ENGINEERING TRAINING REPORT



Figure 1: F-35s model C (left), model B (middle) and model A (right)





LOCKHEED MARTIN

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¹ Figure 1: Picture from F35.com 5/3/15





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2 PREFACE

This report is written as part of the "industrial R&D placement" internship at the Lockheed Martin Aeronautics facility in Fort Worth Texas of the Master's program in Mechanical Engineering at the University of Aarhus, Denmark.

First of all I would like to thank Ms. Na Ree Sørensen (Aarhus University), Mr. Lars Brauner (Aarhus University), Mr. Jan Klinker (Terma A/S) and Mr. Scott Sadler (Lockheed Martin Aeronautics) for guiding me through all the paperwork and making this internship possible. Secondly I would like to thank the kind people of the entire rate transition team for their immense support and willingness to pass on knowledge. I was thankful for being under very competent supervision by Mr. Mike Lally and Mr. Michael McCormick who welcomed me to their team and made me feel right at home at Lockheed Martin Aeronautics from the first day to the last. A special gratitude goes to my two cube mates Mr. Richard Ringwald and Mr. AD King for taking every chance to take on the mentor role, and doing so perfectly. Mr. Tue Bui, Mr. Ricky Jones, Mr. Steve Rathburn and Mr. Rick Urbanski made up the rest of the group and were equally responsible for making me feel at home for the duration of my internship. Their willingness to help and always positive attitudes made for an overwhelming positive experience. In addition I would like to mention Mr. Donny Weaver of Terma NA who provided immense support from start to finish.

Last but certainly not least I would like to thank my fellow Danish intern Mr. Thor Andersen. Thor's always great attitude means a lot to me, and this internship would not have been the same without him. I will forever remember this time we had at Lockheed Martin and the many adventures we experienced together.



3 INTRODUCTION

F-35

The F-35 Lightning II is a 5th generation fighter jet. This means it was designed with stealth and situational awareness as key features². Most noticeably this means the introduction of networked-enabled and sensor fusion, meaning that the input of all sensors are presented as a single picture and distributed to all networked airplanes². The stealth aspect means that the F-35 is designed with internal weapons bays and Low Observable (LO) features².

PROGRAM

The Joint Strike Fighter (JSF) program has ties back to 1996 when Lockheed Martin and Boeing were selected to demonstrate their designs for the JSF³. In 2001 the System Development and Demonstration (SDD) contract was awarded to Lockheed Martin (along with Northrop Grumman, Pratt & Whitney and BAE Systems as partners) for their X-35 concept demonstrator airplane³. In 2006 the first F-35A took flight⁴.

The first international participant in the JSF program was the United Kingdom who in 1995 signed on as a partner. In 1997 Canada signed on, and since then the collaboration has extended to include nine countries. The Danish JSF partnership began in 2002 and when the first F-35 took flight in 2006 it already had Danish components onboard. Currently Denmark contributes with composites, aero-structures, machined parts, logistics and electronics. In addition the Danish military is providing an F-16 fighter jet, a pilot and mechanics to the test flight program in the USA.



Figure 2: The Danish F-16 contribution flying with two F-35s and a tanker

² <u>https://www.f35.com/about</u> 6/11/2015

³ CRS Report for Congress June 16, 2003 <u>http://www.dtic.mil/cgi-</u>

bin/GetTRDoc?Location=U2&doc=GetTRDoc.pdf&AD=ADA472773 6/10/2015

⁴ <u>https://www.f35.com/about/history</u> 6/10/2015

⁵ Figure 2: Picture from F35.com 6/3/15



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PRODUCT

The F-35 airplane comes in three variants; A, B and C. The A-model has Conventional Take-off and Landing (CTOL) capabilities comparable to the current F-16s in the Danish airforce, the B-model has Short Take-off and Vertical Landing (STOVL) capabilities similar to the British Harrier and the C-model is a Carrier Version (CV) and has folding wings for operating on aircraft carriers. As all variants are based around the same design they have a lot of common parts and are being built on the same assembly line.



