2024 Internship Report

Lockheed Martin – Marietta

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1 Introduction

This spring from February to June I have participated in the joint Terma/Lockheed Martin internship program in Marietta, Georgia. Embarking on this internship with Terma has been a unique opportunity to immerse oneself in the cutting-edge world of aerospace engineering and defense technology. This report encapsulates my five-month experience at Lockheed Martin Aeronautics' production facility, where I had the privilege of contributing to the production of the F-35 Lightning II fighter jet. As an engineering student from Denmark, this internship has not only been a testament to my academic knowledge but also a significant leap towards professional growth and personal development.

During my tenure I engaged in a myriad of tasks ranging from increasing production rates and improving workflows to ensuring quality and cost reduction. The challenges were immense, yet they paved the way for innovation and excellence. This report aims to detail the projects I worked on, the skills I honed, and the invaluable lessons I learned while being part of one of the most advanced production lines in the aerospace industry.

As we navigate through the subsequent sections, we will explore the details of my day-to-day responsibilities, the professional environment at Lockheed Martin, and the profound impact this internship has had on my career trajectory. Join me as I reflect on this transformative journey, which has equipped me with skills beyond those taught in the classroom and prepared me to take on the dynamic challenges of the aerospace or the broader manufacturing sector.

2 Internship placement

The internship is managed by the Operational excellence team (OpEx), but I, along with my two fellow interns Moritz and William, have had several projects at the Operations technology (Opstech) department. Thus these times has been split between these two.

Operational excellence is an f-35 production support organization and is a flexible team whose job is to conduct continual improvement throughout production. This may take the form of training mechanics, instigating small scale incremental improvements such as the implementation of label printers for chemicals throughout the production. Senior Management tasks the team with a certain goal, such as waste reduction or audit scores and the team is then to figure out how these goals should be met. To interface with the mechanics and supervisors on the floor the OpEx team is made up primarily of previous mechanics.

Operations technology runs projects on a much longer time frame and with larger budgets. Opstech undertakes projects for the f-35 and other programs. These projects are focused on the development of new tools, machinery or implementation of new outside sourced equipment. Internal development takes the form of a small teams of engineers who will seek funding for certain projects which they themselves will push forward. These projects could be the integration of off-the-shelf components, as in the case of the Sandy-project which will be discussed later. These systems are developed, and then piloted onto the production floor, after 2 years of production use they must be changed to a permanent solution. Furthermore, it is also Opstech's duty to contact and manage wider projects with external system integrators when a permanent solution must be developed and implemented into production.

The mix between these two allowed for the interns to allow for the aligning goals between the development of new technology and the actual needs and priorities on the production floor. It did so by facilitating the increased communication between the two, and more importantly through my and the other intern's, comments and suggestions to push the features production personnel would want. Moreover, it allows for the flexibility to move between the two departments depending on workload and deadlines. At the beginning of the internship guest access had not been arranged, meaning that I could not be left unobserved and that I had no access to most of Lockheed Martin's computers. The ability to move flexibly between the departments also alleviated much of this trouble as barriers could be overcome while work could be continued on other projects. It is through these two departments that I have had the opportunity to undertake a number of projects during the internship as well as ad hoc tasks.

3 Ad hoc tasks

Ad hoc tasks where usually performed in the stead of other members of the OpEx team, when they were not ab e to fulfill their duties. Thus we took over some duties.

3.1 Lost tool Instructions Manufacturing Process Tutorial

One of my first assignments was to create a script for an instructional video showcasing the LTI-process. This process is undertaken when a mechanic has lost a tool, but the process itself involves both the area supervisor and a representative of the quality department. However the process has several documentation steps which are performed by the supervisor and the quality representative, however these steps are not clear or known to the mechanic, as the mechanic is not trained on these procedures. Therefore, a video was created to easily be available for the training department and for the individual mechanic should he require it. The script was written on the basis of internal LM material describing the process and the script was the enacted, filmed and edited to create the final video.

3.2 AS 9100 Audit

As part of the requirements for the continued operation of the Marietta F 35 plant, the entire site must be re-certified in AS9100, which is a standard based on ISO 9001 for Quality management. Since we are employed as a part of Lockheed Martin we cannot undertake such audits ourselves due to the conflict of interest. However to ensure that the site passes mock audits will be carried out ahead of the actual recertification to prepare the mechanics for the questions an auditor may ask. This is performed by going to mechanics and asking them questions which are similar to or are a subset of the actual questions. These questions are primarily about company ethics, quality of the work being done, how quality is ensured, processes in case of mistakes and similar.

