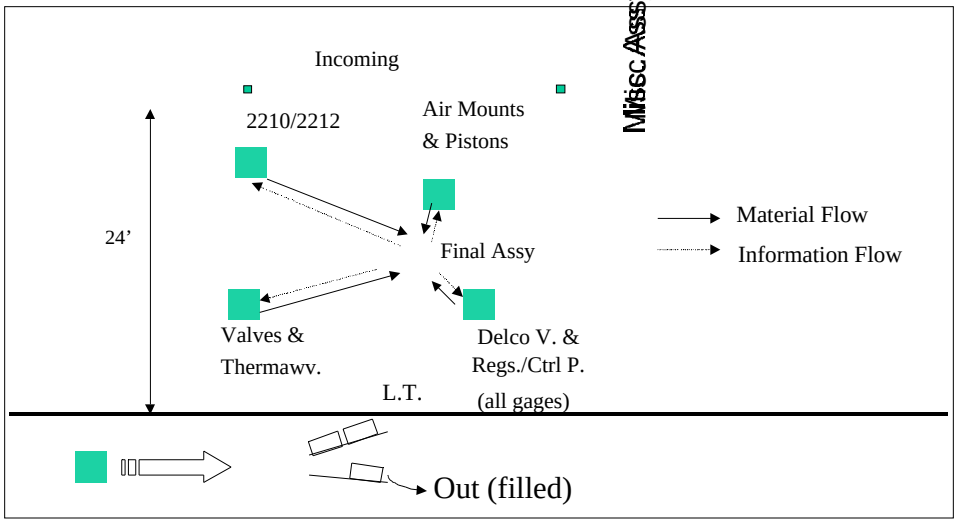
- Cross-train operators between cells

OPERATOR NAME	PRODUCT Level Valve	T.W.	Air-Mount	Piston	Regulator	Control Panel	Delco Valve	Final Assembly	2210/2212
Ron									
Tom									
Luis									
Pepo									

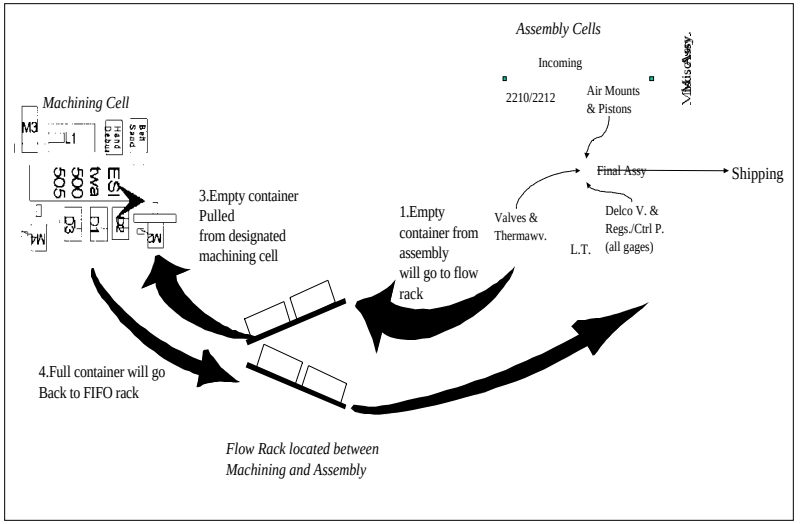
Production Control System interacting with actual production, not from a computer room...



- Material and components were subdivided into three categories:
  - Parts/Components made in-house
    - Standard (Pull system) / Non-Standard (Card System)



Pull System within



Pull System between Machine Shop and Assy

  - High Value Parts (80-20 rule….pull system with suppliers)
  - Low Value Parts (quantity based on the economic order quantity from the source)