Figure 3: Illustration of common parts between the three F-35 variants

TERMA A/S

Terma A/S was founded in 1949 as a company making autoclaves, thermometers and manometers. Today Terma A/S is headquartered in Lystrup, Denmark and is operating in the aerospace, defense and security sectors.

F-35 ROLE

Terma A/S was introduced to the project in 2001 when Lockheed Martin was awarded the JSF contract. Currently Terma A/S is considered a major strategic supplier to the F-35 producing composite and electrical parts for every F-35 being built, among other things.

⁶ Figure 3: Picture from <u>http://www.defenseindustrydaily.com/lightning-rod-f-35-fighter-family-capabilities-and-controversies-021922/</u> 6/9/2015







Figure 4: The F-35 CTOL with illustration of the parts delivered by Terma A/S

LOCKHEED MARTIN

The story of Lockheed Martin (LM) begins in 1912⁸. That year two brothers named Allan and Malcolm Lockheed founded a company in California known as The Lockheed Aircraft Company. Also in 1912 a man named Glenn L. Martin established the Glenn L. Martin Company in Los Angeles⁹. After several mergers and buyouts with companies in the same industry, Lockheed Martin was formed in 1995 by the merge of Lockheed Corporation and Martin Marietta¹⁰. LM employs about 112,000 people worldwide, and is organized in 5 business areas: Space Systems, Mission Systems and Training, Missiles and Fire Control, Information Systems & Global Solutions and Aeronautics¹¹.

LOCKHEED MARTIN AERONAUTICS

Lockheed Martin Aeronautics (LM Aero) business area is headquartered in Fort Worth, Texas, in what is known as Air Force Plant 4¹². The facility was constructed in 1941 and has been producing military aircraft since 1942, starting with the B-24 Liberator heavy bomber¹³. Later the same facility became home to the production of the B-32 Dominator very heavy bomber, B-36 Peacemaker strategic bomber, B-58 Hustler jet bomber and the F-111 Aardvark mediumrange fighter bomber¹⁰. Currently the facility manufactures the F-35 Lightning II and F-16 Fighting Falcon fighter jets, and supports the F-2 fighter and the F-22 Raptor¹². LM Aero employs about 24,000 people at nine primary locations in

⁷ Figure 4: Picture from Terma.com 5/3/15

⁸ http://www.lockheedmartin.com/us/100years.html 6/3/2015

⁹ <u>http://en.wikipedia.org/wiki/Glenn_L._Martin</u> 6/3/2015

¹⁰ <u>http://en.wikipedia.org/wiki/Lockheed Martin</u> 6/3/2015

¹¹ <u>http://www.lockheedmartin.com/us/who-we-are.html</u> 6/3/2015

¹² http://www.lockheedmartin.com/us/aeronautics/about-aeronautics/locations.html 6/3/2015

¹³ http://en.wikipedia.org/wiki/United States Air Force Plant 4 6/3/2015





the US and several international offices around the world¹². In other locations LM Aero supports the C-130 Hercules, P-3 Orion, C-5 Galaxy, U-2 Dragon Lady and the T-50 Multirole Trainer¹⁴.

FORT WORTH, F-35 ROLE

1,400 suppliers worldwide ship more than 300,000 individual parts to Fort Worth which are assembled into each F-35¹⁵. This was where I was placed, and daily saw the production line operating.



Figure 5: The first Norwegian F-35 at the production line in Fort Worth¹⁵

 ¹⁴ <u>http://www.lockheedmartin.com/us/aeronautics.html</u> 6/3/2015
¹⁵ <u>https://www.f35.com/about/life-cycle/production</u> 6/4/2015
¹⁶ Figure 5: Picture from <u>https://www.flickr.com/photos/lockheedmartin/16984386919/</u> 6/4/15





4 INTERNSHIP

Before 2014 the setup of the Master's program in mechanical engineering at the University of Aarhus did not intend for the students to spend a semester interning. This meant that a lot of work was done behind the scenes to accommodate this into the University's official offer to students. The internship is technically at Terma A/S in Aarhus, but the place of work is at LM Aero. This setup allows Danish interns to get the necessary clearance to have the access they need to the Fort Worth facility.

