3P Production Preparation Process

Jonathan Corona, Eng.
Plexus Manufacturing Solutions
Jalisco, México
jonathan.corona@plexus.com

ABSTRACT
Currently the different product sectors are rapidly advancing in new technologies, causing products to change versions or even become obsolete faster than ever before. The required speed of introduction of new products derived from the acceleration of technology in current times cannot compromise the organization and standardization of the process design of manufacturing processes and the designing of a production line. Faced with, product quality, customer service and demand compliance the three non-negotiables that increase the complexity of launches that are in conflict in having shorter periods of execution as a challenge.

Therefore, it is important for the manufactures to find an adequate manufacturing system that helps meet both the external requirements of the market (time, cost) and those related to the product (quality, specifications), in such a way that waste and variations are optimized and reduced in manufacturing processes. A seven step Lean Manufacturing methodology will be presented as a standardization tool where multidisciplinary teams within the company work in an organized and systematic way for the process design of production lines and manufacturing systems that can support the introduction of new products, changes in designs, demand variations or transfers in geographic locations

Key words: 3P, standardization, manufacturing, production line, product, quality, lean manufacturing.

INTRODUCTION
Mr. Chihiro Nakao, a former Senior Manager at Toyota and founder of Shingijutsu in the sixties, developed this methodology.

3P is a systematic methodology for innovation in manufacturing engineering design that help to development a proper manufacturing system according with the external and internal requirements (Quality, Quantity, Cost and commit date)

WHY DOES COMPANIES DOES 3P?
Help to development a proper manufacturing system according with the external and internal requirements:

Quality requirement – The Right Features
Quantity requirement – How many / Mix
Cost requirement – Value vs Cost
Commit date requirement – Highest customer satisfaction

Add value to the process and the ability to create huge gains compared to traditional approaches, designing manufacturing assembly lines that eliminate or reduce:

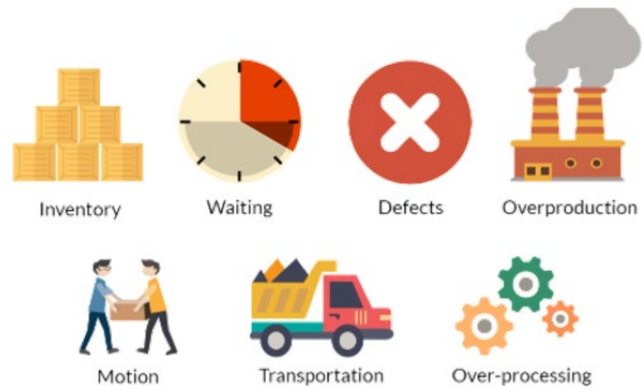

Figure 1. Seven Waste of a production process

WHERE AND WHEN IS 3P APPLIED?

1. Designing a new product or new product introduction
2. Relocating factory operations
3. During process quality improvement efforts (change to the product design)
4. Increase or decrease plant capacity to meet customer demand

With a method that moves quickly through seven steps, we can activate our thinking and help us gain understanding on the process as we evaluate the product and its coverage across the manufacturing layout solution.

WHAT ARE THE SEVEN STEPS OF 3P?

1. Define team and deliverables
2. Define Fish bone parts, Keywords and Jidoka for products
3. List of equipment, Tools, Takt time and Initial standard work
4. Layout design proposals with 7 flows, Change over, Mock up - simulation, and Install facilities
5. Run the line (Pilot)
6. Achieve target of deliverables, Final standard work
7. Release for mass production

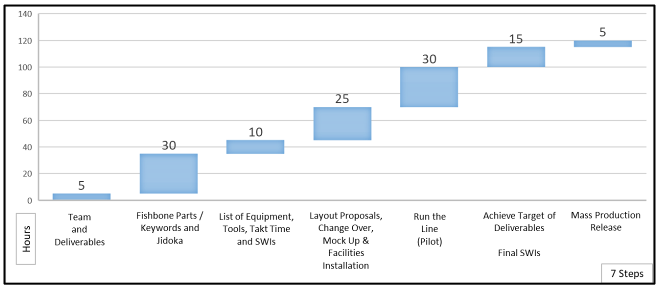

Figure 2. 3P Implementation Recommended Hours

(1) DEFINE TEAM AND DELIVERABLES

The team members must be composed from two or more departments or functional areas working together to handle a situation that requires capabilities, knowledge, and training (multidisciplinary team / customer focus team).