Improvements

Vibration Isolation Assembly Are

	Bef	
Time	50 % of the time t a unit spent lookin	

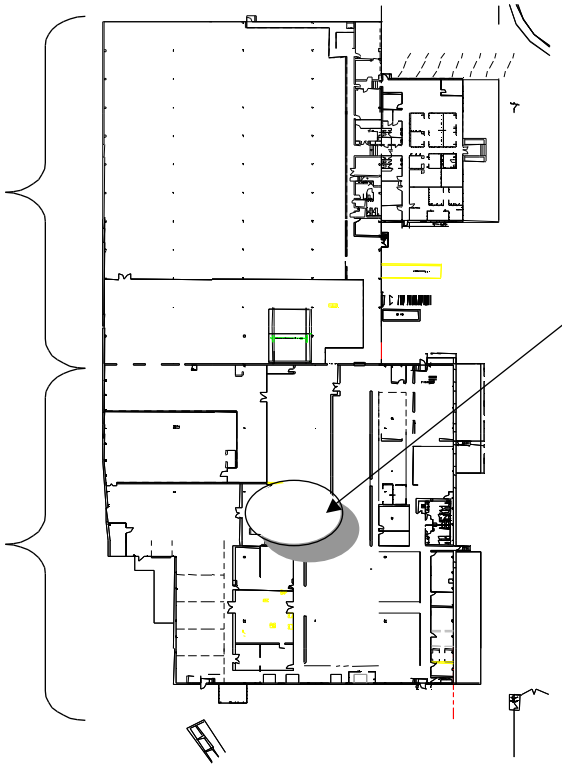
On time delivery	5%	85%

Productivity improved more than 65%

AlliedSignal Phoenix Repair & Overhaul Site

Government Bond Area (warehouse for Gov. parts)

