

Lead Time Reduction of Flight Test Documentation

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Abstract — *Project work is being carried out at Pratt and Whitney in Puerto Rico where Flight Test Documents are drafted and delivered to Flight Test Managers in Pratt and Whitney USA. The current process Lead Time was calculated to be 40.58 days which was too high for Flight Test Managers. With the use of quality tools like Value Stream Mapping and Root Cause Analysis, the Lead Time was reduced to 28.92 days. This was achieved thanks to the removal of non-value added tasks and steps of the process*

Key Terms — *Flight Test Document, Lead Time, Value Added, Value Stream Mapping,*

INTRODUCTION

In today's Service Sector, companies need small lead times, low costs and high customer service quality to compete. Lead Time is commonly defined as the time that lapses between the placement of an order and the delivery of the order. Lead time can influence the customer service experience and impact companies costs. In an attempt to reduce lead time, companies can take existing activities that are non-essential and could eliminate them. By eliminating these non-value adding activities from the processes and streamlining the information flow significant optimization results can be accomplished.

The focus of this project is reducing the Lead Time of Flight Test Documents to Flight Test Engineers. This will be accomplished using Lean Tools and techniques to remove all operations or tasks that are non-value adding to the overall process.

BACKGROUND

Flight testing consists of developing and collecting data during the flight of an aircraft and then analyzing this data in order to validate various

aspects of the design. It is during this phase that design problems of the aircraft are caught and fixed. Once testing is completed, the aircraft can be certified and accepted by the customer who is purchasing it.

Pratt and Whitney Puerto Rico (PWPR) is tasked with creating a document used by Flight Test Engineers called Flight Test Documentation (FTD). FTDs are redacted to contain a list of changes in the aircraft along with the instructions on how to implement them. These documents need to be reviewed and approved by the Flight Test Engineers. Once approved, these documents are used by Flight Test Engineers and mechanics to implement the requested changes.

PROBLEM STATEMENT

Recently it has come to the attention of Pratt and Whitney Puerto Rico (PWPR) that Flight Test Engineers are concerned that not all FTDs are being delivered on a reasonable time and that aircrafts flight testing is being affected. This can have severe effects on the customer certification dates of the aircrafts and is something that needs to be addressed.

OBJECTIVE

The objective of this project is to reduce Flight Test Documentation delivery time.

METHODOLOGY

PWPR has excellent data collection tools in which the dates of each stage of the FTD execution process are logged. This historical data will be used to find all the different types of waste. By pointing out the instances of waste all the areas in need of improvement will be identified. The tools used for this analysis will be the following:

- **Time Study:** Work measurement technique consisting of careful time measurement of the task with a time measuring instrument, adjusted for any observed variance
- **Value Steam Mapping:** Is a flowchart method used to illustrate, analyze and improve the steps required to deliver a product or service. VSM is used to find and eliminate waste. Items are mapped as adding value or not adding value from the customer’s standpoint, with the purpose of removing items that don’t add value.
- **Root cause analysis (RCA):** Is a systematic process for identifying “root causes” of problems or events and an approach for responding to them.
- **Control Charts:** They are graphs used to study how a process changes over time. A control chart always has a central line for the average, an upper line for the upper control limit and a lower line for the lower control limit. These lines are determined from historical data. By comparing current data to these lines, the process variation can be deemed as consistent (in control) or unpredictable (out of control).

days. Also, Figure 1 shows a Variance of 1685.52 days.

Value Stream Mapping

The chance to reduce lead time in service lies within the service process itself. The time it takes to deliver a particular service to a customer is very significant. Therefore, for an organization to be able to reduce lead time, it must have lead time reduction as a company strategy. This will enable the company to address lead time issues more efficiently [1].

Lead time reduction has always attracted significant attention due to the rise of continuous improvement philosophies. Certain processes and their related time are regarded as waste and therefore should be eliminated or reduced. Elimination of delays as a type of waste in a process requires a clear definition of what constitutes value from customers’ perspective. Lead time reduction therefore involves a clear identification of the total lead time; its components, value adding and non-value adding time [2].

Non-value added is said to be the time spent on any activity that does not add value from a customer perspective. While value-added is defined by many as any activity that has significant influence on customer perceived value of a product or service. The classification of what constitute value and Non-value added time or activity lies in the areas between the extreme points of complete value. Value-adding is said to be characterized by the physical change of a service or product resulting from unrepeated process (done right first time) which a customer is willing to pay for. Non-value added activities normally are queuing time,

ANALYSIS

Time Study

Using historical data, the current process Lead Time and variance was calculated using Minitab. These results can be seen in Figure 1. Among the found Descriptive Statistics of the process, the Lead Time was calculated as 40.58 days per each document and it’s Standard Deviation as 41.06

Variable	N	N*	Mean	SE Mean	StDev	Variance	CoefVar	Minimum	Q1	Median	Q3
Lead Time	125	0	40.58	3.67	41.06	1685.52	101.16	1.00	8.00	29.00	50.00
Variable	Maximum										
Lead Time	210.00										

Figure 1
Minitab Descriptive Statistics: Lead Time

rework time and wasted time. However, what defines value-added or non-value-added may differ significantly from one organization or person to other [3].

