

# ***Improvement and automation of functional readiness review presentations for an engine program***

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**Abstract** — *The purpose of this project is to automate the generation of the Functional Readiness Reviews (FRR) presentations for the Pratt & Whitney modeling group's validation of the State Variable Model for engine control systems. The objectives are to eliminate human error and reduce the time it takes to create the presentation from upwards of 38 hours to 1 hour or less. To achieve these objectives a Value Stream Mapping event was completed. This event led to the development of two different tools, one to generate plots and one to create the final FRR presentation. The first tool was implemented as a script for Unigraph and laid the base for the time reduction in the creation of the FRR presentation by creating separate images for each plot in a standard folder structure with a standard naming convention. The FRR presentation tool was implemented using a combination of Microsoft Excel and Visual Basic for Applications (VBA). This tool automated the generation of the PowerPoint Presentation and reduced the time it takes to create the presentation to 10 minutes once the inputs are provided.*

**Key Terms** — *Functional Readiness Review, Software Development Lifecycle, Timing Analysis, Value Stream Mapping.*

## **INTRODUCTION**

### **Background**

Infotech Aerospace Services, Inc. is a company based out of Isabela, Puerto Rico. The company has been in business since 2003, providing a variety of aerospace solutions to multiple customers. One of the departments in the company is Software Systems and Electronics (SSE). SSE provides software solutions to aid engine software development for Pratt and Whitney (PW) engines.

One of the PW groups that SSE supports is the engine modeling group.

The engine modeling group defines the control laws architecture, develops control requirements, and performs design and validation of classical and advanced control techniques. One of the projects SSE supports for the modeling group is the validation of the state variable model (SVM) for engine control systems. The SVM is a linear on-board engine model.

Every new version of SVM needs to be validated in order to determine compliance with requirements and expectations. To accomplish this task a functional readiness review (FRR) presentation is created with every new software version. In this presentation a set of engine parameters is monitored and recorded to analyze overall engine performance.

In the case of this particular set of engine programs, it takes three different processes to complete an FRR presentation:

- **Data Generation:** the model is run to generate data for the engine parameters to be analyzed in various scenarios.
- **Plot Generation:** the data obtained from the model is plotted to create a PDF with the different engine parameters in various scenarios.
- **FRR Presentation Creation:** the PDF is used as input to create the FRR presentation using a PowerPoint template.

An FRR presentation can have anywhere from 11 to 34 different engine parameters. Each of these parameters uses 1 of 6 different slide packages that can have 4, 9, 11, 12 or 21 slides. On average the presentation features 20 different plots per engine parameter.

Even though the task itself is not complex, it is very time consuming, prone to human error and requires multiple inspection points. The simplest presentation consisting of 11 different engine parameters can take upwards of 38 hours to complete.

### Objectives

The scope of the project is limited to the Plot Generation and FRR Presentation Creation processes. The objectives for this project are:

- Eliminate human error in the creation of the images used as input for the FRR presentation and in the creation of the presentation.
- Reduce the time required to create the presentation from upwards of 38 hours to 1 hour.

## METHODOLOGY

The methodology used for the project consists on performing a Value Stream Map (VSM) event on the process of generating the plots and the process of generating the presentation itself. Once these processes were mapped and analyzed for improvements, the software development life cycle was applied to create automated tools to generate the FRR presentation. Finally a timing analysis was performed to validate the time reduction in the creation of the FRR presentations.

### Value Stream Mapping

Value Stream Mapping is a technique that is used to map out, understand and redesign information, people and product flows [1]. The intention of a VSM is basically to map the current process, propose a future process and create an action plan to achieve the future process.

### Software Development Lifecycle

The software development lifecycle is the process used in software engineering to plan, develop, test and deploy software. It is a phased approach that includes: requirements development, design, implementation, verification, validation and deployment of a software product.

## Timing Analysis

A timing analysis is an analysis of the time it takes under the current approach to complete a task vs. the time it takes to complete the same task using a different or improved approach.