3.3 Hazmat Printer

In the production several different chemicals are used, each of these have different work or shelf lives thus it is imperative that the chemical's life cycle is tracked. However, for out or work life the time begins as the chemical is removed from its packaging or is put into use respectively. Since these times are not known beforehand the mechanic has to write the time manually onto the container, which is time wasted, it is harder to read, and relies on the mechanic finding the correct source for the chemical’s life time and computing the correct expiration. To combat this a number of small label printers were given to the production floor, these printers included templates for the most used chemicals. Now the mechanic only has to select the template, then the printer calculates the expiration and prints a sticky label which can be put directly onto the chemical. This yielded a significant reduction in the number of used chemical wrongly used after expiration, a reduction in the number of unlabeled chemicals, and lastly according to the mechanics a reduction in the time to label the chemicals.

4 Projects

Throughout the internship I continued two projects which were started by previous interns or other F 35 sites, these were "Sandy" and "Sealant AI". And I was also able to start some of my own projects, one of which focused on Line flow tags. These projects will be explored in the coming sections.

4.1 Sandy

A prime feature of the F-35 is its !ow observability, while this is built into every facet of its design, a very significant part of this comes from the radar absorbent coating. This coating process contains several steps, among which is a number of sanding processes. Currently these sanding processes are made by hand using a hand sander tool as seen on the right. This has several drawbacks, the manual process is highly monotonous and time consuming, and it is boring for mechanics, which causes error through lack of attention. Furthermore, it tiresome to gauge if the specification has been followed as each person will sand differently and the work quality is not easily inspectable. Furthermore, the positions required often for extended periods of time, are unpleasant for the mechanics, especially mixed with the gyrating movement of the sander. Therefore, the process is a prime candidate for automation, this is performed using an UR10e robot, because it does not require the same safety installations as larger industrial robots. The sanding is performed with a tool similar to a hand sander attached to a pneumatic compliance kit at the end of the robot flange. This robot is then pinned into a cart holding the work piece, the robot program is then activated. Thereafter the robot moves a simple premade trajectory and turns the sander is turned on once the sander makes contact with the work piece.

Image Deleted Figure 1

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Figure 2

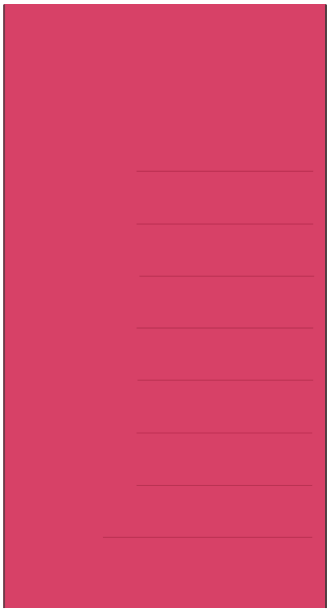
Currently the project is on Technology readiness level (TRL) 9, as it is in active operation in Fort Worth, however this version of the system is simplistic and is only capable of working under constant supervision, as an operator must rolls the trolley around and tell which program to execute.

Execution under reduced supervision should be possible but has not yet been attempted. Since the version in Marietta will operate on different components it is not fully mature, furthermore it will utilize different subsystems to achieve a similar goal. At the beginning of the internship the Marietta version is on TRL 2 and has been moved to TRL 6 by our work through the internship.

4.2 Sealant AI

The center wing consists of many separated bays, some of these are "wet", meaning that they are intended to store fuel. These bays must be made liquid tight to ensure fuel does not escape into a dry bay. For this reason the fasteners and part edges are covered with sealant. As there are hundreds of fasteners and many meters of edges, manual inspection of the sealant in tedious and prone to human error. Therefore, an AI-mode has been trained to detect defects in sealant application, through a video feed from a borescope. To increase the degree of automation the borescope is to be mounted onto a UR10 manipulator. Thus allowing the borescope to see all of the inside of the bays of the center wing, while the focal distance is maintained. The technology readiness level of the system is 4, as inspect on has been performed in lab, with mixed results. Primarily due to the lack of training data for the AI Model.