To reduce lead time there should be two parts: First, describing the current state, and second, reviewing this state in order to find the causes and effects that are affecting the process. This can be done with the use of value stream mapping (VSM) tools. The purpose of a VSM is to identify and remove/reduce "waste". "Waste" can be defined as any activity that does not add value to the process [4].

FINDINGS

A Cause-and-Effect of non-Value adding and non-value adding but necessary activities is plotted to identify, sort, and display possible causes of a specific problem. It illustrates the relationship between wasted time and what customers are not prepared to pay for (Non Value Adding and non-Value adding but necessary Activity). For determining causes and effects of waste, the construct of a causes and effect diagram using the fishbone analysis will help in determining the root causes of waste and longer lead time [5].

Root Cause Analysis

The following wastes were identified via Root Cause Analysis as shown in Figure 2:

- Time researching FTD is large
 - PW PR can't have direct communication with Foreign Engine Parts Flight Test Managers (FEP FTM) due to export regulations.
 - Constant reworks.
 - Manual FTD Approval Process is too slow.
 - Number of inspections in the process is too large
 - JCL2 numbers of practitioners is low
 - Lack of export license that includes PW PR.
- Need of an electronic Database to store FTD once completed and to keep track of them.

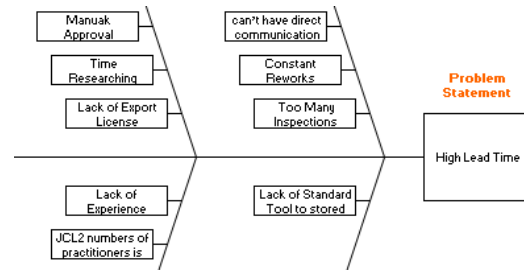


Figure 2
Root Cause Analysis

FUTURE STATE VALUE STREAM MAP IMPLEMENTATIONS

Based on the future state of the value stream mapping a new process flow was implemented. Non value added activities were reduced or removed by implementing the following measures:

- **Provide on the job training to newer employees** – A couple of the team members are newer employees. This clearly affects the lead time of the Flight Test Documents (FTD) as their defects numbers are normally high and their time in redacting the documents is slower in comparison to more seasoned members. Giving more guidance to these employees will clearly reduce the number of reworks and the time wasted in gathering the required information to successfully redact the FTD.
- **Eliminated Inspections** – The process had too many inspections. FTDs content was first inspected and after they were signed for approval by each Flight Test Managers and the Customer they were inspected again. This could mean that each FTD could be inspected at least 3 times. The content inspections are the more important and were the majority of the imperfections are found, therefore it will be prioritized. Also, this is only where a critical issue could arise
- **JCL2 number increased** – Due to the nature of the U.S export regulations these FTDs need to be classified in order to comply with them. Due to the lack of individuals with the knowledge to classify FTDs they sometimes spent too much time in queue and delayed

Flight Testing schedules as a result. Because of this FTM have taken export regulations trainings and have been certificated as JCL2. Also, PW PR members have been certificated and can now classify FTDs.

- **PW PR can't have direct communication with foreign Engine Parts Flight Test Managers (FEP FTM) due to export regulations** - .Some parts of the aircrafts are produced by a foreign company as a joint venture. This company provides necessary inputs regarding their produced parts but their involvement in the production of the aircraft is limited to only these parts, therefore the information exchanged between them and FTM needs to be monitored in order to prevent a regulation violation.

Pratt & Whitney Puerto Rico (PW PR) was forbidden to talk with any member of this foreign company. When any need for information regarding the parts manufactured by the company came up PW PR had to communicate with FTMs so they could contact JCL2s in order to approve the information inquiry. Once approved FTM communicated with the foreign company and their answer was forwarded to PW PR.

Due to PW PR members being certified as JCL2 and an increased in JCL2 within the member of FTMs this is no longer a concern. Information inquiries can be quickly reviewed and sent to the foreign company. PW PR can use the same license as PW USA.

- **Electronic Signatures Implemented** – The FTD signature process was completely manual. The reviewers printed the documents and hand signed them. Then their signatures were scanned and added to the FTD. This process was repeated until every one of the reviewers approved the FTD. To accelerate this process an electronic signature process was added so all the manual hassle can be avoided.
- **Electronic Database** – Every FTD was tracked in a Spreadsheet. This caused the spreadsheet to malfunction from time to time due to metadata corruption. Also, every

member of the FTD team has access to it and could change some data by mistake. This concern was taken to the FTM and a Web Tool was implemented in order to track and stored the FTDs.

