Faculty of Engineering Science and Technology (IVT)
Department of Industrial Engineering

The Pre Study Report
Thin Wall Structure by Welding

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UiT
THE ARCTIC UNIVERSITY OF NORWAY

Title: Thin Wall Structure by Welding	*Date:* 17 / 01 / 2019 *Classification* Class
Author(s): Hans Ivar Arumairasa	*Number of pages:* 10 *Number of attachments:* 11
Subject Name: Master Thesis - Pre Study Report	*Subject Code:* SHO6266
Faculty: Faculty of Engineering Science and Technology	
Master Program: Industrial Engineering	
Supervisor: Gabor Sziebig	
Co-supervisor None	
External Organization/Company: University if Tromsø (UiT)	
External Organization's/Company's Liaison:	
Keywords: Welding, Robotic, Analyze, WAAM	
Abstract (max 150 words): This Pre study give insight in the thesis subject of thin wall structure, how its organized and implemented over 19 weeks, important milestones and what the study will result in.	

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1 Introduction

1.1 Introduction

The master thesis is divided into two parts. Part one is a literature review where information and research of the topic are collected to gain a platform of basic knowledge where the further work in part two is based on. During the next part of the thesis is the actual work conducted and documented which the result is built on.

The study entails about manufacture thin wall structure by welding which is a more economic and faster way of production than standard milling and machining. It generates growth in relation to engineering structures, with areas from aircraft, bridges, ships and general complex and large structures. The thin wall structure is an arc-based deposition process of a thin wall structure in a layer upon layer manner, which is conducted by a technique of Additive Manufacturing [AM]. AM are commonly known as 3D-printing technology with a waste specter of different methods, however, this study will utilize GTAW-Based Wire Arc Additive Manufacturing System to weld the component, explained in the figure below [1].

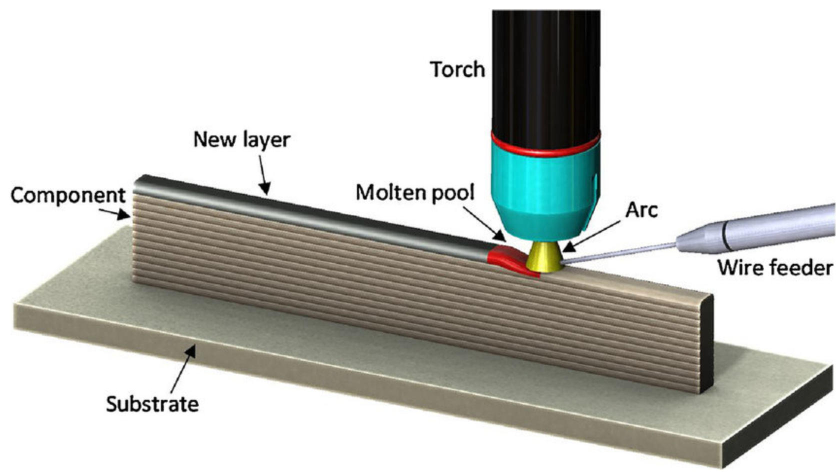

Figure 1: GTAW-Based Wire Arc Additive Manufacturing System. Source [1]

Figure 1 describe the process of GTAW-Based Wire Arc Additive Manufacturing that produces a thin wall structure. Short described: a process where a wire of a given material is fed beneath the tungsten arc to be melted under the molten pool which generates layers of deposition. The layer is welded on top of each other until a component is produced. This study of welding technology (3D-printing) aim for utilizing GTAW-based wire arc additive manufacturing which is conducted by a KUKA-KR30-3 robot to produced an optimal thin structure. A method of measure the residual stresses then take place to find out how much stresses (tensile) the component contains. All samples made are documented by a welding procedure qualification record (WPQR), it represents how the component was made and its property after production. When the activity ”robot welding” and ”residual stress test” are completed, a digital simulation method by the software ”ANSYS” are used to give an analytic overview of the results. A comparison of the digital analyzes and the practical result are then presented to conclude the thesis’s outcome.

