UNIVERSITY OF TWENTE.

Faculty of Mechanical Engineering,
Production Management

Internship Gestamp Automación

Part 1: "Arc welding standard for production & quality inspection"

Part 2: "Implementing the principles of lean in a productive classroom"

Nick D. de Groot
M.Sc. Internship Assignment – Gestamp Automoción
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Supervisors University:

ir W. de Kogel-Polak

Supervisors Gestamp:

Marta Urdiain

Jaime de la Maza

Maite Larios

Amaia Elorriaga

Preface

This report has been written as part of the curricular internship of the master Production Management at the Faculty of Mechanical Engineering for the chair of Production Management. The internship is performed at Gestamp, in both Madrid (Spain) and Bilbao (Spain). During this internship, both a change in assignment and a change of location has been made. The reason for this change can be found in the appendices.

I express my deepest thanks to Wieteke de Kogel, Marta Urdiain, Maite Larios, Jaime de la Maza, Francisco Álvarez and Amaia Elorriaga for the mentoring and assisting me during this internship. I am also grateful for the help of all the others that assisted me during this internship but that are not mentioned specifically here.

I would like to thank Gestamp for offering the opportunity to perform this internship inside their inspiring enterprise.

Summary

This report consist of two parts. Part 1 is performed in Gestamp Servicios in Madrid with the subject: 'creation of a global arc welding standard'. This standard serves the purpose of ensuring the same level of quality globally. This part is not completed and is ended after reading the current materials and literature on both visual inspection and lean learning. The change of assignment and location that occurred has two reasons. First of all, the request from my side for a more technical and practical assignment. The second reason was me having difficulties with adapting to the appropriate working culture. More on this part can be found in the appendices.

Part 2 is performed in the Gestamp Technology institute with the goal of investigating the possibilities for the implementation of lean and its methods. After identifying the current situation and the existing wastes, three tools of lean are implemented with the goal of reducing the identified wastes. An inventory database (inventory management) is constructed, 5S is implemented in an area with 18 workbenches and students and teachers are trained in the basics of lean manufacturing.

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List of abbreviations

AC	Alternating Current
AIC	Automotive Intelligence Center
BIW	Body In White
CNC	Computer numerical control
DC	Direct Current
GTI	Gestamp Technological Institute
GUI	Graphical User Interface
HAZ	Heat Affected Zone
L&D	Learning and Development
MAG	Metal Active Gas
MIG	Metal Inert Gas
NIE	Número de Identidad de Extranjero

1 Introduction

This report is written as part of the internship of my master Mechanical Engineering at the University of Twente in the research chair of Production Management. The internship is executed at Gestamp, a major supplier of metal components of the automotive industry, in both Madrid and Bilbao.

Gestamp, a company founded in Spain, is a major supplier of metal components of the automotive industry. Before continuing, I would like to address the point that this report consists of two different parts. This is due to the fact that the assignment and the location changed during the internship.

The introduction continuous with a short history of the Gestamp group, followed by the motivation of the assignment, after which the rest of the report follows, divided in two parts.

The first part of this report describes the project performed in Gestamp Servicios, located in Madrid. The second part of this report describes the project performed in the Gestamp Technology Institute in Bilbao. Both parts are build up in the same manner, starting with a problem definition, followed by the objective, theory, results and a conclusion plus discussion.

The explanation for the change within this internship can be found in Appendix A: Change of Assignment.

1.1 The company: Gestamp Group

Gestamp was founded in 1997 in Spain as a result of vertical integration by Gonvarri, a company dedicated to steel processing. Gestamp had the goal to become global in supplying metal automotive components. Due to constant improvement of current technologies and the acquaintance of new technologies to increase the safety and reducing weight, Gestamp has grown global with a large base of Clients consisting of most known car manufacturers.

Gestamp had major growth after the founding in 1997. At the moment of writing (sept 2016, Madrid), the company has over 35.000 employees, 95 manufacturing plants in 20 countries on four continents and 12 R&D centers. [1]

In 2007, another branch of Gestamp was created, Gestamp Renewables, focusing on renewable energy sources. In this report, only the Gestamp branch focused on the manufacturing of automotive components and systems is considered. Within this part of Gestamp, a division is made between three different technologies: Gestamp Body In White (BIW), Edscha (Mechanisms) and Gestamp Chassis. This division and examples of products can be seen in Figure 1.