RESULTS

The implementation of the Future State VSM resulted in a significant change on the mean and standard variation of the process. The mean changed from 40.58 days to 28.92 days and the standard deviation changed from 41.055 to 19.673 which is a reduction of 59.2%. Figure 3 Control Charts also show the substantial decrease in Variance of the process.

These results were obtained via Minitab using a Before/After I-MR chart. This chart is intended to make comparisons before and after a process change. Although the primary objective is not process control, the I-MR chart checks the data for stability, normality, correlated data, and the amount of data, which can affect the accuracy of the chart. If the data is not normal, Minitab automatically corrects the problem when possible.

Since the implementation of the Future State VSM, 28 FTDs have been delivered. This sample is large enough to consider this new tendency as reliable. Also, the new implemented changes have caused a 67.11% reduction in the defect ratio on inspections.

CONCLUSION

The implementation of the new process with non-value added tasks removed resulted in a reduction of the Led Time from 40.58 days to 28.92 days. Also, the standard deviation was reduced from 41.055 to 19.673 which was a reduction of 59.2%. Both of these changes are considered significant and from now on PWPR has committed itself to deliver all FTDs in a 30 day period to Flight Test manager.

The new process will be monitored with statistical control charts from now on to make sure it remains under control.

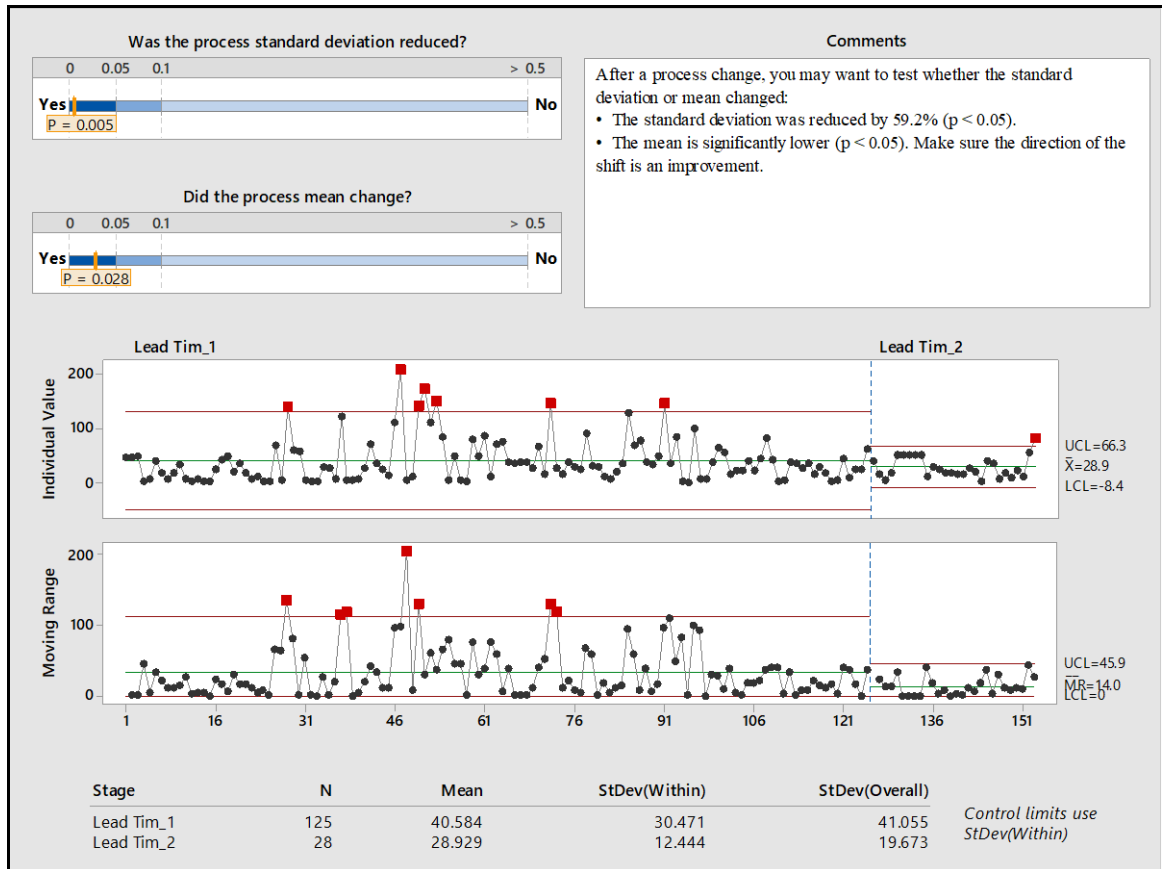


Figure 3
Minitab Before/After I-MR Chart of Lead Time

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