1.2 Background

Reason for choosing this thesis subject is based on my earlier experience at welding in a job context, robotic subject from earlier in our thesis program also woke my interest in this world of technology. The thesis was handed out from the University of Tromsø campus Narvik, who wanted to achieve further result and documentation of robotic welding. Especially when the topic of thin walls structure is a low documented theme which has global increasing popularity of technology within the additive manufacturing [2].

1.3 Problem statement

Problem statement: Most productions of today's structure component are in general generated by subtracting machining. To achieve a more complex and efficient production, the 3D-printing technology by additive manufacturing is utilized: welding of thin wall structures by additive manufacturing. During the GTAW process thermal and mechanical distortion occurs and creates residual stresses, shrinkage and tension, which can compromise and decrease the structure's tensile strength and grain structure. To control or to minimize the residual stress, stress distribution is needed to be known.

1.4 Assumptions and project framework

Prerequisites and framework for the project contain limitation within the lab works as welding process and tensile stretch bench. The alloys of stainless steel 304l and X3CrNiMo13-4 are assumed to provide wide enough specter of a different outcome to compare and lay a basis for discussion and result. Since there are just the material X3CrNiMo13-4 that need PWHT (Post Weld Heat Treatment) it is predicted that the material property of the thin wall structure is equal to the original material before welding. The last assumption regards preheating, where a portable torch are used to generate enough energy to heat up the material to an acceptable level The project contains a framework of the experimental part of the study. This includes the welding process, strength, and fatigue -tests and analyses of the produced thin wall structure, which is documented by the welding procedure qualification record which is the framework in written form.

2 Effect goal and results

This section provides knowledge of the study's purpose, what the involved parties gain from it, how long the project is and potential costs.

2.1 Effect Goal

The profit from this study is to gain a solid procedure and a documented analysis of the thin wall structure process, for the University of Tromsø. It strengthens the school's knowledge in the new 3D-printing technology (AM) which further can be developed by the school's resources as in lab projects or for future master's/doctor's degree studies. This could further affect the school's reputation for welding/robotic-technology that could attract interest for upcoming students and researchers around the world.

2.2 Outcome and Scope

2.2.1 Objective for results

The main outcome of the thesis are to find the measurement of the residual stresses in the thin wall structure. This study will result in these concrete tasks:

- Conduct a welding experiment with a mixture and manipulation of parameters, design of weld and thermal and mechanical process techniques to produce thin wall structures.
- Study, analyze and identify residual stresses and distortion in weld.
- Develop an optimal procedure process which contain documentation of the thin wall structure process and compare it to a digital simulation model.
- Carry the documents in written form

2.2.2 Time frames

The study report is to be expected done within 30 May 2019 in week 22, where the thesis will be conducted over 21 weeks period.

2.2.3 Costs

In this study are there no direct costs except the material and equipment the school provide at the lab.

2.3 Theory/hypothesis

The theory/hypothesis of the thesis is to use the 3D-printing technology of GTAW-based WAAM system to make a component/structure that have preserved/ improved its property in the material after the weld. The welded structure is expected to consists of a homogeneous weld that has more endurance and strength than the original material. The result of the product is to have an reduced amount of residual stress and has a limited amount of distortion (deformation/shrinkage) in the base plate if the preheating and PWHT is done right.

3 Implementation and Organization

3.1 Project phases / main activities

Activity	Name:	Purpose:	Results:
A	Project Management	Weekly planning and monitoring the progress at the study's result.	Gain overview in the time schedule to plan weekly goals.
B	Concept Phase	Selection of the best concept to weld structures design to compare with the originally thin wall structure..	Concepts structure sketched in Inventor.
C	Robot welding	Produce thin wall structure by use of robotic GTAW technology.	An developed optimal procedure to weld an thin wall structure by use of KUKA-30-3 robot and create different design.
D	Residual stress test	Examine residual stresses in the component.	An graph that shows the components stresses (tensile).
E	ANSYS	Provide an digital point of view with the FEA-method to compare with the practical results.	Gain an illustrated figure of the different concept design and provide an digital analyze.
F	Analyze data	Gather and analyze the data from the lab test and compare to the results from ANSYS.	Draw an discussion and conclusion from the analyzed data if the structure are sustainable.
G	Report writing	Documentation of the study in its entirety. The report is the result of the entire project and is considered the most important part.	The finally project report.
H	Prepare presentation	Complete a part of the project, present the progressed work.	Make an PowerPoint presentation
I	Complete Report	Control the content, typo, layout etc..	Final controlled report.