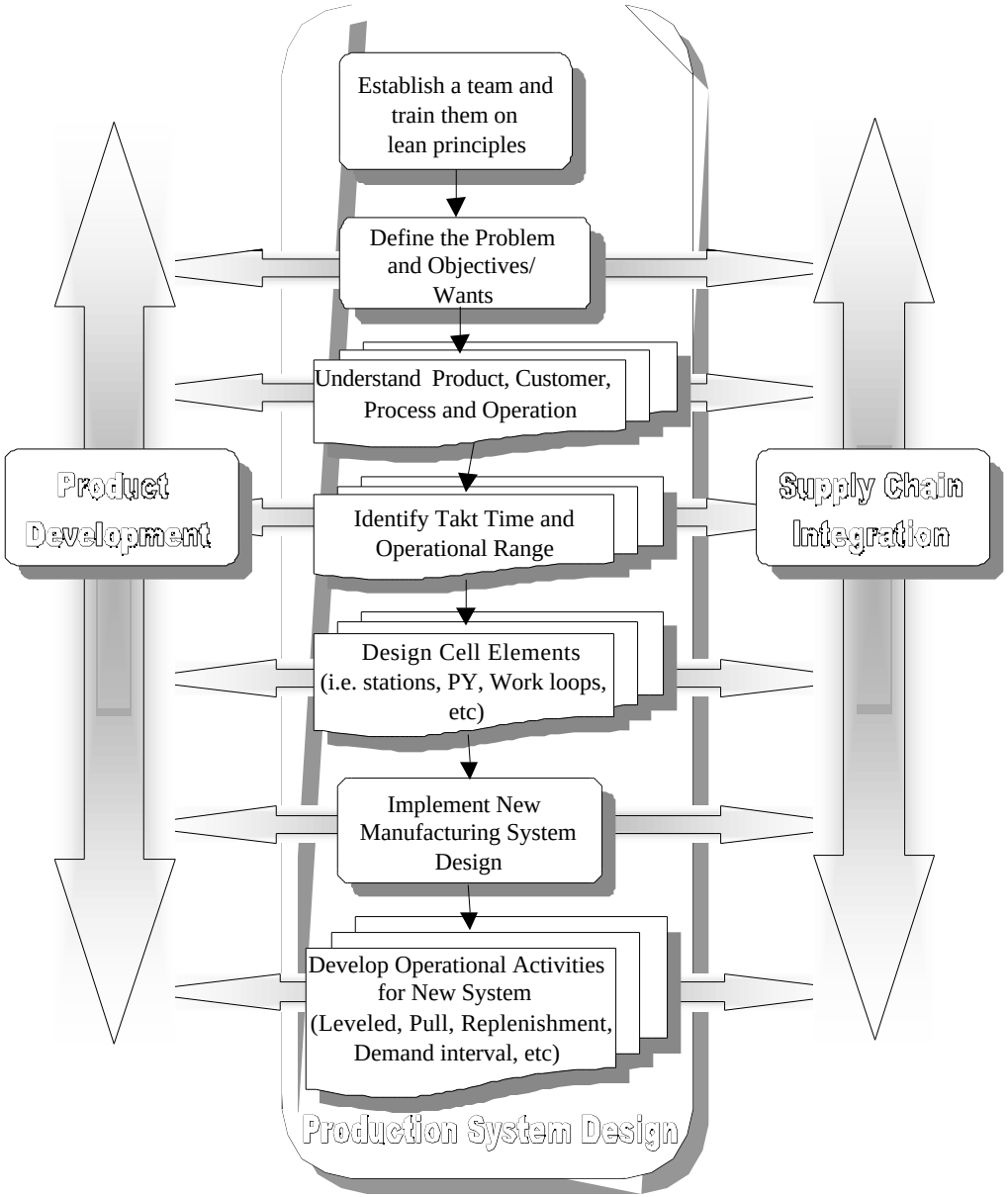
Production Area



- R&O of Components
- A component is a replaceable unit that comes from an engine (e.g. clutch, fuel control, Oil pump, etc)
- Two types of components:
  - Components coming from the engine (LRU)
  - Spare Piece Parts (Stand Alone)

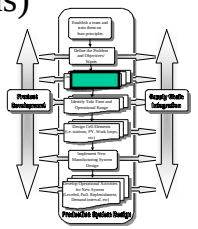
- 150 Employees
- $50M in sales

Same Methodology Used



Current Flow of Material and Information

(LRUs Only…for Stand Alone add at least 5 more persons)



Person # 1 Induction →

Person # 2 Make blue cards for the components
-Stamp if it needs to T/D

Person # 3 Create Child RO and Release #
Move to 705 LOC

Person # 4 Move component from 705 location
to assembly bench

T/D ? → No → - Move Component to LAB LOC

Person # 5 (Operator)
Yes
- Clean Parts
- Inspect Parts and Write Checksheet
- Clock To 720 LOC

→ - Input Check Sheet into Computer and create 'pick-tickets' to flag 1204/1205 locations to look for parts ***Person # 8***

↓

- Look for parts needed in 1204/1205 Location
- Place parts in box with 'pick-tickets' when available ***Person # 9***

↓

- 'Open-Screen' to match part with component
- Parts are moved to 823 LOC to match component ***Person # 10***
- When all parts needed are available, move to 701 LOC

RWK? → No → ***823 LOC***

Yes

Person # 6
- Create Grandchild RO and
- Clock to 410 LOC or 823 LOC

701 LOC

Person # 7
- Operator Picks Up Components from 701 LOC
- Perform Assembly of Component
- Move Component to LAB LOC