INTERNSHIP SETUP

Since 2008 LM Aero has hosted interns from The Netherlands during a 5 month semester once a year. In 2014 this possibility was extended to Denmark. No communication about the internship was made official, so my first knowledge of this internship came from a classmate at the university. In the early spring of 2014 Thor Andersen one day asked; "what are you doing the first half of 2015"? We got to talking and I ended up submitting an application to one of the two positions offered.

AU, TERMA A/S, LM AERO AND THE ELIMINATION PROCESS

The semester passed into exams, and I went on holiday for the summer. One day my phone rang with a representative from Terma A/S on the other end, saying he had good news and asked me to check my email. In my inbox was a place, date and time for an interview. My vacation was put on hold and I drove home to meet for an interview at Aarhus University with two representatives from Terma A/S. I was one of several people being interviewed that day, so naturally I was nervous as to my performance relative to the other applicants. Soon after this I was asked back for a second interview at the same place. This time it was over the phone with people at LM Aero in Texas. For the second interview we were 4 people competing for two positions, the mood was good but tense. Shortly after I got a call from Terma A/S with the offer of going to Texas together with Thor Andersen in the spring of 2015. I was ecstatic!

PRACTICAL ISSUES

January of 2015 was a bit hectic for me as I had my last exam the 12th, departed Denmark on the 14th and had my first day at work the 19th. This gave me 3 days (including Sunday) to get settled. Fortunately Terma A/S has an office in town as a part of their North American branch; Terma NA. Not only had Terma NA made sure we were picked up at the airport, they had also booked a hotel for us to stay the first few days. In addition they made an employee available to drive us around so that we could get all the practical issues sorted. Throughout the internship Terma NA was kind enough to make sure we were doing alright and helped us whenever we needed it.



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Figure 6: Me (middle) with my fellow intern Mr. Thor Andersen (middle left), Mr. Donny Weaver of Terma NA (right) and a few more that helped us out greatly.

APARTMENT

The first thing we had to sort out was a place to live. From previous Dutch interns we had established contact with the Marquis at Stonegate apartment complex in the fall of 2014, so all we had to do was pick up our key. Immediately after we went out and bought beds. The previous Dutch interns had established good relations with some tenants in the complex, so they had left their kitchenware for us to use.

TRANSPORTATION

The apartment is only 11 kilometers from work, but in Fort Worth the public transportation network is inferior to the one we were used to in Aarhus, so much so that we had to invest in a car in order to get to work. As part of working in the US we were determined to experience as much of USA as possible, meaning we had to buy an American Car. After having looked for two days we signed a deal for a yellow convertible Ford Mustang, and we named her "Sally".

¹⁷ Figure 6: Private picture taken at the Terma NA offices







Figure 7: Our car "Sally" with me (left) and my fellow intern Mr. Thor Andersen (right) in front of the "El Capitan" cliff in the Guadalupe National Park in west Texas

COMMUNICATIONS

Some other necessities we needed included mobile phones and internet in the apartment. We were surprised how much more expensive mobile phones are in the US. We ended up buying a joint service, with Thor getting the ability of calling Denmark and I got the larger data package. Buying internet was a whole other experience. In the US there is something called a "credit history". This is to give companies an indication as to if you can pay your bills on time. Having no credit history at all we were perceived as unattractive customers and therefore were presented with internet plans that had a \$400 "non-refundable deposit". It took some persuasion and several visits before we finally got around that initial fee.

¹⁸ Figure 7: Private picture taken in the Guadalupe desert in Texas





GETTING STARTED AT LM AERO

The first morning drive to Lockheed Martin Aeronautics was one to remember. It was cold, we were in our new car and driving down the main highway until we saw a big sign saying "Lockheed Boulevard". This led us to a 3 lane highway that ended right at the main gate to the company.



Figure 8: Main gate of the Lockheed Martin facility in Fort Worth

We were instructed how to work with security and get to the reception area where we were welcomed by Scott Sadler. We went through the whole security system until we had a badge, and then we were escorted to meet our managers for the next 5 months.