Team requirements

- Skills
- Technical knowledge
- Supporting
- Partnership
- Experience

Create deliverables, which are simply defined to measure progress and important for the business as well as customer satisfaction.

Another way to describe is what will we expect? In addition, what will be the results in terms of: resources, time, cost, space, sales, OTD, etc.

The deliverables must be touchable, realistic, and measurable

(2) DEFINE FISHBONE PARTS, KEYWORDS AND JIDOKA FOR PRODUCTS

FISHBONE PARTS

Objectives of a fishbone parts:

- For the team to gain knowledge on the product that will be assembled in the designed manufacturing line.
- To know the raw material that conforms the product
- Understand the sequence of the raw material that will be assembled

Completing previous objectives, helps develop the initial standard work (ABIs) and the key words on each operation.

The fish bone parts is key in the 3P methodology, every rib represent the product transformation process and each bone is a sub assembly of the next one.

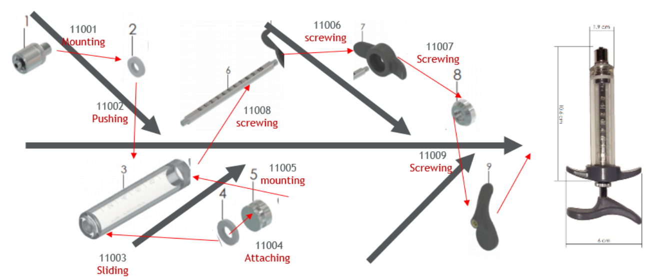

Figure 3. Fishbone parts example

KEYWORDS

The keyword is the action that needs to be done to perform the product transformation between two parts:

- Raw material and raw material
- Raw material and Sub-assy

Example:

- Paint
- Cut
- Paste
- Screw

JIDOKA

Jidoka is sometimes called autonomation, meaning automation with human intelligence, consisting of the following objectives:

- Eliminates the need for operators to continuously supervise machines and in turn leads to large productivity gains because one operator can handle several machines, often termed multi-process handling, reducing variations.

- This is because it gives equipment the ability to distinguish good parts from bad autonomously, without being monitored by an operator.

Jidoka steps:

a. Automation of process
b. Automation of holding
c. Automation of feed
d. Automation of stop
e. Automation of return
f. Part removal (Hanedashi)
g. Quality check - Pokayoke

Example: Keyword: **"Screwing"**

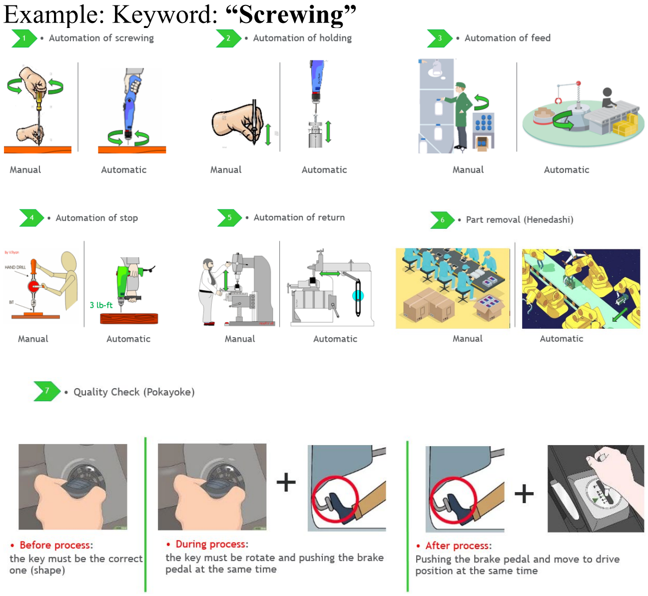

Figure 4. Jidoka methodology example

Developing a Jidoka matrix is essential to understand the capabilities of our processes.