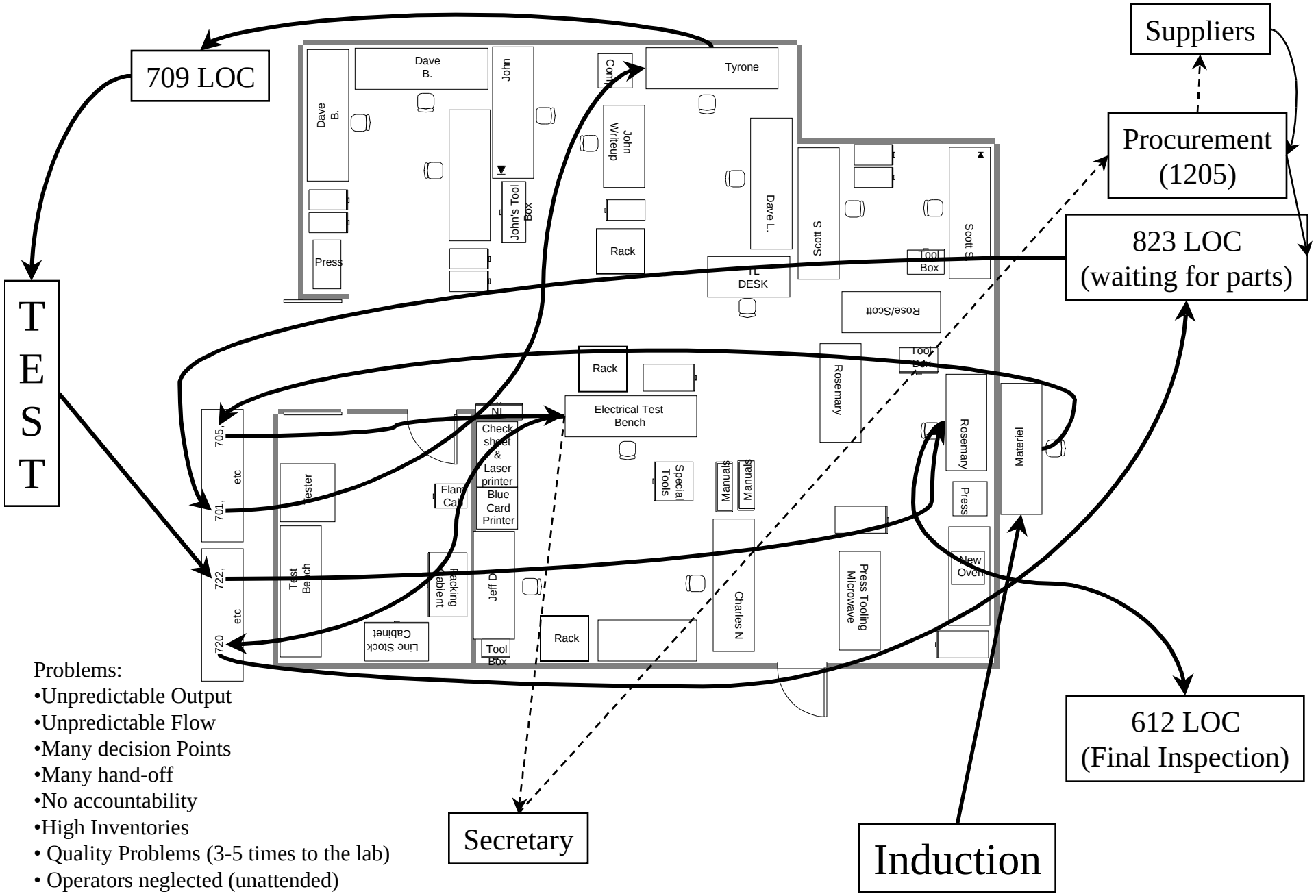
LAB LOC → ***LAB TEST*** ***Person # 15***

Person # 11 Engineer Opens Box, reads paperwork to
identify cause of failure and move to 722 LOC