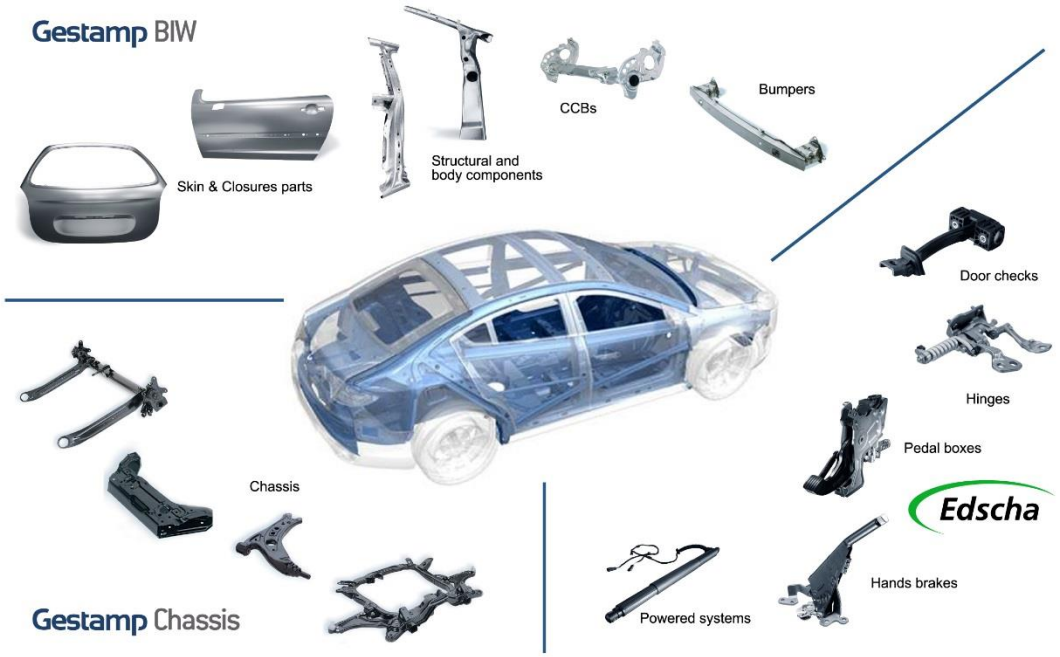


Figure 1: The three divisions within Gestamp Automotive with corresponding examples of products. [2]

1.2 Motivation of the assignment

As the assignment and the report are split up into two separate parts, here two separate motivations are given.

1.2.1 Part 1: Gestamp Servicios

Because the massive growth since the founding consists partially of acquired companies, there are now different cultures and ways of working within the different divisions and manufacturing plants. With major clients demanding consistency in communication and especially quality, a major call for creating standards is present within Gestamp. This report, as part of an internship, covers the path followed for creating standards for Arc Welding in all manufacturing plants of Gestamp.

1.2.2 Part 2: Gestamp Technology Institute (GTI)

The Gestamp Technology Institute is a relative new concept within Gestamp and is opened in September 2015 as a training center for employees and new hires of Gestamp. As this location is new and not equal to the other (manufacturing) locations that are part of Gestamp, implementing the lean methodology is more difficult than in the manufacturing locations. The focus during this internship was to improve the quality of learning and working in GTI by implementing the lean methodology in a productive classroom.

Part 1 – Gestamp Servicios

1 Introduction

Gestamp Servicios is the main office of Gestamp in Madrid. Here, the Learning and Development department is based. This part of the report covers the internship in the L&D department. The focus of this project lies on creating a training and quality standard for the arc welding process.

2 Problem definition

Gestamp gained a lot in size and diversification into different markets after acquiring other firms like ThyssenKrupp's metal components division in 2011 and Edscha, specialized in mechanical movement components like hinges and throttle bodies. The acquiring of other firms does not only results in diversification of product groups, but also in diversification of working cultures and standards within the Gestamp cooperation. When one of the major clients (BMW) insisted on having a single standard for each technology throughout all production plants and departments of Gestamp, a big standardization project was started. This project is divided through different divisions within Gestamp like Quality management and the Learning Department. The focus of the project that I, as a mechanical engineering student joined, is to create a standard for arc welding and the quality control of arc welding.