The Jidoka matrix is linked to the fish bone parts, because it follows the assembly sequence and the raw material that we need to use in every steps of the manufacturing process, also including all machines, fixtures, work station and tools that we need to perform every define keyword from fish bone parts.

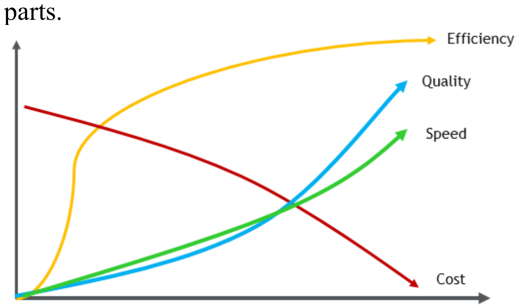

Figure 5. Process advantages doing Jidoka methodology

(3) LIST OF EQUIPMENT AND TOOLS / TAKT TIME AND INITIAL STANDARD WORK

LIST OF EQUIPMENT AND TOOLS

According with Jidoka matrix, now we know what kind of:

- Equipment Tooling
- Fixtures
- Work station
- Machines
- Pokayoke

Our process / product will be requiring.

TAKT TIME

Takt time is the maximum amount of time in which a product needs to be produced in order to satisfy customer demand.

The term comes from the German word "takt," which means "pulse." Set by customer demand, takt creates the pulse or rhythm across all processes in a business to ensure continuous flow and utilization of capacities.

- Takt Time = *Available Time / Demand*

- Total Machines = *Total Automatic Cycle Time / Takt Time*

- Total Work Station (Defined on Jidoka Matrix) = *Total Manual Cycle Time / Takt Time*

- Total Direct Labor = *Total Manual Cycle Time / Takt Time*

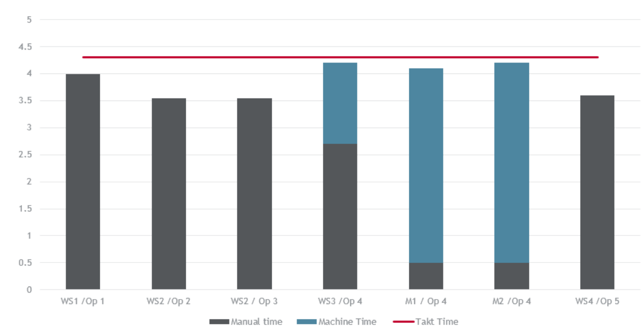

Figure 6. Balance Chart Example

INITIAL STANDART WORK

Having defined workstation, machines, headcount, tooling, and keywords from Jidoka matrix, now we can develop the initial standard work (visual aids) that will be tested in the pilot run.

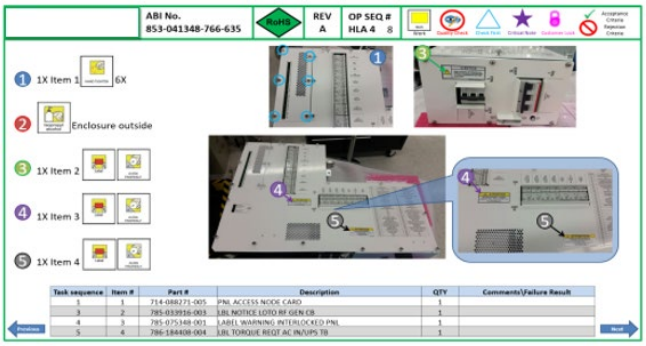

Figure 7. Standard Work Example

(4) LAYOUT DESIGN PROPOSALS WITH 7 FLOWS, CHANGE OVER, MOCK UP – SIMULATION, AND INSTALL FACILITIES

LAYOUT DESIGN

For Layout design, we need to consider the calculated resources obtained from Jidoka matrix for workstation, machine, tooling and headcount as well as the calculation of TT for the quantity of each of them.

Depending of the products that we are manufacturing (HMLV, HVLM) we need to validate what kind of manufacturing line is better.