Table 1: Main activities

3.1.1 Milestones

Milestones:	Date:	Description:
Project start	11.01.2019	Starting the project, delivering the task
Determination of concept	20.01.2019	Determine the design of the structure
Finish the lab tests	22.02.2019	Finish with weld and tests of thin wall structures
Simulate in ANSYS	31.03.2019	Analyze the component and present as digital data.
Complete the report	28.05.2019	Write and finalize the report.

Table 2: Milestones

3.1.2 Submission and status dates

Submissions during the Master Thesis:	Date:	Description:
Project start- part 2:	14.01.2019	Delivery of Master thesis description Part 2.
Pre-study report	05.02.2019	Delivery of pre-study
Status meeting 2	13.02.2019	Mandatory status meeting
Status meeting 3	20.03.2019	Mandatory status meeting
Status meeting 4	10.04.2019	Mandatory status meeting
Status meeting 5	15.05.2019	Mandatory status meeting
Last oral presentation	31.05.2019	Presentation of final work.
Final Report	31.05.2019	Delivery of end report

Table 3: Dates of status delivery

3.1.3 Decision points

Decision point:	Date:	Decription:
First draft of concept	16.01.2019	Make different suggestion as structure design to weld
Completed concept	20.01.2019	Deside three design to produce.

Table 4: Dates of decisions

3.2 Progress monitoring

It's worked out a detailed plan for the project, to monitor planned hours compared to actual hours done for each week and activity. This is presented by a time schedule, Gant-diagram, an S-curve. Time schedule shows all activity that is planned, how many hours the different week have at different activities and how much of the project that is left. The Gant-diagram are based on the time schedule activities that present the data in a column chart. It provides precise data of each activities starting week, and the length of it in weeks compare to other activities and the total length of the project. The S-curve presents how many hours are planned at given weeks in percent. Data from the S-curve and Gant-chart are presented as planned in the pre-study report where it later compared to actual progress in the status meetings and in the end report. The time schedule (with actual hours done) are updated for every week in the study

3.3 Status reporting

Every status report that is presented in table 3, are based on progressed work compare to the planned work addressed in this study report. During this master, there is five status meeting and total six representations.

4 Risk Analyses

4.1 Critical success factor

As a part of the HSE work in the lab at UiT, a risk analysis has been developed to map thoroughly high potentially cause injuries or illness in the workplace. The Norwegian Working Environment Act requires that all businesses performing this analysis have three simple tips that are the core of risk assessment:

- What can go wrong?
- What can we do to prevent this?
- What can we do to reduce the consequences if this happens?

In order to assess the risk, a critical success factor is used to classify the risks:

$$Probability \times consequence = Riskfactor \tag{1}$$

Consequence: Probability:	1. Insignificant	2. Less serious/ A certain danger	3. Considerable/ Critical	4. Severe / dangerous	5. Very serious/ disastrous
5. Extremely likely	5	10	15	20	25
4. Very likely	4	8	12	15	20
3. likely	3	6	9	12	15
2. Less likely	2	4	6	5	10
1. Little likely	1	2	3	4	5

Figure 2: Critical success factor spectre. Source: [3]

The risk analysis is presented by figure 3 which shows unwanted events that are inflicted by possible cause and result as a consequence that impacts the progress of the project. The consequences are based on a risk factor which consists of a specter between 1-25 as shown in figure 2. The red area at the top of the corner indicates the severity of the danger while the yellow color in the middle of the specter indicates less serious/danger to the project's progress. At last the green color at the left corner indicates an insignificant degree of danger. Probability and consequence have a factor of range one to five that indicates the severity.