ORGANIZATIONAL PLACEMENT

Within Lockheed Martin Aeronautics I was placed in the "F-35 Rate Transition Execution" team. The team's main objective is to ramp up the production until the facility can roll out fourteen F-35s each month. It's a very interesting role that requires a lot of communication and organizing between several groups, teams and companies, to make sure everything goes as planned.

¹⁹ Figure 8: Private picture taken from outside the facility perimeter on the first morning of the internship







Figure 9: Organizational chart of the Rate Transition team, mechanical engineer is abbreviated ME

TRAINING

To prepare as much as possible for the internship I went through as much literature as I could find about Lockheed Martin, the JSF program and the relationship with Denmark. Lockheed Martin Aeronautics was equally enthusiastic about teaching me as I was learning. Whenever the opportunity presented itself I was given a tour of parts of the facility. I would estimate that a complete tour of the entire facility in Fort Worth would take a week.

I was given several internal training courses. I spent days with a CATIA instructor learning the transition from Solid-Works. I was in a LEAN class for several days that ended with me handing in an assignment and getting credit for it. Much time was spent in the FOD (Foreign Object Debris) center learning how to identify and avoid FOD getting into the products. When you get as big as Lockheed Martin Aeronautics custom software becomes a must, so I was also trained in using a lot of different programs tailored specifically to this company. Lockheed Martin Aeronautics also has their own system for writing technical documents which means I had to be taught how to do that as well. In the midst of all this I had to become acquainted with an entire new working culture and an extremely complex product in a foreign language.

TEAM

True to the rumors about American offices my team was located in cubicles. For those not familiar with the term, a cubicle is a made up of thin vertical walls the height of a small person. Cubicles come only in one shape but in sizes ranging from one person all the way up to six people. My team was placed in cubicles close to one another which mean conversations often took place without looking at the person you were talking to. This was something I was used to only doing by email, and I never got comfortable with these kinds of conversations. My team was assigned to ramp up production in a specific segment of the factory, and my role was to support team members and the role of the team.

I was placed in a cubicle with two ME's from my team and one of these was my mentor. He assigned me most projects, prioritized my tasks and was always ready to help me. My other cube mate was a former U.S. Army Ranger with decades of experience in engineering.





RESPONSIBILITIES

In addition to having several projects I was also assigned some responsibilities. One of these was being the liaison for my team at PMT (Performance Management Teams) meetings. These meetings are held each week for different segments of the production line where opportunities for improvement are identified and progress of improvements is tracked. Another responsibility was to create a layout of the entire assembly line as it should look at full rate production. In addition several overlays were required to show and track changes. This was a valuable tool and ended up measuring 10 meters and was put up in a meeting room. The last responsibility I was assigned had to do with tracking certain large components. Some of the parts shipped to the facility are so large that Lockheed Martin Aeronautics had to develop the world's largest certified shipping containers, whereas other parts required the development of air/ocean containers. As these parts were shipped to and from countries around the world I was tasked with presenting the load, direction and status of each container.

PROJECTS

During my internship I was assigned 23 major projects and a lot of minor projects, besides the responsibilities. I have chosen to describe a few outstanding projects.

TESTING OF CRANES

In a PMT meeting it was mentioned that the remote control to some cranes was not functioning properly. This specific PMT related to an area of the facility that had 46 bridge cranes. I started out by writing a test scenario that would test all functions of each crane and corresponding remote. After this I had to coordinate with supervisors in the area as to perform my test without disturbing production. During the tests I discovered several issues ranging from depleted batteries to a defunct motor. Crane users complained that the current remotes had a design that made them difficult to use. Because of this I made contact with the producer of the cranes and was working with them to make a crane remote with a new design that would allow the users to operate the crane in a safer manner. This led me to research rules and regulations in the area. The whole project made for a great learning experience and familiarization with that part of the production line.







MOVE PLAN

As mentioned some of the components that are shipped to and from the facility in Fort Worth are quite large and also very heavy. The containers reflect the complexity of the components they support which means loading and unloading a container requires special knowledge of each container type. In order to make sure the component is handled correctly a technical document known as a "move plan" has to be created. Essentially a move plan instructs relevant people on how to carry out the operation. This involves safety issues, special precautions, special tools, communication across multiple departments and presenting this in very clear instructions accompanied by graphics that themselves have to comply to their own set of rules.