Arc welding within Gestamp consists of automatic (robot) welding with manual loading and offloading. Visual inspection is performed at each station by different types of workers and 3D scanners. Rework is done manually on and off-line. At different production sites, different standards and training programs are used for both welding and the quality control, consisting of visual inspection and rework.

The use of different standards and trainings methods results in different quality levels for the customer, eventually leading to a higher defect rate. BMW, a major client, demands a single standard to ensure quality within all of their manufacturing plants.

This project consists of identifying current standards and training methods used throughout the plants of Gestamp and the standards that all clients demand. This will be used as a basis of an internal standard and training program for arc welding that ensures consistency throughout the different plants and creates clarity for the customer. After the standards and the training program is designed, it will be implemented in an online environment together with a pilot plant and the Gestamp Technological Institute (GTI).

2.1 Objective

"To assure constant quality to our Clients over all different plants by training our Professionals in Arc Welding in a globally standard procedure."

Sub goals:

- To identify the current flow of the welding processes
- To identify the roles within the welding process
- To identify all current standards used for training of the current roles within the welding process.

2.2 Scope

The scope of this project is the creation of a standard for the arc welding process, both in learning and quality inspection (mostly visual inspection). This is done in cooperation with experts in these fields. The project is focused on the arc welding technology only, other types of welding are not considered. The training program is used in various manufacturing plants around the world.

2.3 Approach

First, some theory on learning and visual inspection is studied, after which parts of the learning module that have been worked on during the internship are shown. A start has been made by summarizing the currently used (ISO) standards in visual inspection.

As stated before, this project is not finished completely, because of the transfer to another location of Gestamp. This means there are no results that can be displayed.

3 Theory

To create a single standard for training of welders, one has to gain knowledge in the welding process itself, the different roles of the operators and supporting staff, the required skill level of the employees, the way of training and the requirement for the standard set by clients. When entering the project, some identification was completed. This is not covered in great detail.

3.1 The arc welding process

Within Gestamp, different welding techniques are used in the process and new techniques are under development. This project is limited to the single technique of Arc Welding. Arc Welding is one of the oldest forms of welding, where a constant arc between the electrode and the base is used to create a weld between to metals by melting the metals. There are different techniques, using a consumable or non-consumable electrode. As for the types of current, two options are available, Alternating Current (AC) or Direct Current (DC).

The technique used in the arc welding process of Gestamp is a combination of both MIG (Metal Inert Gas) and MAG (Metal Active Gas) with both AC and DC.

When I entered the project, the process of creating a defect catalogue was started. This defect catalogue is used to train all the staff involved in the arc welding process. This catalogue contains the different types of defects with images, theoretical background, corresponding repair actions, official naming and practice exercises. Most of these defects are detected using visual inspection. This catalogue ensures consistent detection and actions throughout all the Gestamp arc welding lines. This catalogue is described in short after the information on visual inspection.

To improve the quality of arc welding, the human factor is of high importance. This is due to the fact that within the arc welding process, visual inspection is used at several stations to assure quality. For this reason, some literature research about visual inspection is done and shown below.

3.2 Visual inspection

Visual inspection or visual testing, in this case human, is part of non-destructive testing. Some advantages and disadvantages are summarized and shown below.

Advantages

- Low cost equipment
- No power consumption
- Inexpensive
- Quick identification

Disadvantages

- Errors due to the human factor
- Inspector training necessary
- Can / will miss internal defects
- Report must be recorded by inspector (time consuming)

Even under 100% inspection, in which each single part is visually inspected, not all defects will be detected due to human error. Modern production processes, especially the ones in line with

lean, tend to produce to the zero-defect theory. This means post-production inspection, common in the 20th century, has shifted towards in-line inspection on multiple stages, preferably after and or before each step in the production process. [3]

When a single part is visually inspected by e.g. the unload and the load operators in between a single process, one would have 200% visual inspection. This means that if the visual inspection is e.g. 87% effective, with 200% visual inspection, it would have an effectiveness rate of 98%.

P(rejects being identified by at least one inspector) = 1 – (1-e)^n where n = number of 100% inspection and e = inspection effectiveness. This formula only holds if all inspectors have the same effectiveness and under the assumption that the inspections are independent events.