Explanation of figure 3, the specter of critical success factors. If risk number four should occur that present a possible unwanted event of ”defect part” (the component that has distortion and high tension), would it be inflicted by a possible cause of thermal or mechanical processes which would risk progressed and achieved goals of the project. The degree of probability for this to occur was set to five and the consequence to three which generate a risk factor of 15. The risk factor is located in the severity part of the specter in figure 2. An action is therefore implemented to conduct either preheating, welding sequence or post-welding heat treatment. This is due to prevent distortion and tension in component (defect). Thus will the probability for the situation to occur reduced to three and the consequence to 2 which result at a risk factor at six which is less danger.

Risk	Possible unwanted event	Possible cause	Consequence
1	Absence	Disease, travel, job or potential injury	**Risking progress in the project, achieving goals and reaching deadlines.**
2	Insufficient expertise.	Low knowledge of the process and general low expertise in welding.	
3	Welding blindness or heat damage	Not wearing welding mask.	
4	Defect parts	Thermal or mechanical processes	
5	Not homogeneous weld	Not enough sufficient welded. Wrong parameters	
6	Compromise the component during residual stress test	Machining the thin wall structures	
7	Time – Not finish the activity at the lab and find a way to test residual stress	Errors with the robot during welding and travel to China.	
8	Robot fails to conduct the operation.	Equipment malfunction, short circuit.	

	P	C	R	Actions	P	C	R
	* Assessment of risk before action				* Assessment of risk after action		
1	2	3	6	Prioritize away partying, holidays and excursions in the coming semester. Avoid and lift too much weight at the gym.	1	3	3
2	3	4	12	Seek in literature review or tips/help from professionals (professors)	1	4	4
3	5	5	25	Use mask equipment and follow HSE procedure	2	3	6
4	5	3	15	Attention at preheating, welding sequence and post welding heat treatment	3	2	6
5	3	5	15	Use standard parameters used in earlier operation of robot welding as basepoint then try and test experience.	2	4	8
6	4	4	16	Careful with machining, counseling with advisor	5	2	10
7	3	5	15	Meet at school earlier and use the whole day from 08:00 to 16:00 AM. Call other universities to conduct the residual stress activity	2	2	4
8	2	5	10	Double check every component and practical procedure before welding.	2	2	4

Figure 3: Critical success factor. Source: [3]

5 Costs

5.1 Planned amount of time

There is no direct cost related to the thesis. However, a budget is set up regarding student's hours used. In total has each student 1200 hours to spend, where 400 hours are for the literature review and around 800 hours for part two which is the main part of the thesis. This project's part two are based on 828 planned hours in total where the main priority lies at activity ”Robot welding” (136h) and ”report writing” (209h).

5.2 Cost / Benefit

The task is built on a theoretical and a practical part. The practical part includes lab activities which are used to develop a procedure of qualification to achieve an optimal procedure of a thin wall structure by robotic welding. The procedure process, in this case, results as the reward/benefit of the study, along with the analytic knowledge where the lab-result are compared with. This gives the school knowledge in future 3D-printing technology by welding.

6 Quality management, HSE and Monitoring

6.1 Quality management

Good quality management from the start of the project, the UiT, and the student-facilitated has implemented a new orientation structure. It is therefore added a solid procedure of frequently mandatory status meetings and presentation of progressed work to ensure positive progress and more fluent implementation of the project. This would also result in a close follow-up of the requirements specifications from the task description part two and by NS 9001: 2008. During the project, especially under the lab-test activity will regularly contact with supervisor be attended to make sure quality management during the riskiest phase in this study.

6.2 HSE

Health, security, and environment (HSE) are important factors that impact the project's progress and results. As a part of HSE-evaluation, it is prepared a risk to analyze internally in the project as shown in figure 3. In the critical success, factor analyzes risk number three takes a dangerous situation that can occur into account and which action to take which result in a lower risk factor.