Figure 10: CATIA models showing the air/ocean shipping container that required a move plan, in different configurations

From my previous internship I was familiar with writing technical documents, but the level of detail in these was not something I had expected. It was interesting in being a part of developing operating procedures for new equipment, and communicating this in a way so that users in several countries would know what to do.

²⁰ Figure 10: Picture from CATIA V5 6/8/2015





SAP OVERVIEW AND FRAMEWORK

Earlier I described how custom software is an everyday thing at Lockheed Martin Aeronautics. One of the pieces of software is an SAP system tailored as an ERP (Enterprise Resource and Planning) system. This system was launched several years ago and was meant to cover the entire facility. Initially the capabilities were limited to keep complexity down, and it has been steadily expanding as more departments are integrated. Before long the system would expand to also over my department, so I was tasked with instructing my team about it. This meant I would need to familiarize myself with the history of the implementation and the relevancy to my team.



Figure 11: Areas of operation covered by the SAP ERP system at the Fort Worth facility

It was not a task I would have ever thought I would do as a mechanical engineer but it was interesting none the less. I got to work with something that my team had very little knowledge about, and was working with new departments. It proved a good exercise to learn about how the massive amount of data is managed within a company the scale of Lockheed Martin Aeronautics.

²¹ Figure 11: asug conference May 15-18 2011, "Managing a Large and Complex Development Team at Lockheed Martin" presentation by SAP Development Lead Gary Norris 6/8/2015







PDCA CAPSTONE

PDCA stands for Plan-Do-Check-Adjust and is a scientific method proven to ensure the continuous improvement of processes. It integrates LEAN and SIX-SIGMA methodologies to reinforce problem solving and root cause analysis, by introducing structured approaches. An example is the 6S methodology that promotes Sort, Straighten, Shine, Stand-ardize, Safety and Sustain to create an environment where things happen on time, every time and flow is optimized. In addition it prepares for Structured Improvement Activities (SIAs) which means you will be ready to participate in a task force to handle complex problems and implement countermeasures. The course ends with a Capstone assignment to ensure knowledge application. The Capstone is homework that is to be completed after the course where everyone identifies an opportunity for improvement and designs countermeasures to deal with it, using the tools taught in the course.



Figure 12: Excerpt from my PDCA Capstone data analysis, showing one of the analysis results

The Capstone was meant to be an individual task but my fellow intern Mr. Thor Andersen and I got permission to do a joint assignment. We identified a process where duplicate reports were being produced and analyzed data to identify the cause. The Capstone was submitted along with the results of the data analysis and we were told we did an outstanding job. It was interesting to learn how to structurally break down complex problems and to learn how much easier it made the problem solving. I am sure this is something I will use later in my career.

²² Figure 12: Graph taken from my PDCA Capstone assignment. Edited for data protection 6/8/2015





WING TEAM TASK TRACKER

The Lead ME for my team wanted me to do a task tracker, in order to keep track of the team member's current tasks and progress. I built a complete status of all tasks in Microsoft Project and updated it in the weekly team meetings.

Resource Names	Task Name	% Complete 🔻	Duration 💂	Start 👻	Finish 👻
Name(s)	⊞ Task	0%	22 days?	1/6/2014	2/4/2014
Name(s)	⊞ T ask	0%	24 days?	12/6/2013	1/8/2014
Name(s)	Task	0%	1 day?	3/12/2015	3/12/2015
Name(s)	⊞ Task	0%	1 day?	12/6/2013	12/6/2013
Name(s)	Task	0%	1 day?	3/12/2015	3/12/2015
Name(s)	Task	0%	1 day?	3/12/2015	3/12/2015
Name(s)	Task	0%			
Name(s)	⊞ Task	97%	548 days	4/1/2014	6/21/2016
Name(s)	⊞ T ask	45%	1062.98 days?	12/6/2013	2/16/2018
Name(s)	⊞ Task	1%	851 days?	3/4/2015	7/23/2018
Name(s)	Task	70%	130 days?	4/6/2015	10/22/2015
Name(s)	⊞ Task	0%	109 days	4/6/2015	9/21/2015
Name(s)	Task	0%	30 days	4/6/2015	5/20/2015
Name(s)	⊞ Task	5%	434 days	12/6/2014	9/19/2016
Name(s)	⊞ Task	67%	346 days	10/22/2014	3/28/2016
Name(s)	Task	100%	10 days?	4/6/2015	4/20/2015 23