## ACTIVITIES SUMMARY

A VSM was performed on the two processes targeted for improvement: Plot Generation and FRR Presentation Creation. The current and future state process maps for the Plot Generation process is shown in Figure 1. The current and future state process maps for the FRR Presentation Creation process is shown in Figure 2.

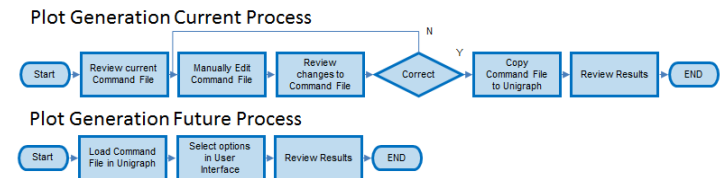


Figure 1  
Plot Generation Process Map Comparison

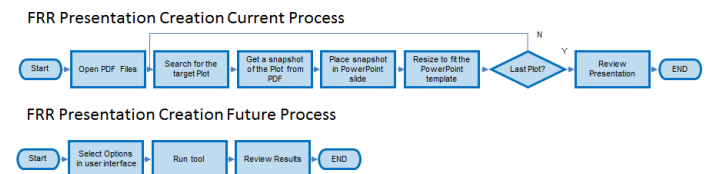


Figure 2  
FRR Presentation Creation Process Map Comparison

As part of the implementation plan for the future state process maps of each process, a set of requirements was created for each process. These sets of requirements outlined the automation needs required for the implementation of automated tools and were used as an input in creating a high level design to determine implementation options.

In the case of the Plot Generation process the implementation option was an upgrade to an existing tool in a Unigraph scripting language. Unigraph is a United Technologies Corporation (UTC) proprietary program to plot data. The focus of this implementation was in a user interface and a

standardization of a folder structure and naming convention.

In the case of the FRR Presentation Creation process, there was no existing tool, but there was a requirement to have a PowerPoint presentation as the output. This PowerPoint output uses various slide templates to include plots generated in the Plot Generation process.

For the FRR Presentation Creation tool, the following programming language alternatives were analyzed: Java, .NET and VBA. The analysis performed included interviews with experts on the different options, researching books on Java [2], .NET [3]-[4] and VBA [5] and a review of the Microsoft developer network library [6].

The experts provided a high level outline plan on the implementation required for each programming option, including expected objects, interfaces and completion time to have a final product ready for verification. The Java option was listed as requiring 210 hours to complete due to the need of creating multiple objects and interfaces. The .NET option was listed as requiring 130 hours to complete by accessing existing objects in the MS office suite of products. Finally, the VBA option was listed as requiring 90 hours to complete by using MS Excel as the main program, thus reducing the amount of programming required and then interfacing with MS PowerPoint. This information was then reviewed against book information and the Microsoft developer network database to assess validity and viability of the options.

After careful consideration of the information presented and reviewed, it was decided to go with the VBA option. This option provides the fastest and easiest implementation. It's also the easiest to maintain and update to add options. The implementation will include an Excel spreadsheet as the main user interface which allows including information in an easy to update and see format, while providing protection from unintentional changes.

Once the implementation options were selected, the tools were implemented, verified internally, validated with the customer and a timing

analysis was performed to validate the time reduction.

## **PLOT GENERATION TOOL**

### **Description**

The plot generation tool is a script for Unigraph. It has a simple user interface in command line format. It takes the information from the user or the user can select the default values for each input, except engine variant, which is required. Once the user completes the required fields, the tool proceeds to create all the plots. If the option for FRR presentation is selected, the tool creates a folder structure and places the separate image files for each plot using a standard naming convention and location. The tool includes data validation to the inputs to make sure they are feasible. The tool takes approximately 12 minutes to plot every parameter and create the files.