In the real world, especially this last assumption may not hold. First of all, not all defects may have the same detection rate, making some defects more difficult to detect, even for multiple inspectors. Also, inspectors may start to assume that they can rely on the other inspector's work, making them less effective by paying less attention. Both mean that the separate inspections cannot be treated as independent events.

3.2.1 Types of 100% inspection:

- Parallel: Each inspector inspects only half of the batch.
- Two accepts: Both inspectors inspect each item and both must accept each item before continuation.
- Two rejects: Both inspectors inspect each item and both must refuse each item before rejecting.
- Re-inspect accepts: Inspector 2 only inspects the items accepted by inspector 1.
- Re-inspect rejects: Inspector 2 only inspects those items rejected by inspector 1. [4]

3.2.2 Visual inspection process

As multiple literature studies show, the visual inspection process generally consists of five basic steps:

1. Set up: procedures or work instructions, items to be inspected, and equipment needed for inspection.
2. Present: prepare item for inspection by placing in a holding fixture or on an inspection table.
3. Search: examine item for defects with searching. Searching can be random or systematic.
4. Decide: compare possible defects against to standard to determine the type of defect. Standards can be in the form of physical products or written / visual standards.
5. Respond: accept or reject the item. After the decision is made, mark the item if or fill in paperwork if necessary and place it in the correct location. [4]

Within this process, the search and decide steps are the most prone to the human factor. For this reason, these two steps are elaborated below in greater detail.

3.2.3 Searching

Searching can be done in generally two different ways; systematic and random. Random can result in more overlap of the inspected areas. Systematic requires a memory of all the inspectedareas. A systematic search method is generally superior to a random search strategy. [3]

3.2.4 Visual inspection decision making

Decision making in visual testing consists of two options, reject or accept. The actual condition of the item, defective or good products, makes four decision outcomes, showed in Table 1.

Table 1: Decision making in visual inspection.

		Actual condition	
		Defective product	Good product
Response	Reject	Correct Reject Hit (H)	False Alarm (FA)
	Accept	Miss (M)	Correct Accept (CA)

Each of the four decision outcomes are shown in Figure 2, where probability is displayed against the sensory excitation. This sensory excitation consists of both background noise and a defect signal. Background noise can be present within the environment, the equipment or the product. Training in visual testing may reduce the effect of the noise compared to the signal. Also reducing noise within the process reduces the False Alarm (FA) and Miss (M) rates. The 'position' of the criterion depends on the individual worker.

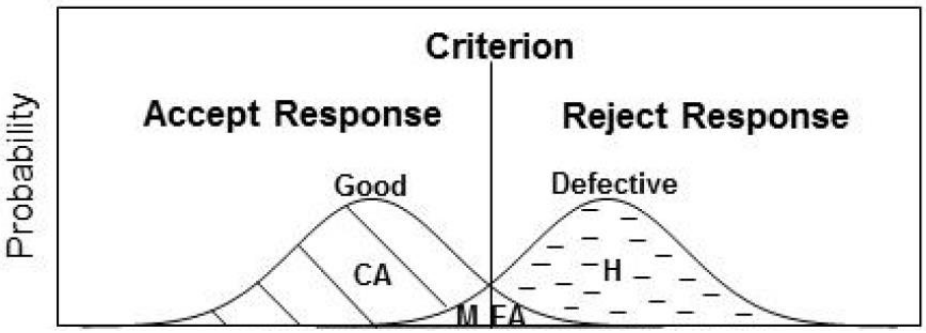


Figure 2: Continuum of sensory excitation with two possible decisions: Accept or Reject. [3]

Some workers have this criterion more biased towards accepting a higher percentage of defective items, also known as a lenient worker. In this case the criterion shifts to the right in the figure. Others might have a bias towards the other side, rejecting good items by being conservative / cautious, resulting in the criterion to shift more left in this figure. By training personnel in visual testing, one can achieve a smaller differentiation in this criterion among its employees.

3.2.5 Performance parameters

Judy E. See shows a list with parameters affecting the inspection performance as can be seen in Figure 3. Within this paper, only the ones thought to be of high importance within the arc welding process are elaborated in more detail below.