Regarding HSE some point of view are taken into account to prevent potentially HSE problems:

- Use protection equipment as welding mask and cloth that cover the surface of the skin
- Not enter the welding area while the robot are working

- Secure the welding equipment before and after welding (example cut the filler metal after weld)

6.3 Monitoring

During the project phase has the student together with the supervisor agreed to have electronic status meetings through Skype, because of the distance from China. Possible meetings beside the mandatory status presentations need to be a planned appointment in the supervisor's favor. This is done to avoid unnecessary costs in form of work with unwanted concepts. Otherwise, will future work in China be discussed with the supervisor provided by Bejing Institute of Technology, which will be an internal arrangement.

7 Attachments

Following attaqchments will be added in to the pre-study:

- Time schedule
- Gant-diagram
- S-curve
- Activity descriptions (10 descriptions, one for each activity)

Attachment 1

Planned				**Weeks**					**China**														
Activity	**Starting week**	**Length in weeks**	**Hours**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**
Project start	3	1	10	10																			
Project Management	3	20	43	5	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Concept phase	3	1	15	15																			
Robot welding	4	5	136		30	30	30	30	16														
Residual stress test	4	5	50		10	10	10	10	10														
ANSYS	9	5	125							25	25	25	25	25									
Analyze data	14	4	120												30	30	30	30					
Report writing	3	17	209	10	10	8	7	5	5	12	12	12	12	20	12	12	12	20	20	20			
Prep.Presentation	5	6	60			5	10	5				5	5		5	5				5	5	5	5
Complete report	20	3	60																		20	20	20
Total for Project:			828	40	52	55	59	52	33	39	39	44	44	47	49	49	44	52	22	27	27	27	27
Plan.Hours(acc)				40	92	147	206	258	291	330	369	413	457	504	553	602	646	698	720	747	774	801	828
Plan.progress(%)				4,831	11,11	17,75	24,88	31,16	35,14	39,86	44,57	49,88	55,19	60,87	66,79	72,71	78,02	84,3	86,96	90,22	93,48	96,74	100