The team need to develop at least five layout proposals using the Seven Nakao flows, which will afterwards be evaluated and the team will choose the best layout.

TYPES OF MANUFACTURING CELLS

Cells take different forms based upon the characteristics of the parts (P), quantities (Q) produced, and the nature of the process sequence or routing (R) employed. The relationship of these characteristics – P, Q, and R – and their influence on manufacturing cells can be seen in Figure 8.

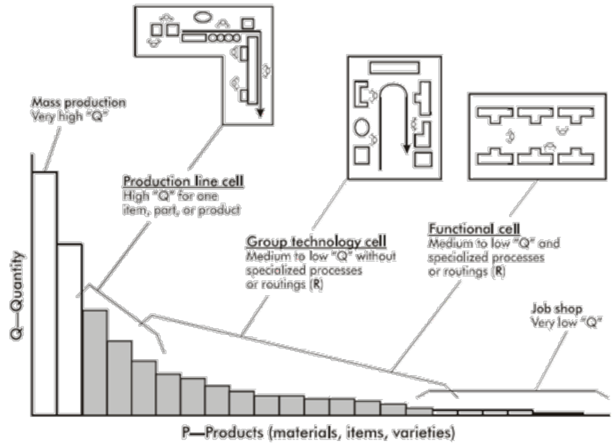

Figure 8. Key considerations in types of manufacturing cells definition.

LAYOUT AND FLOW PATTERNS

- Straight-through
- U-shaped
- L-shaped
- Comb or spine
- U-open shape

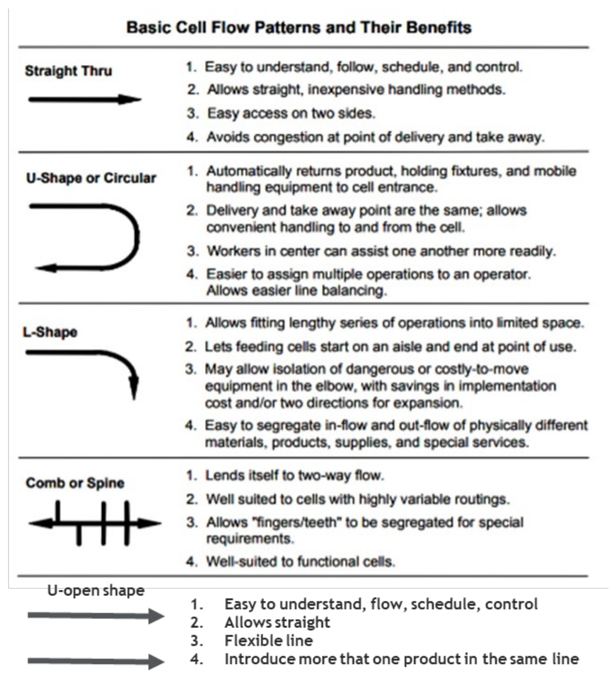

Figure 9. Flow patterns

Each of five proposals needs to be evaluated to get the best production flow, considering the seven Nakao flows.

1. Process flow (sequence of assembly)
2. Raw material flow (how the material will be delivered in the point of use)
3. People flow (How the operator moves through the production line)
4. Parts flow (How the part or sub assemblies moves between process or stations)
5. Equipment flow (How can we remove or integrate the equipment in the line)
6. Information Flow (How the information moves, delivery and receive the information)
7. Support Flow (How the technical support gives service or resolve issues in the lines)

Figure 10. Seven Nakao's Flows

The best layout should be obtained from proposals evaluation, considering:

- Cost, time of implementation
- Resources
- Area
- Products touches
- Others aspects that can be relevant for the operation / business