4.3 Line flow tags



Each part of the aerostructure of a center wing must be tagged, such that it is a ways clear which aircraft it is going on. However not all parts are delivered pre-tagged, some are made in hand, this takes time away from value adding operations, can lead to human error. Moreover, since the tags are applied manually some mechanics forego or circumvent them, leading to audit findings. Furthermore, the mechanic writing the tag may be in a rush, therefore the handwriting may be sloppy, the writing itself may also be unclear because of the writing utensil used. A pen may be perfectly usable, whereas a permanent marker will be much harder to read. Introducing all parts into the tag database would relieve these issues as no handwritten tags would be made. To do this the list of parts in the database was compared to the list of all parts, then the difference was investigated individually. Some of these parts are delivered to one task center, processed, but not consumed and thus sent on later in the production. These parts may be processed at a later task center, to do so the tag is often ripped off. Thus tags for the same part are needed for some parts.

Next while the database is now complete, the ordering of the tags is also clumsy and unoptimized. Currently the SWBS Supervisor or specialist s responsible for ordering the tags. Ordering the tags 's not necessarily time consuming, but it is quite manual because of the GUI, both the pink line flow tags and the purple FTW travel tags are ordered at the same time, but they are ordered through different interfaces, and they must be ordered for each task center/cell. This is needlessly convoluted and unnecessary, as one never needs only one kind of tag or only the tags for just one task center. Thus a simple intermediate solution would be to improve the GUI of the database to allow all cards for a ship to be ordered at once for the SWBS.

A more permanent solution however would be to change the ordering and delivery process of the tags. Since the tags are useless without the parts, and the parts should never be used without the parts, one should automatically order the tags when ordering the parts. This could be done by attaching the tags directly to the kit cart which is sent to every task center with the parts for the ship. As these parts return to the warehouse once they are no longer needed, the warehouse is the common distributor for all task centers. Thus tags should be delivered to the warehouse added directly to the relevant kit cart and then distributed onto the production floor. The main task of this project has thus been to convince the warehouse services to take on this added responsibility, this is reflected in the Stakeholder analysis seen on the right.

Stakeholder Analaysis - Power-Interest Grid

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Figure 3. The stakeholders for the implementation of combined tag and part distribution.

The technology readiness level is **9.** As the ability to order print and distribute the tags are already implemented, a modest increase in the scale does not change the **feasibility nor** the **maturity of the technology** itself.

5 Lockheed Martin's Culture of accountability

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6 Acknowledgements

I am writing to express my deepest gratitude for the opportunity to participate in the F-35 Internship Program at Lockheed Martin Aeronautics in Georgia. This experience has been both professionally enriching and personally rewarding. During my time as an intern, I was able to contribute to the production process of the F35 lightning II, which has been an incredible learning experience. The knowledge and skills I have gained are invaluable and will I undoubtedly play a significant role in my future career as an engineer.

First and foremost, I would like to Terma A/S for this unique opportunity and for the preparations they have made for us. In particular I would to thank Tommy Pruitt for his great help and care for us while we have been in the US. Your efforts are most appreciated.

I would like to extend my sincere thanks to the entire team at Lockheed Martin for their support, guidance, and the collaborative environment they foster. The mentorship provided by the experienced professionals was instrumental in my development throughout the internship. Specifically, I would like to thank Brian Padgett for his help and guidance in navigating Lockheed Martin's many systems, as well as entertaining, respecting and appreciating my input. I greatly appreciate your leadership style, in particular your structured approach to leadership. I will use that in my career.

I am also grateful for the opportunity to work alongside a diverse group of talented interns, Moritz and Wiliam. Living with you has been a joy and a pleasure, the trips with you both have been a great addition to this trip. That camaraderie have made this journey all the more memorable. I am happy you were ones where there could have been a zero.

Lastly I would like to thank Jeffrey York, Christopher Diemer and the team at OpEx for escorting and bringing us along for tasks, so we would have something to do. I wanted to take a moment to express my heartfelt gratitude for the warm welcome and guidance you've extended to me during my recent integration into the team. Your willingness to escort me around and introduce me to the nuances of our workplace has been incredibly helpful.