Figure 4: Attachment 1. Time schedule

Attachment 2

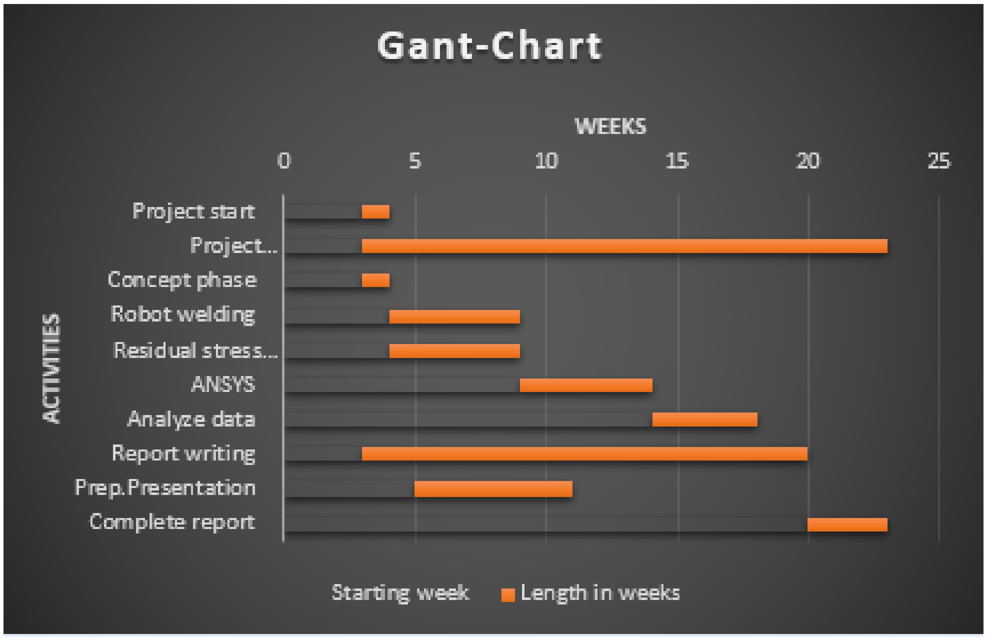

Figure 5: Gant-Diagram

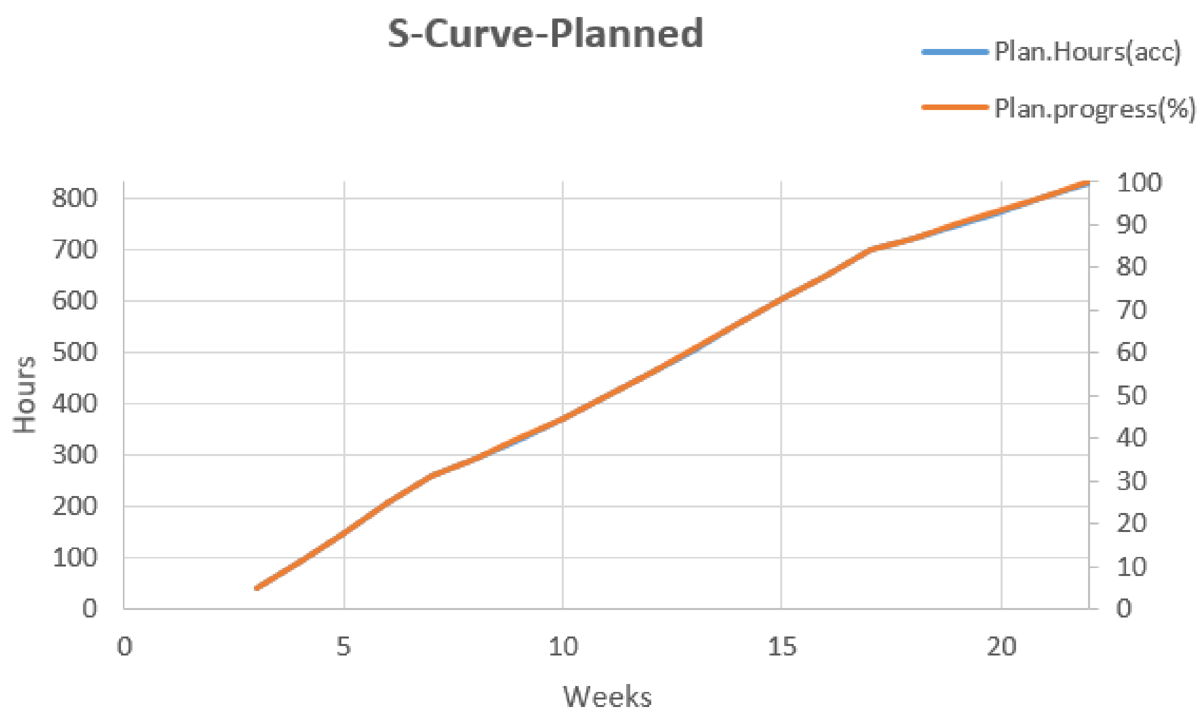

Figure 6: Gant-Diagram

Attachment 3

<table>
<tr><td>Project title:
Thin Wall Structure by Welding</td><td>Sign:</td><td>Date:
17.01.2019</td></tr>
<tr><td>Activity name:
Project Management</td><td colspan="2">Activity Nr:
Nr. A</td></tr>
<tr><td colspan="3">Responsible:
Hans Ivar Arumairasa</td></tr>
<tr><td colspan="3">Task Description/intention:
Weekly planning and quality management to monitor progression</td></tr>
<tr><td colspan="3">Scope:
Start of every week some hours are use to monitor progressed work and compare the actual work to the planned onces. Then a weekly planning will be conducted to manage the time frame and ensure everything will be done.</td></tr>
<tr><td colspan="3">Method:
Excel in form of S-curve and update on the actual time schedule</td></tr>
<tr><td colspan="3">Dependency:
On progressed work and pre-study</td></tr>
<tr><td colspan="3">Documentation/results:
Documented in Latex (pdf)</td></tr>
<tr><td>Written by:
Hans Ivar Arumairasa</td><td colspan="2">Duration:
20 weeks</td></tr>
</table>