Figure 13: Excerpt from the task tracker showing a few tasks and their timeframe

I was surprised to find out how difficult it was to gather information on all the tasks. Each team member had a personalized way of keeping track of their own tasks and merging all the different methods into a single tracker proved more difficult than anticipated. When it was all done it was rewarding to see an improvement in meeting efficiency and transparency throughout the team as a result of a better structured process.

²³ Figure 13: Picture from task tracker, edited for data protection 6/8/2015





SAFETY STOP

In the facility there are several sets of rail that are used to transport materials and parts. All of these rails have a plethora of sensors and mechanisms to prevent mishaps. An incident happened on one of these lines and I was tasked with investigating that the safety mechanisms were working as intended.



Figure 14: Excerpt from a 2D parts drawing showing some of the affected equipment

I did some manual inspections and measurements and cross referenced these with digital layouts and parts drawings. It was very interesting getting to know the inner workings of one of these rails and the implementation of safety features. I identified several issues but found no flaws. The issues were corrected in collaboration with multiple departments and it was verified in several similar positions that this was a one-time incident.

²⁴ Figure 14: Partial picture from a 2D drawing, edited for data protection 6/8/2015





CONSUMABLES REPLENISHMENT

Some of the materials used to assemble the plane are listed as Consumables. This classification covers aids like gloves, brushes and similar items where the usage per plane is hard to quantify. In a meeting it became apparent that the users were missing consumables as the local storage was not being replenished in a timely manner. This was not an issue relating to my department but because of the complexity I volunteered to work it.



Figure 15: Excerpt from the presentation about consumables, showing one of the data analyses that was presented

I partnered with my fellow Danish intern Mr. Thor Andersen and together we identified a number chain of different issues, where one was causing another etc. We also identified several ways the current systems could be improved, and in some places redesigned. In addition we made recommendations for what to change, in order to account for the increased capacity need that would come with full rate production. Because the problem spanned a lot of departments it took more time than anticipated to acquire the information about how the current systems worked, and which processes caused which issues. A process in one department might cause an issue several departments away on the night shift, and vice versa. It was almost an "investigation" to map out all the processes and identify issues, and personally I enjoyed it. We presented our analysis, identified issues and recommended countermeasures to an audience spanning all affected departments immediately before the end of our internship.

This report was sent out for approval a few days before the presentation was delivered, so for logical reasons the feedback could not be described here.

²⁵Figure 15: Picture from presentation about consumables, edited for data protection 6/8/2015





CONTAINER TRACKER

As several parts and assemblies are shipped to the facility in Fort Worth from all over the world, it becomes necessary to have several custom containers in circulation from site to site. Because my team was interesting in tracking certain containers, I was tasked with presenting the status of each container in an easy to read fashion that would quickly give the reader the overview he needed.

Status of containers			Last update: 6/8/2015 13:33					
\square	LOCKHEED MA	RTIN 4	Container # 1 Ship-set Origin Destination Status	DATA	DATA	DATA	DATA	DATA
	SHIPPING C LOCATIC	ONTAINER ON MAP	Container # 6 Ship-set Origin Destination Status	DATA	DATA	8 DATA	DATA	DATA
V \	· · · · · · · · · · · · · · · · · · ·		Container # 11 Ship-set Origin Destination Status	DATA	DATA	DATA	DATA	s DATA
Nagoya, Japan	Fort Worth, USA	Cameri, Italy Tel Aviv, Israel	Container # 16 Ship-set Origin Destination Status	DATA	DATA	DATA	DATA	DATA
	1 dias		Container # 21 Ship-set Origin Destination Status	DATA	DATA	DATA	DATA	DATA
			Container # 26 Ship-set Origin Destination Status	DATA	DATA	DATA	DATA	DATA
			Container # 31 Ship-set Origin Destination Status	DATA	DATA	DATA		