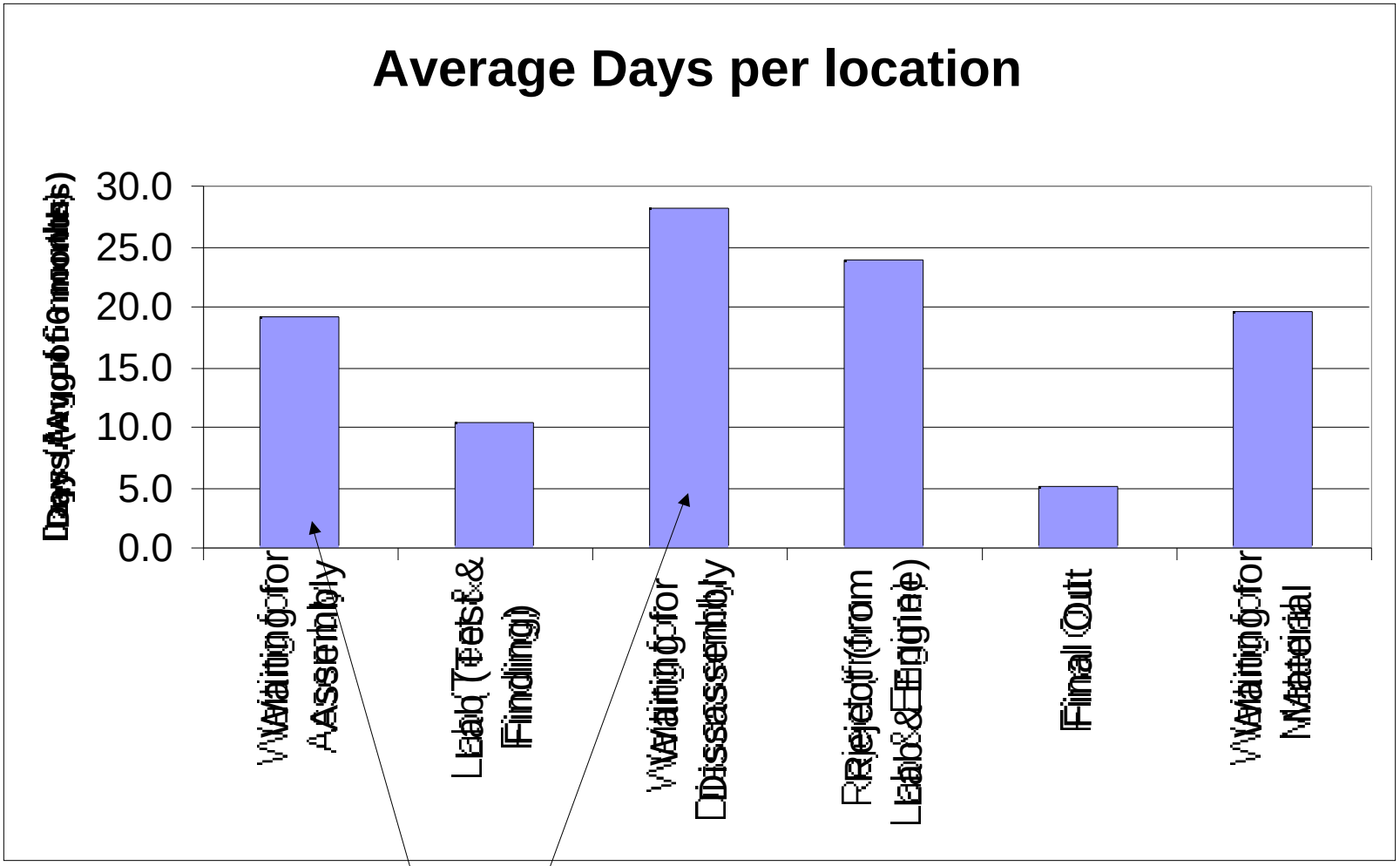
Person # 12 Move to 710 LOC if Passed Test
- Operators moves component from 710 LOC to workbench
- Final-Out
- Move component to 612 LOC

Person # 13
- Inspector takes component from 612 LOC, open box, visual inspects component, stamps paperwork and move to 621 LOC → - Materiel takes component and places it on cart for assembly ***Person # 14***

Current Process Map for component with no major problems



Problems:
- Unpredictable Output
- Unpredictable Flow
- Many decision Points
- Many hand-off
- No accountability
- High Inventories
- Quality Problems (3-5 times to the lab)
- Operators neglected (unattended)