Attachment 4

<table>
<tr><td>Project title:
Thin Wall Structure by Welding</td><td>Sign:</td><td>Date:
17.01.2019</td></tr>
<tr><td>Activity name:
Concept Phase</td><td colspan="2">Activity Nr:
Nr. B</td></tr>
<tr><td colspan="3">Responsible:
Hans Ivar Arumairasa</td></tr>
<tr><td colspan="3">Task Description/intention:
Make an design of the thin wall structure to be welded in the lab-test activity.</td></tr>
<tr><td colspan="3">Scope:
Create multiple design in the software Inventor and then use a conceptualization analyze to choose the best designs to be welded. Afterwards a comparison of the original one then take place to show differences in its properties.</td></tr>
<tr><td colspan="3">Method:
Inventor</td></tr>
<tr><td colspan="3">Dependency:
The pre-study</td></tr>
<tr><td colspan="3">Documentation/results:
Concept sketch will be documented and evaluated in the report (Latex).
Results are evaluated in tables included drawings.</td></tr>
<tr><td>Written by:
Hans Ivar Arumairasa</td><td colspan="2">Duration:
1 week</td></tr>
</table>

Attachment 5

<table>
<tr><td colspan="2">Project title:
Thin Wall Structure by Welding</td><td>Sign:</td><td>Date:
21.01.2019</td></tr>
<tr><td colspan="2">Activity name:
Robot welding</td><td colspan="2">Activity Nr:
Nr. C</td></tr>
<tr><td colspan="4">Responsible:
Hans Ivar Arumairasa</td></tr>
<tr><td colspan="4">Task Description/intention:
Weld up thin wall strucutres to conduct residual stress testes on.</td></tr>
<tr><td colspan="4">Scope:
The robot KUKA-30-3 are used to weld an thin wall structure with given parameters. When the right parameters are found, different design are created to generate different outcome.</td></tr>
<tr><td colspan="4">Method:
GTAW-based WAAM process by KUKA-30-3 robot in the lab.</td></tr>
<tr><td colspan="4">Dependency:
Concept Phase</td></tr>
<tr><td colspan="4">Documentation/results:
Documented by the procedure called WPQR (welding procedure qualification record) in the pdf (latex) Result are the component produced and the optimized procedure.</td></tr>
<tr><td colspan="2">Written by:
Hans Ivar Arumairasa</td><td colspan="2">Duration:
5 week</td></tr>
</table>

Attachment 6

Project title: Thin Wall Structure by Welding	*Sign:*	*Date:* 21.01.2019
Activity name: Residual stress test	*Activity Nr:* Nr. D	
Responsible: Hans Ivar Arumairasa		
Task Description/intention: Examine the residual stresses at the surface the weld and material.		
Scope: Find a methods of measure the residual stresses in weld. Collect samples of stresses at the weld and material and represent the data in form of a graph.		
Method: Non-destructive, semi-destructive or destructive test		
Dependency: Lab welding		
Documentation/results: Documented by the procedure called WPQR (welding procedure qualification record) in latex.		
Written by: Hans Ivar Arumairasa	*Duration:* 5 week	

Attachment 7

<table>
<tr><td>Project title:
Thin Wall Structure by Welding</td><td>Sign:</td><td>Date:
25.02.2019</td></tr>
<tr><td>Activity name:
ANSYS</td><td colspan="2">Activity Nr:
Nr. E</td></tr>
<tr><td colspan="3">Resbonsible:
Hans Ivar Arumairasa</td></tr>
<tr><td colspan="3">Task Description/intention:
Conduct an FEA analyze method to gain an illustration of possible high stress and distortion in baseplate and structure component.</td></tr>
<tr><td colspan="3">Scope:
Conduct an FEA analyze where the geometry of the structures created in Inventor are transferred to ANSYS to generate an stress and displacement analyze.</td></tr>
<tr><td colspan="3">Method:
ANSYS</td></tr>
<tr><td colspan="3">Dependency:
Lab tests and Concept Phase</td></tr>
<tr><td colspan="3">Documentation/results:
Documented in latex.
Result provides an illustrated figures of the different concepts design and
contribute an digital analyze.</td></tr>
<tr><td>Written by:
Hans Ivar Arumairasa</td><td colspan="2">Duration:
5 week</td></tr>
</table>