The inputs for the plot generation tool are:

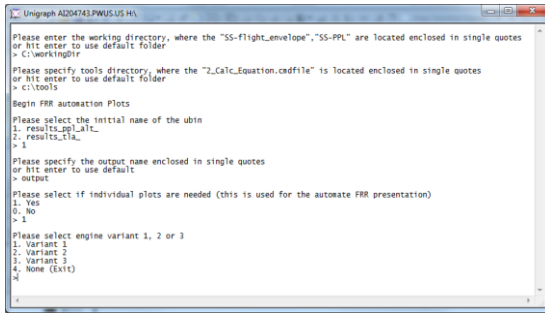
- Data location
- Tools location
- Input Name
- Output name
- Decision if the tool run will be used for FRR Presentations
- Engine Variant

The outputs for the plot generation tool are:

- PDF with plots
- Separate image files for each plot in a folder structure if the tool is run to create FRR Presentations.

### **User interface**

Due to export control restrictions, the actual user interface cannot be shown, but is similar to Figure 3.



**Figure 3**  
Plot Generation Tool User Interface

## FRR PRESENTATION CREATION TOOL

### Description

The FRR presentation tool is an Excel spreadsheet with a Macro that connects to PowerPoint and creates a presentation. The tool consists of a set of worksheets that provide the basic architecture for the user interface and for the PowerPoint slides and a macro that finds the information and assembles the PowerPoint presentation. This tool automatically finds the plots in the folder structure and formats them to the required slide template. The tool includes data validation for inputs and the output presentation. If an image is missing it provides the link and name of the missing file so it can be recreated if needed. The tool takes approximately 10 minutes create an 11 parameter presentation.

The inputs for the FRR presentation tool are:

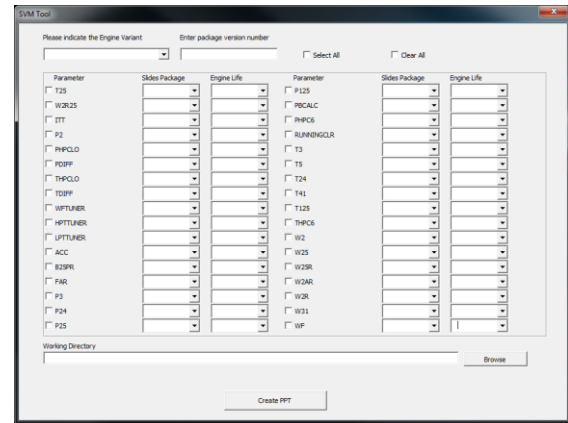
- Engine Variant
- Location of the folder structure
- Parameters to include in the FRR presentation

The output for the FRR presentation tool is:

- PowerPoint presentation with the plots for the parameters selected in the user interface.

### User interface

Due to export control restrictions, the actual user interface cannot be shown, but is similar to Figure 4.



**Figure 4**  
FRR Presentation Creation Tool User Interface

## RESULTS

The process to create FRR presentations was listed and validated at 38 hours for a standard 11 parameter presentation. With the implementation of the tools, the process was validated at taking 30 minutes for a 34 parameter presentation and 22 minutes for the same standard 11 parameter presentations. This represents a reduction of 99% of the time and cost.

**Table 1**  
Time Reduction Analysis

<i>Process</i>	<i>Current Process</i>	<i>Updated Process</i>	<i>Reduction</i>
Plot Generation	0.8 hrs	0.2 hrs	75%
FRR Presentation Creation	35.2 hrs	0.17 hrs	99.5%

The tools provide the opportunity to create multiple presentations using different scenarios and more parameters than were feasible before in a shorter time frame and for a fraction of the cost.

## CONCLUSION

The implementation of the tools was completed ahead of schedule and under budget. The objective to eliminate human error in the creation of the images used as input for the FRR presentation and in the creation of the presentation was achieved by creating user interfaces that eliminated the interaction of the user with the Unigraph script code and the need to manually place the plots into

the PowerPoint presentation. The objective to reduce the time required to create the presentation from upwards of 38 hours to 1 hour was achieved with the tools performance. The overall process takes less than 1 hour for every presentation size.

The tools created a productivity improvement in the SVM validation and provided the opportunity to create multiple presentations using different scenarios and more parameters than what was feasible before. The customer approved the improvement and awarded a productivity improvement savings of \$37,560.00.

## REFERENCES

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