Criteria	WGT	Proposal layout 1		Proposal layout 2		Proposal layout 3		Proposal layout 4		Proposal layout 5	
		Score	Wtd	Score	Wtd	Score	Wtd	Score	Wtd	Score	Wtd
Process flow	3	1	3	3	9	1	3	2	6	3	9
Raw material flow	3	1	3	6	18	1	3	1	3	3	9
People flow	2	5	10	2	4	3	6	4	8	1	2
Parts flow	3	2	6	2	6	3	9	7	21	1	3
Equipment flow	2	2	4	5	10	7	14	4	8	1	2
Information Flow	3	2	6	8	24	9	27	2	6	1	3
Support Flow	3	3	9	1	3	10	30	2	6	5	15
Cost	2	1	2	10	20	6	12	1	2	6	12
Time for implementation	3	1	3	2	6	7	21	3	9	7	21
Complexity	3	2	6	4	12	4	12	8	24	1	3
Score			52		112		137		93		79

Figure 11. Pugh Matrix Evaluation Process

MOCK UP / SIMULATION

- Model Scale

- Digital Simulation

- Cardboard City

(5) RUN THE PILOT

Once we finished the production cell installation, a pilot run should be planned and executed to test our layout with engineering runs.

Variables		Indicator	UOM	Start	Target	ACTUAL Day 1	Day 2	Day 3	Day 4	Day 5
Output Variables		OUTPUT (UPH)								
		Head Count								
		Cycle Time								
		WIP #								
Input variables	WIP	Std WIP								
		Process WIP								
		P 2 P WIP								
	Down Time	Material								
		Quality								
		Changeover								
		Equipment								
	Defects	ICT								
		Fucntional								
		OBA								
		X1								
		X2								
		X3								

Figure 12. Indicators Matrix for Line Efficiency Test

(6) ACHIEVE TARGET OF DELIVERABLES AND FINAL STANDARD WORK

Once the pilot run has been finished, it is recommended to manage and follow an open action list to get a better tracking and ensure our deliverables were fully completed.

		% Closed	% Open
Quantity Open	5	55%	45%
Quantity Closed	6		
Quantity On Hold	0		

Open Issues List (OIL) JIT frame pilot

N	Issue / Action	Area	Owner	Date Rais	Due Date	Revised Date	Status	Comments / Notes
1	Modify OMS with pilot build findings	Process Engineering		23-Aug	4-Sep		Closed	
2	Update Agile BOM with correct material usage	Product Engineeering		23-Aug	4-Sep		Closed	
3	Generate PR to update mylam BOM	Product Engineeering		23-Aug	6-Sep		Closed	
4	Submitt PR to schematics redlines	Process Engineering		24-Aug	4-Sep		Closed	
5	Change the torque sequence on HL1 operation	Process Engineering		24-Aug	12-Sep		Open	
6	Design fixture to install security brackets	Process Engineering		28-Aug	12-Sep		Open	
7	Modify CellFusion torque metrics to HL1 steps	Process Engineering		29-Aug	4-Sep		Closed	
8	Include the torque seal validation in Quality Inspection OMS	Quality Engineering		29-Aug	6-Sep		Closed	
9	Complete PPQP phase 4 activities	NPI		30-Aug	14-Sep		Open	
10	Send FAIR to Lam for validation	Quality Engineering		30-Aug	9-Sep		Open	
11	Prepare information for PRR with Lam	Program Manager		1-Sep	18-Sep		Open	

Figure 13. Open Item List

Finally, we can perform the last version of standard work by:

- Improving work sequence and process flowchart
- Assuring line balancing according to process and customer needs.
- Best practices documentation.
- Factory visual aids.
- Metrics and indicators for process monitoring and feedback.

(7) RELEASE FOR MASS PRODUCTION

The last step of 3P is a formal meeting with the customer focus team and Functional / Operation managers to hand shake activities for the release of 3P process to mass production.

Figure 14. Mass Production Line Release / CFT

Never forget to congratulate the team!

CONCLUSIONS

3P application represents a huge opportunity for cost savings and operations improvement.

Results are reflected in:

- Cost reduction
- Increasing staff efficiency
- Meeting the customer demand
- Achieve product specifications and quality

Anything that has a lot of complexity in it is a good candidate.

The more components, materials, processes, transactions, etc, that are required to produce and deliver a part, the more opportunity there is to make drastic improvements through 3P by reconsidering alternative methods to do it the Lean way.

Plexus Guadalajara is using 3P process since 2017 and introducing successfully the NPI projects.