Attachment 8

<table>
<tr><td>Project title:
Thin Wall Structure by Welding</td><td>Sign:</td><td>Date:
21.01.2019</td></tr>
<tr><td>Activity name:
Analyzed data</td><td colspan="2">Activity Nr:
Nr. F</td></tr>
<tr><td colspan="3">Resbonsible:
Hans Ivar Arumairasa</td></tr>
<tr><td colspan="3">Task Description/intention:
Gather and analyze the data from the lab test (WPQR) and compare to the results simulated from ANSYS.</td></tr>
<tr><td colspan="3">Scope:
Compare the difference in the data from the simulation and to the actual data provided in the lab. Followed by documentation why the result occurred as they did and provide an analyze that shows if the thin wall structure was successfully.</td></tr>
<tr><td colspan="3">Method:
Latex</td></tr>
<tr><td colspan="3">Dependency:
Lab tests and ANSYS</td></tr>
<tr><td colspan="3">Documentation/results:
Documented in latex with tables and analyzes. Result contains material to discuss and draw an conclusion from the analyzed data.</td></tr>
<tr><td>Written by:
Hans Ivar Arumairasa</td><td colspan="2">Duration:
4 week</td></tr>
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Attachment 9

<table>
<tr><td>Project title:
Thin Wall Structure by Welding</td><td>Sign:</td><td>Date:
18.01.2019</td></tr>
<tr><td>Activity name:
Report writing</td><td colspan="2">Activity Nr:
Nr. G</td></tr>
<tr><td colspan="3">Responsible:
Hans Ivar Arumairasa</td></tr>
<tr><td colspan="3">Task Description/intention:
Documentation of the project in its entirety and conclusion. The report is the result of the entire project and is considered the most important part.</td></tr>
<tr><td colspan="3">Scope:
Write documentation of hypothesis/theory and result from the other activities which will be conducted some hours every week.</td></tr>
<tr><td colspan="3">Method:
Latex</td></tr>
<tr><td colspan="3">Dependency:
Result from other activities</td></tr>
<tr><td colspan="3">Documentation/results:
Documented in latex. Result in a final report of the thesis study.</td></tr>
<tr><td>Written by:
Hans Ivar Arumairasa</td><td colspan="2">Duration:
17 week</td></tr>
</table>

Attachment 10

<table>
<tr><td>Project title:
Thin Wall Structure by Welding</td><td>Sign:</td><td>Date:
30.01.2019</td></tr>
<tr><td>Activity name:
Prep.Presentation</td><td colspan="2">Activity Nr:
Nr. H</td></tr>
<tr><td colspan="3">Responsible:
Hans Ivar Arumairasa</td></tr>
<tr><td colspan="3">Task Description/intention:
Complete a part of the project, present the progressed work.</td></tr>
<tr><td colspan="3">Scope:
Conduct an PowerPoint presentation of the work from last submission.</td></tr>
<tr><td colspan="3">Method:
PowerPoint</td></tr>
<tr><td colspan="3">Dependency:
Result in the progressed work from other activities</td></tr>
<tr><td colspan="3">Documentation/results:
Documented in latex. Result in a PowerPoint presentation of the progressed work.</td></tr>
<tr><td>Written by:
Hans Ivar Arumairasa</td><td colspan="2">Duration:
17 week</td></tr>
</table>

Attachment 11

Project title: Thin Wall Structure by Welding	*Sign:*	*Date:* 13.05.2019
Activity name: Complete report	*Activity Nr:* Nr. I	
Responsible: Hans Ivar Arumairasa		
Task Description/intention: Control the content, typo, layout before deliver the final report		
Scope: Read over the document several times and ensure a secound party also read the final report.		
Method: Latex		
Dependency: Report writing		
Documentation/results: Documented in latex. Result as a final report.		
Written by: Hans Ivar Arumairasa	*Duration:* 3 week	

References

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