Figure 16: World map showing the current location, heading, contents and schedule for each container

With 4 primary hubs of traffic destinations I made the above map. In the black square sits the list seen to the right of the map with detailed information about every container. Every container is then highlighted at its current position on the world map with a corresponding number. Colors indicate the type of container. I liked this task because it involved communicating with several international stakeholders, and finding a way to communicate a lot of shipping details in a way that one could quickly gather an overview just by looking at the map.

²⁶ Figure 16: Excerpt from the container tracker I designed, edited for data protection 6/8/2015





5 EVALUATION

During my internship I developed a lot of impressions about the working environment at Lockheed Martin Aeronautics that I feel compelled to share.

INTEGRATION INTO LM AERO

My primary concern before arriving was how I would ever be integrated into a company the size of Lockheed Martin Aeronautics. I have to admit that my group immediately managed to make me feel right at home. It was apparent that they were not strangers to foreign interns, as they have had Dutch interns for several years. Naturally there is a transition period where you learn to find your way and you have to remember a lot of new names and faces, but this was very smooth and I always felt comfortable.

INTEGRATION INTO TEXAS

Before my internship I had been to the USA several times before, but never this far south. I only knew Texas from literature and popular culture so my impression was that Texas was all about trucks, bbq, guns, rodeo, oil and steaks – I was right. Because of the proximity to Mexico, native Texans are used to people speaking and looking foreign but apparently two Scandinavians will still stand out in any crowd. The Texans are very open to meeting new people, and will never be rude or offended by how the Danish systems work. Popular culture creates an image of a people with narrow minds unable to comprehend socialism like it is in Denmark, but that image could not be further from the truth.

I always felt safe and welcome in Texas. It was continuously a pleasure talking to the locals about the differences between our cultures. My impressions were that Texans find Danish culture just as interesting as we find theirs. As I was already a fan of bbq (and quickly became a fan of rodeo) I had no problem adapting the Texan mindset.

INTERNSHIP TASKS

The tasks I was given during my time at Lockheed Martin Aeronautics had very little relation to what I had been taught at the University of Aarhus. I was expecting to have been using more of my theoretical knowledge, but it proved it was the mindset and the way of thinking like a mechanical engineer that was needed. This was a welcome challenge as it meant that I needed to quickly use my theoretical knowledge in practical situations. This could be anything from identifying the cause of wear on a part to figure out how certain machinery could be serviced without disrupting the production. The added layer of using the imperial system in a foreign working environment made for a true challenge of my communication skills. Few awkward moments were unavoidable but I quickly learned to navigate the Texan working culture.

PERSONAL OBSERVATIONS

When arriving at a factory the size of Lockheed Martin Aeronautics in Texas one cannot avoid bringing some preconceived notions of how one might think things are inside. In addition when coming from a different culture you will always compare what you see, to what you are used to from your home country. Here I present a few of the most outstanding differences I experienced.





HISTORICAL FACILITIES

Because of the history of the facility in Fort Worth it is unavoidable that some features are outdated. After visiting Terma A/S in Lystrup, Denmark, before leaving for the USA, I was expecting similar open office facilities in new settings. This was not the case, as I was placed in one of the infamous American cubicles with a color scheme and materials that I suspect are from the 1970's. I learned that massive renovations are underway throughout the facility, and because of the size it was of course not possible that all departments could get renovated facilities at the same time. This was understandable and the offices in which I was placed might have looked old, but they functioned impeccably. My only wish was that they would have renovated all the restrooms before focusing on the offices.

SECURITY

The security aspect was new to me, as it was the first time a Non-Disclosure Agreement (NDA) was not enough for me. It made me a bit nervous in the beginning but my team helped me with many questions and I quickly learned how to handle different situations, and the reason behind many processes. The level of security could sometime seem like an obstruction, but I was surprised as how quickly things could be done despite going through several reviews.

