DESIGNING THE PRODUCTION PART APPROVAL PROCESS (PPAP) TO REDUCE THE TOTAL LEAD TIME

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Designing the production part approval process. PPAP process is a series of proactive measures before any part is taken up for mass production. This project was carried out to reduce the total lead time by eliminating the waste process or non-value added process. PPAP process ensures that the organization understands the requirements of the customer and also ensures whether the process has potential to produce the product consistently meeting the requirements. This process called PPAP in short. The problems in this process are identified through brainstorming session and then value stream planning was done to solve these problems. And then the quality analysis was done to ensure that the new process design is not affecting the quality of the product.

Keywords: PPAP-production part approval process, VSM - value stream mapping, VSD - value stream design, VSDIA - value stream design for indirect area

INTRODUCTION

Lean manufacturing, lean enterprise, or lean production, often simply, “Lean,” is a production practice that considers the expenditure of resources for any goal other than the creation of value for the end customer to be wasteful, and thus a target. However, the modern view takes a more holistic approach where the definition of waste is far more generic. Irregular production with ups and downs in production levels would be considered waste.

Three Mu’s of Lean Manufacturing Process

1. MURI- It is a strain due to
   - Over burden
   - Poor design
   - Posture
   - Non-availability of people causing stagnation or bottlenecks resulting in failures.
   - Doing work manually which are to do done by machines also causes strain.

2. MURA- it is inconsistency/improvement of load due to,

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• Busy in one and ideal in another area.
• Mixing of experienced and inexperienced.
• Variation in quality.
• Irregularity of tooling quality.
• Using equipment wastefully.

3. MUDA- it is waste due to,

**Overproduction** is to produce more than demanded or to produce it before it is needed. It is visible as storage of material. It is the result of producing to speculative demand.

**Transportation** does add any value to the product. Instead of improving the transportation, it should minimize or eliminated.

**Motion** of the workers, machines and transport (e.g., Due to the inappropriate location of tolls and parts) is waste. Instead of automating wasted motion, the operation itself should be improved.

**Waiting** for machines to process should be eliminated. The principle is to maximize the utilization/efficiency of the worker instead of maximizing the utilization of the machines.

**Processing** waste should be minimized. All unnecessary processing (non value added) steps should be eliminated. Combine steps where possible.

**Inventory** or Work in Process (WIP) is material between operations as a result of large lo production or processes with long cycle times. This creates excess inventory that requires extra handing, space, interest charges, people and paperwork.

**Defects:** Making defective products is pure waste. Focus on preventing the occurrence of defects instead of finding and repairing defects.

The 7 types of waste in production are:

- Overproduction
- Waiting time
- Transport
- Waste in the production process itself
- Storage
- Non-value-added movement
- Faults and rework

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**Figure 1: Fuel Injection System**

Fuel-injection system
1 Fuel tank, 2 Fuel supply pump, 3 Fuel filter, 4 In-line fuel injection pump, 5 Timing device, 6 Governor, 7 Nozzle holder with nozzle, 8 Fuel return line, 9 Glow plug (GSP), 10 Battery, 11 Glow plug and starter switch, 12 Glow control unit (GZS).
FUEL INJECTION SYSTEM

PPAP Process Description

PPAP is a process of handling the production part approval process every time before the physical product delivers. It means regular monitoring of part approval status, validity and block the shipments of the product without approval or expired.

Overview

PPAP is a process of maintaining and monitoring the customer approval of every product before supplier ship the goods to customer. The purpose of PPAP is to determine all the customer product specific requirements have been taken care by the supplier so that the customer manufacturing process has the potential to produce their final product and consistently meet their expectations.