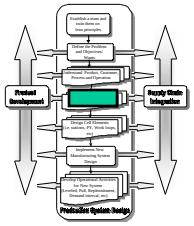


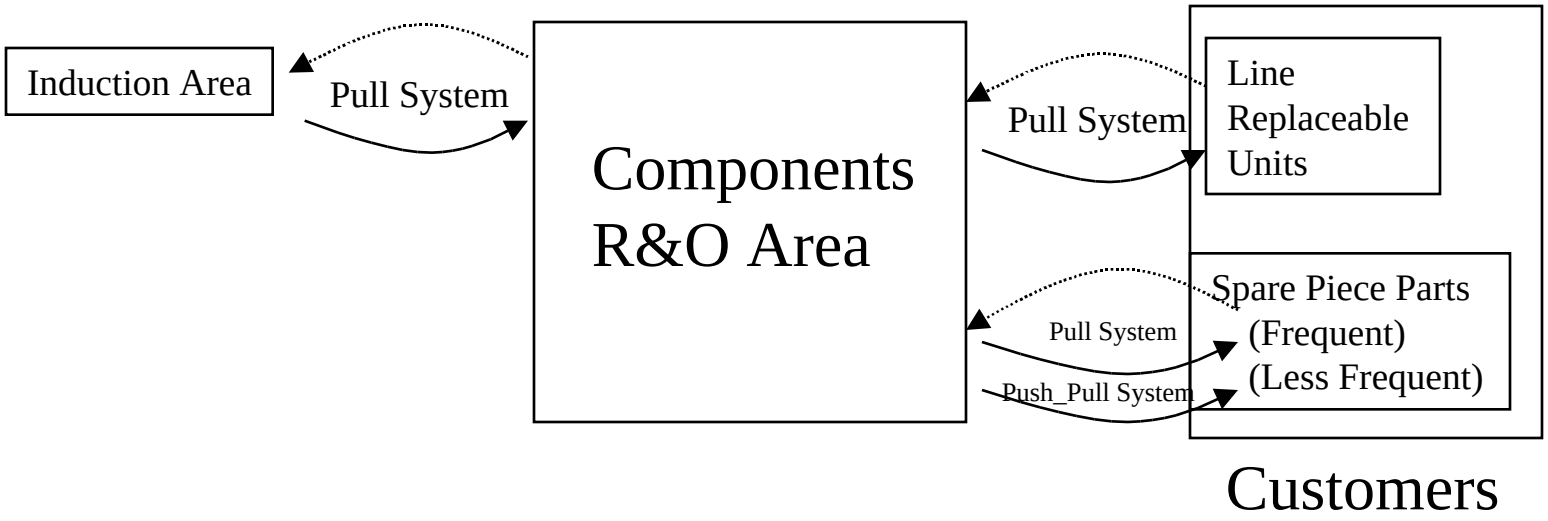
Problems with Capacity?

NO…

- Around 40% of operations are non value added (no standard operations)
- No Scheduling Tool
- Productivity never measured before
- Component is moving and may be clocked to “waiting for assy” location

New Components R&O Area Designed based on Customer Demand (TT)

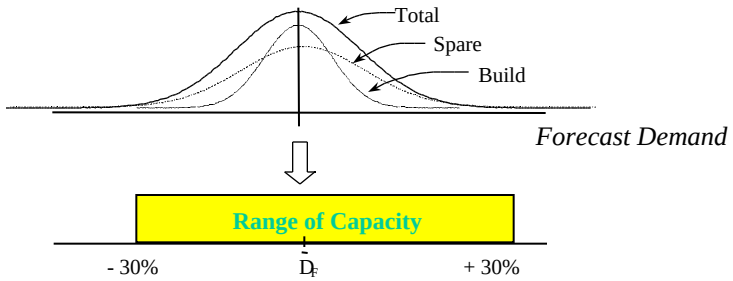




Within the Spare Piece Part Business, there are two types of customer

- Frequent Customer (Establish a Pull System)
- Less Frequent (Push-Pull System)