INTERNATIONAL PROGRAM AWARENESS

Because the F-35 is a contestant to become the new fighter jet in Denmark, there is naturally a Danish curiosity of the program. The University of Aarhus was very kind to guide us through interviews, providing media training and dealing with curious journalists. During our internship we also met with several Danish reporters who were visiting the facility, the board of a major Danish union and top members from both Terma A/S and Terma NA. I liked the interest for the program, as it was a reminder of that even though we were working a long way from home, the JSF program could have major impact on Denmark for years to come. It certainly helped me to perform my best.

WORKING WITH AU VS TERMA A/S VS LM AERO

As this internship was coordinated between 3 companies, 1 overseas office and 1 faculty there was initially a lot of communication. I am sure we only saw a fraction of it, as many people did a lot of work "behind the scenes" to get this program worked into the official master's program at the University. Because of the Danish fighter jet competition there was also political interests, and the University of Aarhus was very thorough to make sure they did not show any preferences in regards to the fighter jet contestants. This made for one more aspect to be aware of in the beginning, but once we had secured the internships these considerations were over. I was very surprised, especially with the University of Aarhus, about how efficient they were. Similarly Terma A/S and Terma NA did an excellent job providing information and help whenever we need it.

WORKING ENVIRONMENT AND COOPERATE CULTURE

The working environment at Lockheed Martin Aeronautics is very similar to what I would expect in a Danish company. The tone is more formal than in Denmark, but it is something you quickly adapt to. The hierarchy is not as flat in Denmark, as there are many layers of management in the USA. The work attire is formal but relaxed with few people wearing ties on a daily basis.



6 PROSPECTS FOR FUTURE INTERNS

It is my hope that this internship program will continue to provide experiences to many more Danish interns. To conclude my report I will briefly describe why I think my fellow students should apply.

TECHNOLOGY

World's largest certified shipping container? You've got it. Autoclaves the size of a big house? Yup, several of them. A 4 lane highway that ends at the factory? Oh that is just how we get to work. Portal cranes in 3 layers? Of course. CNC machines larger than a typical McDonald's restaurant? Yes sir!

As mechanical engineering students it is a dream coming true when you are allowed to poke around the production facility of Lockheed Martin's F35 assembly line. The sheer amount of technology packed into this facility is staggering and during my internship I tried, but did not manage, to see everything. I can safely assure future interns that they will learn of new technologies they have never heard of before, see precision on a scale never experienced before and watch the exotic materials and methods that are used to build the F-35.

BIG BUSINESS

Imagine a puzzle with 300,000 very expensive pieces made out of a wide range of exotic materials by 1,400 different companies all over the world¹². Now imagine that it is your job to build more than 3,100 of these puzzles²⁷ and to glue all the pieces together with more than 8 million lines of software code. A puzzle on this scale requires 129,000 people focused on it in the US alone²⁸.

Being in an environment like this on a daily basis and seeing how everything comes together is inspiring. Numbers are easy to present but it is not until you get to see the scale of the assembly line and the supporting facility that the size of the F-35 program dawns on you. This is something I wish that all my fellow students at The University of Aarhus could experience, because it really is something you will not forget.

AIRPLANES

Building airplanes, seeing them flying away and hearing the roar from the engine as flight testing is conducted should be enough for any student to quickly send an application for this internship. As the place of work is sharing their runway with the US Navy¹⁰ you get to see more planes flying than just the F-35. During my internship I have seen Harriers, F-18s, F-22s, F-16s, T-50s and C-130 Hercules aircraft flying out of or in to this shared airfield. I grew up very close to a commercial airfield and never looked twice at airplanes, but since learning what it takes to produce one I always enjoy seeing them in flight. This is definitely something future interns should also expect and it makes the whole experience even more awesome to actually get to see the product in action.

TEXAS

Future interns should come to Texas with a big appetite for adventure. The weekends off is a perfect chance to explore the southern USA and get to see and taste stuff that you can only experience here. The true American freedom lets you do pretty much anything you want, so all you should bring is an open mind!

²⁷ https://www.f35.com/resources/faqs 6/9/2015

²⁸ https://www.f35.com/about/economic-impact 6/9/2015





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