Improving Efficiency in Military Aircraft Maintenance Operations in Terms of Jobs Completion Time

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Abstract *— Extensive job completion time in the aircraft maintenance operations has resulted in countless extra man-hours and impacted thousands of military missions for decades. The main cause of this problem narrows down to the time spent in preparation to start a maintenance task. Current operations of an aircraft maintenance organization in Kadena Air Base, Japan, were evaluated in efforts to reduce the time to at least 50%. It was found that by implementing a software tool developed by a startup company, maintenance start times can be reduced up to a 60%, allowing aircraft to a mission-ready status much quicker and giving back time to technicians for resiliency and proficiency training.*

Key Terms *— Aircraft Maintenance Operations, Aircraft Tools & Equipment, Aviation Maintenance Process Improvement, Maintenance Task Management.*

INTRODUCTION

As military aircraft technicians are dispatched to perform a maintenance task, three elements are most likely needed: tools & consumables, support equipment, and the technicians performing the task. It is essential for maintenance organizations and their members to start and complete the job as soon as possible. Doing so increases the aircraft's availability to support other missions and provides maintainers time to tackle other maintenance tasks or to conduct proficiency and readiness training as needed. Therefore, high efficiency in military aircraft maintenance operations ins imperative. Current maintenance operations in the United States Air Force are hindering the maximum potential of their force to conduct efficient maintenance. To solve this problem, a study was conducted in Kadena Air Base, Japan, to identify key factors and generate the most efficient solution.

Motivation for Study

While specific maintenance tasks have benefit from the implementation of innovative ideas, there still plenty room for improvement in the overall military aircraft maintenance operations, particularly within the United States Air Force. In most military bases, the three most-needed elements to perform a maintenance task are geographically separated. The problem lays in the integration of all three in the current process, particularly in the time spent between the notification of a maintenance task and having maintainers on the aircraft fully ready to perform the task. This time is known as "Start Time", which varies depending on the task requirements and directly affects overall job completion.

Objective

The objective of this project is to improve efficiency in the military aircraft maintenance operations by reducing "Start Time" to at least 50%. A study was conducted to identify factors affecting current process with the intent of developing solutions to meet the objective. The solutions must be cost-effective and aligned with military policies in conjunction with local and federal regulations.

BACKGROUND

Military Aircraft Maintenance

The Air Force Smart Operations of 21st Century (AFSO21) is probably the most popular initiative, which "was designed to increase productivity, responsiveness, and efficiency, thus improving equipment readiness, reliability, and availability" [1]. The initiative supported the "Red is Good" culture in the aircraft maintenance community, which utilize metrics to bring problems to light

rather than been used as measurement of failure or success. Moreover, “Red is Good” is what ignited the proposal for this study.

In the aviation industry, particularly in military operations, time is critical [2]. One breakdown in the process of maintenance operations could add hours to an aircraft on the ground, jeopardizing time-sensitive missions, and overall health-of-fleet status. Companies like Fleetio offers application software to streamline the management and maintenance operations of an aircraft fleet. While aviation maintenance is reviewed, four areas are highlighted: manpower, facilities, tooling, and equipment [3]. It is important to understand each area and find the most efficient way to integrate all, while maintaining compliance of local and federal regulations [4].

Organizational Structure

In the United States Air Force, aircraft maintenance organizations are broken down into three main departments: Aircraft Sortie Generation, Support Sortie Generation, and Aircraft Maintenance Management.

- **Aircraft Sortie Generation:** This is the largest department and most important, as it is the on-field team performing the inspection, servicing, and repair of the aircrafts. Unlike other military branches, aircraft technicians are broken down into eight specialties: Engines, Hydraulics, Electricians, Electronic Warfare, Fuels, Communication & Navigation, Guidance & Control, and Crew Chiefs. This type of structure allows having experts on each major aircraft systems for more reliable and efficient maintenance. Whitin this department is also found the Production section, which directs the aircraft maintenance thru the management of these specialties.
- **Support Sortie Generation:** While this department is often overlooked, it is at times the most impactful within an aircraft maintenance organization. It stores, maintain, and manage all tools, equipment, and hazardous materials required for the performance of aircraft maintenance. This requires the management of approximately ten major programs ensuring the integrity of a $15 million inventory sustaining reliable and safe aircraft maintenance.
- **Aircraft Maintenance Management:** This department collects, retrieve, and provide all data impacting the health of an aircraft fleet. Data includes maintenance actions, time of aircraft out of commission, number of flights, etc. This data is utilized to identify trends and overall health and performance of the fleet. Organizations leaders made informed decisions based on this data, therefore its integrity is imperative.