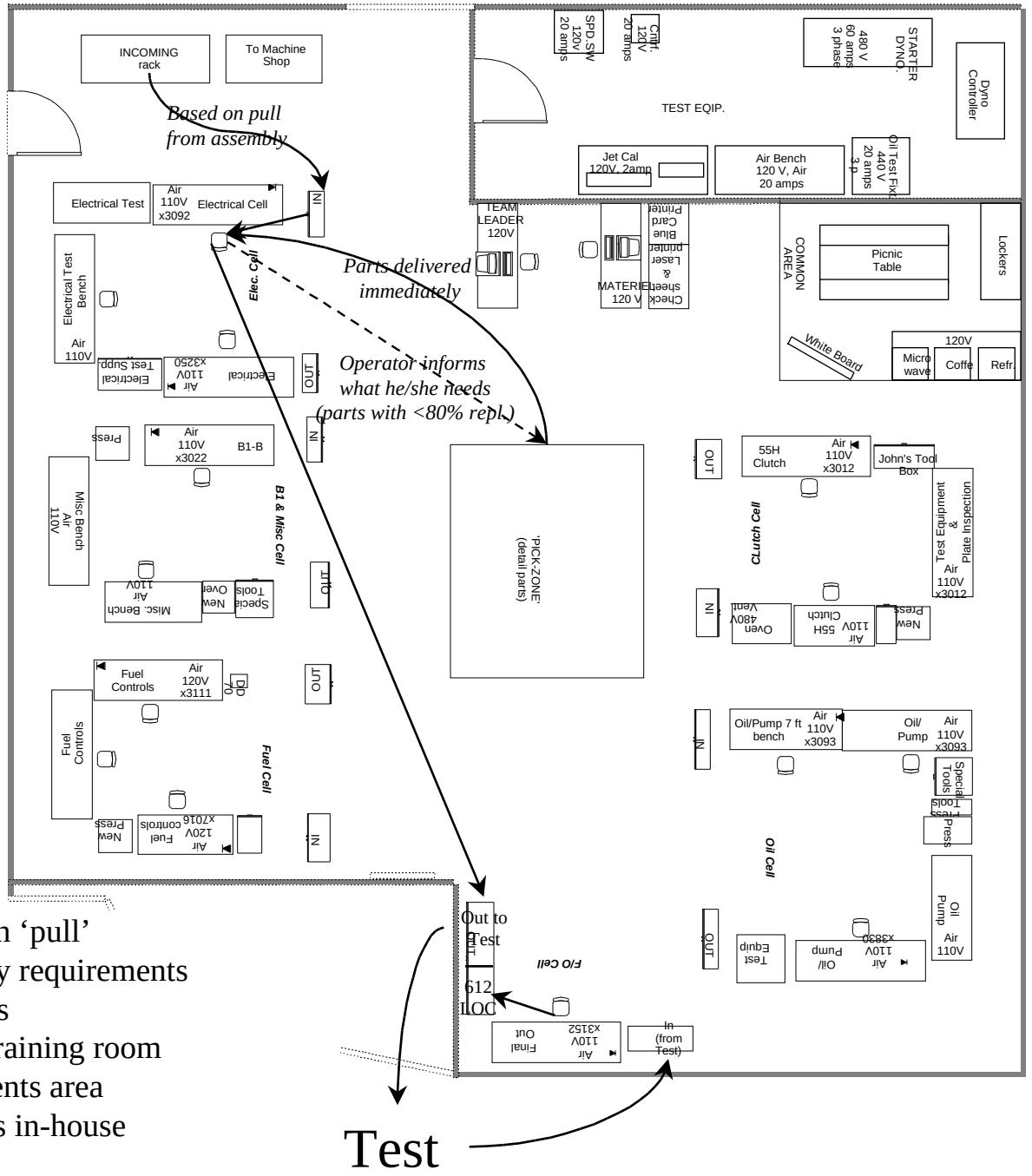
The takt time for cells in the components are is based on demand from every customer



Proposed Components Layout and Production

to be implemented by 10/98

- 6 Cells based on Families
  - Fuel Cell
  - Electrical Cell
  - Oil Cell
  - Clutch Cell
  - B1/ Misc Cell
  - Final Out Cell
- Takt Time of cell based on demand for LRUs and Spare Piece Parts
- New Break Room for operators



Highlights:

- 80-100% replacement parts at Stations
- Details Parts located in components area
- Production of engine components based on ‘pull’
- Production of stand-alone based on weekly requirements
- Components area grouped by type families
- Common area used as a break-room and training room
- Materiel and Engineer located in components area
- Test room double to test more components in-house
- Simple tests performed at station

Future

- Integrate Suppliers and change mentality of the Government Procurement
- Standardize Databases within and outside the company
- Implement an Enterprise Resource Planning to completely integrate every function within the company
- Continuous Improvement !