Purpose

The PPAP for production components bought externally (PPAP), in the phases of development and operation, defines general requirements that products used for production have to satisfy. PPAP objectives are:

1. To define activities and responsibilities in order to ensure the correct application of PPAP for production components bought externally, as well as the process of development and operation;
2. To determine that general requirements have been properly applied

PPAP Requirements

1. Design Records: A copy of the drawing is received from the customer. Ballooning is done for studying the diagram and reviewing of technical specifications is done and documented.
2. Process Flow Diagram: A copy of the Process Flow, indicating all steps and sequence in the fabrication process, including incoming components.
3. PFMEA (Process Failure Mode and Effect Analysis): The PFMEA follows the Process Flow steps, and indicate “what could go wrong” during the fabrication and assembly of each component
4. Control Plan: The Control Plan follows the PFMEA steps, and provides more details on how the “potential issues” are checked in the incoming quality, assembly process or during inspections of finished products.
5. Measurement System Analysis Studies (MSA): MSA usually contains the critical or high impact characteristics, and a confirmation that gauges are used to measure these characteristics
6. Dimensional Results: A list of every dimension noted on the ballooned drawing.
7. Records of Material/Performance Tests: A summary of every test performed on the part. The quality engineer will look for a customer signature on this document.
8. Sample Production Parts: A sample from the same lot of initial production run. The PPAP package usually shows a picture of the sample and where it is kept (customer or supplier).
9. Master Sample: A sample signed off by customer and supplier, that usually is used to train operators on subjective inspections such as visual or for noise.
10. Checking Aids: When there are special tools for checking parts, this section shows a
picture of the tool and calibration records, including dimensional report of the tool.

11. Customer Specific Requirements: Each customer may have specific requirements to be included on the PPAP package. It is a good practice to ask the customer for PPAP expectations before even quoting for a job.

12. Part Submission Warrant (PSW): This is the form that summarizes the whole PPAP package. This form shows the reason for submission and the level of documents submitted to the customer.

Calculation of Total Lead Time: Total Lead time gives the total time taken by an element to be processed from a raw material to the finished element.

Value Added Time (VAT): is the time of work that actually transforms the product thereby increasing its value.

Non Value Added Time (NVAT): This time does not add any value to the product. Total lead time was calculated by adding the VAT and NVAT of each process and was obtained in days.

Problems Identification Through Brain Storming Session

- The total lead time of the entire process was found to be high.
- Repetition of the work was found in creation of test program.
- Non-value added process was consuming more time.

![Figure 2: Value Stream Mapping (VSM)](image)
With this session we could notice that we can reduce the lead time by merging the two process.

There was also a suggestion from the session members that any measures taken to improve (or) the process design should not affect the quality of the product.

**Problem Identification**
Observations from VSM

- The cip flash in the VSM drawn identifies the non-value added process that causes more lead time in the PPAP process.
- The total lead time was found to be 18.113 days, including both value adding and non-value adding elements.
- PPAP results not optimized in diesel fuel injection pump
- Non value added or repeated works were found
- As it was taking eight program files to be created in the test program creation, there was an increase in the manual work, among which four versions / program files were not required.

Observation from VSD

- Changes in calibration and functional audit:
  By merging the two process calibration and functional audit and by making the task to run in parallel 50% of the process time is reduced and transition time is eliminated.
- Changes in creation of test program:
  By eliminating the four test programs / versions / layouts which were very rarely asked by the customers 50% of the process time is reduced.
- From VSD, VSDIA was drawn which shows the future state.

The entire process is shown in a step wise sequence as shown below:

1. The process starts when they receive Purchase order and PPAP request
   PT=0
2. Then they call for a meeting were they decide the schedule and other required customer requirements
   PT=0.041d    TT=4.96d
3. After they finalize every thing in meeting, they start with the assembly using 1 assembly line and 3 shifts, 8 associates are involved in this process
   PT=0.042
4. After the assembly process they go for pre-stroke check, this is done by 2 associates using 2 benches
   PT=0.25    TT=0.75
5. Then they create test program for trial version (3 pumps)
   PT=1d    TT=1d
6. These trial version values are send to R&D department for the approval
   QT=0.33
7. If the trial values are approved from R&D dept. then they release layout which has to be updated in regular layout which is called PV updating.
   PT=1    TT=1
8. Once the PV layout is updated, pumps are ready for the calibration; this is done on calibration bench.
   PT=1d
9. Next step is Visual inspection, here they check visually for all the necessary parts assembled.
   PT=0.75    TT=0.25
10. Final audit or barrier audit is done; here they manually check torque and all the customer requirements.
mounting dimensions according to the offer diagram using tools like gauges and torque wrench. Then it is sent to the logistic dept for the dispatch.

11. Document is prepared for every PPAP order, And all the necessary documents required for the customer are sent along with the product.

PT=1  TT=0.5 QT=0.5

12. Before sending the product they arrange for a closing meeting for cross functional team, includes members from dept like quality, production, engineering (planning), development, application.

PT=0.08  TT= 0.16

**Final Observations**

1. The total lead time is 16.11 days after the improvements.

The Table 1 shows the comparison between the lead time before and after the improvements.

### Table 1: Lead Time Before and After Improvements (Figure 5)

<table>
<thead>
<tr>
<th>Processes</th>
<th>Total Lead Time in days</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Before</td>
</tr>
<tr>
<td>Release meeting</td>
<td>5.001</td>
</tr>
<tr>
<td>Assy. as per BOM</td>
<td>0.04</td>
</tr>
<tr>
<td>Pre stroke</td>
<td>2</td>
</tr>
<tr>
<td>Create test program</td>
<td>2</td>
</tr>
<tr>
<td>Coordination w.r.t delivery</td>
<td>0.33</td>
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<tr>
<td>PV update</td>
<td>1.5</td>
</tr>
<tr>
<td>Calibration and functional audit</td>
<td>2</td>
</tr>
<tr>
<td>Visual inspection</td>
<td>1</td>
</tr>
<tr>
<td>Check as per offer diagram</td>
<td>1</td>
</tr>
<tr>
<td>PPAP report</td>
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<tr>
<td>Quality gate</td>
<td>1</td>
</tr>
<tr>
<td>PAP closing meeting</td>
<td>0.24</td>
</tr>
</tbody>
</table>

The Table 2 shows the total lead time.

### Table 2: Total Lead Time (Figure 6)

<table>
<thead>
<tr>
<th>Total Lead Time in Days</th>
<th>Before</th>
<th>After</th>
</tr>
</thead>
<tbody>
<tr>
<td>18.113</td>
<td>16.113</td>
<td></td>
</tr>
</tbody>
</table>

**Figure 5: Graph of Total Lead Time**

**Quality Gate**

In the Quality gates, Quality analysis was done using the software Q-DAS. This was done to ensure that the process design is not affecting the quality of the product.

The process capability study is a longer-term
study. In addition to variation arising from the machine, external factors that influence the production process over a longer operating time are taken into account. Quantitative measures for capability or performance are Cmk, Cpk, Ppk. Minimum requirements according to CDQ0402. Process capability: Cpk ≥ 1.33 and Cpk ≥ 1.33.

**Q-DAS**

Q-DAS is an international Software company focusing on Statistical Analysis and Reporting Systems for every type of manufacturing industry. Q-DAS products encompass the complete software toolkit necessary for Data Collection, Evaluation and SPC Reporting of process quality data that is required to effectively implement 6 Sigma manufacturing strategies at every level of a manufacturing system. In addition to Quality Software Development, Q-DAS is a leading provider of training, Workshops and Seminars.
The procedure can only be used with the assistance of a computer.

RESULTS AND CONCLUSION
50% of process time is reduced in creating test program.

By merging the two process 50% of process time is reduced and transition time is eliminated.

Overall total lead time is reduced from 18.11 days to 16.11 days.

From the quality gates it is clear that the new process design is not affecting the quality of the product.

REFERENCES