METHODOLOGY

Since the objective of this project is to improve current process, the traditional DMAIC model, shown in Figure 1, was implemented to drive the study. The following provides a quick overlook of the study roadmap utilizing the aforementioned methodology:

- **Define** – Although there is a general knowledge of how efficiency is being affected across all military aircraft maintenance organizations, one will be selected to maintain relevance of the study and safeguard the integrity of the collected data.
- **Measure** – The study will revolve around the Time, Cost, and Feasibility of the alternative to improve the process.
- **Analyze** – Current operations will be monitored and documented for a period of one week to identify organizations-specific problems, investigate root causes, and generate possible solutions.
- **Improve** – Implement possible solutions for one week and compare results against the previously analyzed.
- **Control** – Determine which solutions best fit the organization needs and meet the study objective. Identify any areas within the recommended solutions that might be worth to go through another DMAIC study.

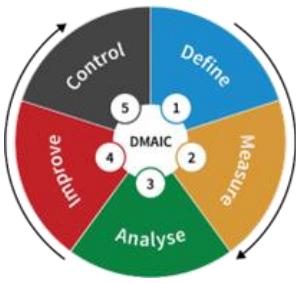

Figure 1
DMAIC Model

ANALYSIS APPROACH

As stated in the methodology model, current aircraft maintenance operations were monitored to identify the major factor affecting maintenance efficiency in terms of job completion.

Major Factor

Observation was conducted for a period of one week, where maintenance tasks where timed from start to finish. They were then broken down into four categories: preparation, maintenance, follow-up, and others. The following explains each of them while collected data is found in Figure 2.

- **Preparation:** it starts when a technician or maintenance team is notified of a maintenance discrepancy requiring a corrective action. It then ends when they have everything required to start the job. It also includes being at the affected aircraft, ready to start the repair.
- **Maintenance:** process in which the repair or maintenance task is performed, up to the point where the affected system is ready for operational checkout.
- **Follow-up:** actions taken to ensure safe operation of affected system. This includes operational checkouts and leak checks.
- **Others:** other factors affecting job completion. Most are out of technician's control and may include weather, work schedule, etc.

It is evident that the major factor affecting job completion is during preparation. For this project, it will be known as "Start Time", as it is the time spent to start the maintenance process.

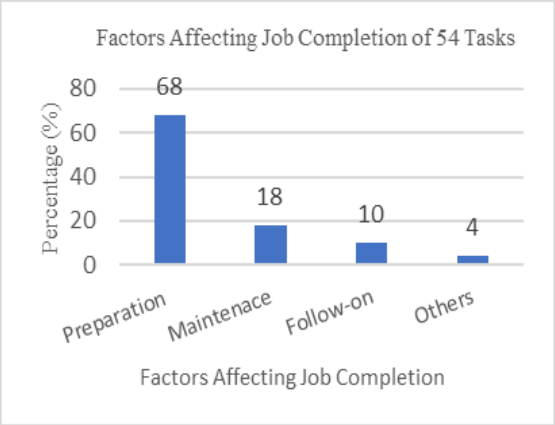

Figure 2
Factors Affecting Job Completion

The following week was then focused on each task "Start Time". Figure 3 shows a graphical representation of current "Start Time", with tasks averaging 47 minutes before maintenance is started.

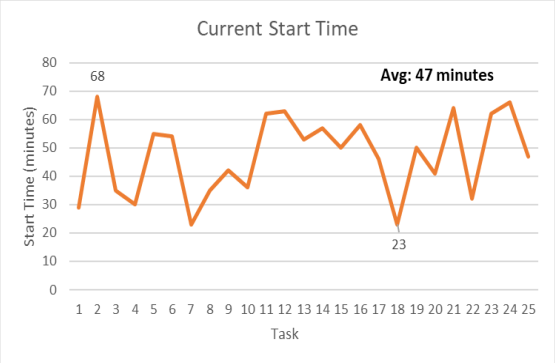

Figure 3
Current Start Time

Objective Requirements

Based on the project's objective, the goal was to reduce "Start Time" to the 20-minute timeframe. In addition to meeting this objective, solutions must adhere to United State Air Force regulations policies. The project is conducted in Kadena Air Base, Okinawa, Japan. Therefore, solutions must also be implemented in accordance with United States & Japan agreements and restrictions. It must also be reliable and cost-effective.

Primary Solution

The primary solution is the use of a software tool to streamline and support the integration of the

elements in the preparation for a maintenance task: personnel, support equipment, and tools. Support equipment consists of maintenance platforms, power generators, air compressors, and other assets required to facilitate the maintenance to be performed. While tools and personnel are managed by the same organization, support equipment it is not. If both organizations agree, each could benefit from this solution. It is also mobile and cost-effective. Only disadvantage could be the software upkeep.

The way the software tool would work is with a computer station at the tool room and another one at support equipment dispatch office. The software would store all tools and equipment required for each maintenance task. When technicians are tasked, the select the job to be perform from their e-tool (laptop) and would request each department the required tools and equipment. Technicians can head straight to the aircraft to perform other preparation tasks while waiting for tools and equipment to be delivered. To ease the finding of each support equipment around the airport, each equipment would have a finder tracker.

Secondary Solution

With most delays happening due to support equipment delivery times, a designated location for these assets would be the alternate solution. Figure 4 shows the geographical location of aircraft parking (brown), technicians & tools (green), and support equipment (yellow). Having designated location would eliminate the wait of the driver looking for the requested equipment (if available). A small satellite tool room could also be implemented with high-use tools. However, this solution would require a much bigger capital and will only benefit those parked next to it. Historically, organizations change parking locations due to multiple reasons. Therefore, mobility would be a huge plus.

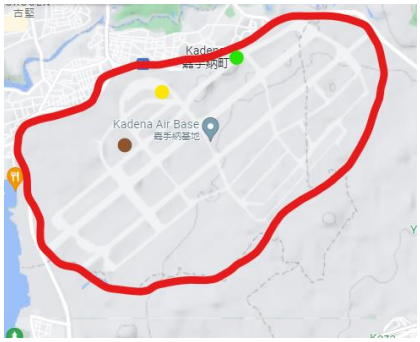

Figure 4
Kadena Air Base – Airport

RESULTS & CONCLUSION

Only primary solution was tested due to monetary capital and time required for the development of new infrastructure. However, as shown in Figure 5, the software tool seems promising to future aircraft maintenance operations. The trial run shows a 60% decrease in "Start Time" when compared to performance shown in Figure 3.

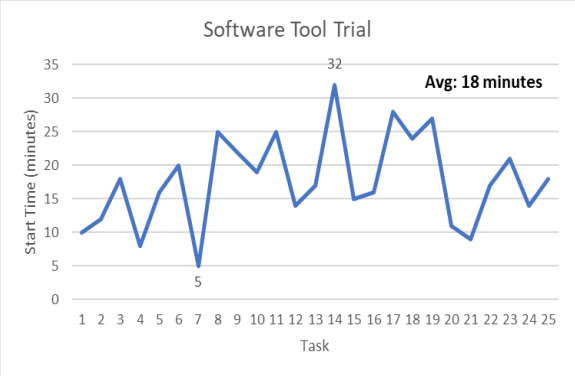

Figure 5
Software Tool Trial

The objective of this project was to increase military aircraft maintenance efficiency by reducing maintenance preparation time, also known as Start Time, to at least 50% of current time. While only one of the two possible solutions was conducted due monetary capital and time constraints, the application of a software tool showed a 60% decreased in maintenance preparation time, 10% more than the project's target.

The most notable challenges for the implementation of such tool are the buy-in from

organizations and agreement of everyone involve. Being something new to this industry, reluctancy is expected. If adapted, it could revolutionize military aircraft maintenance operations. However, additional testing would be required to determine the impact in other aircraft maintenance organizations within the United States Air Force.

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