Task	Individual
• Defect Rate • Defect Type • Defect Salience • Defect Location • Complexity • Standards • Pacing • Multiple Inspections • Overlays • Automation	• Gender • Age • Visual Acuity • Intelligence • Aptitude • Personality • Time in Job • Experience • Visual Lobe • Scanning Strategy • Biases
Environmental	**Organizational**
• Lighting • Noise • Temperature • Shift Duration • Time of Day • Vigilance • Workplace Design	• Management Support • Training • Retraining • Instructions • Feedforward Information • Feedback • Incentives • Job Rotation
Social	
• Pressure • Consultation	• Isolation • Communications

Figure 3: List with parameters that might affect the performance of visual inspection. [3]

3.2.6 Defect rate

Multiple researches have been performed on the effect of the defect rate within the parts compared the detection rate of these defects. Harris has shown that as the defect rate is reduced, the inspection accuracy reduces, resulting in increased false alarms and reduced detection rate [5]. Similar other results have been obtained by other research studies.

3.2.7 Defect type

Inspection performance is degraded with increasing number of defect types, mainly because of the limitations of the human brain to remember and distinguish the different types of defects. [6]

Also, accuracy in detecting one type of defect is only slightly correlated with the accuracy in detecting another type of defect. This means an inspector might be good at detecting one type of defect, but that does not mean he is able to detect another type of defect with the same accuracy. [7]

Multiple researches show that inspectors should not be looking at more than 5 or 6 different defect types [8] [9]. Meaning that if there are substantially more defects than 5 or 6, one could divide these defect types among different inspectors.

3.2.8 Standards for comparison

Standards consist both of the definition of the defect, including its name and corresponding code and any standards that are used to define it compared to a good product. In order to reduce variability in the use of definitions or even the use of personal criteria, clear definitions are of high importance.

Usage of standards to compare the defect with reduces the need of remembering all types of defects by heart. The use of simple to understand standards is of great importance, as well as simple accessibility.

3.2.9 Lighting

Good lighting is of high importance for visual inspection. Often, light intensity levels used for visual inspection are above the 300lx to 500lx, normally present in office buildings and plants. Up to 2000lx can be used for difficult inspection work. One should also pay attention to focus, color and glare. Highly increased illumination level can result in glare, reducing the effectivity of visual inspection. This is extra important when inspecting metals. Also different defect types might need different light intensities and focus.

3.2.10 Workplace design

Workplace design can have an effect on the effectiveness of the visual inspection. One can think of difficult accessibility, glare caused by placement of lighting and other ergonomic issues. Also accessibility to standards, measuring and reporting tools is of importance.

3.2.11 Training & retraining

Training can improve both the work of novice and expert trainers. Training is especially effective if focused on someone's week areas. There are various ways of training, listed below, together with a short explanation.

- Queuing
  Present both good and defect parts in a row. Items are classified according to their status.
- Progressive / Modular approach
  Training parts of tasks progressively reduces the initial overload of information and learning objectives.
- Feedback
  Supply frequent and accurate feedback during the training.
- Active method
  Active methods, requiring response of the trainees, improves learning performance over passive observing.
- Self-paced discovery
  When trainees can pace their own learning, productivity improves. Trainees decide themselves when they are ready for the next subject.
- Error keys
  It is helpful to show some of the common errors made during visual inspection. Examples of false alarms or misses can improve awareness of the errors made during the inspection process.
- Wide variety of defects
  To allow trainees to form a complete picture of the process and the defects that can occur during this process, it can be advisable to show the complete set of defects and the reason they occur. Also information on the measures to solve the issue helps in this understanding.

3.2.12 Feedforward & Feedback

Feedback can be divided in performance and cognitive feedback. Feedback if the right acceptance / refusal policy is used is an example of the latter. An example of cognitive feedback

is feedback on the search strategy and reporting / documentation. Both are of great importance to maintain constant improvement. [3]

3.2.13 Vigilance

Vigilance, the ability to sustain focused after a long period of time in order to detect potential critical signals, is known to be affected by the length of the shift in this particular activity. Defect detection could deteriorate up to 40% within 30 minutes [10].This deterioration can be countered by having a break from visual inspection. This break can also mean performing a different task that differs from visual inspection

4 Results

4.1 Defects catalogue

Here, a summary of the defects catalogue for arc welding is described. Here, only the basics of these defects are explained without any great details. In the learning piece created for all personnel involved in the arc welding process of Gestamp, all defects are shown with photographs, a theoretical diagram and explanation, plus the causes and corresponding improvements. Also the rework actions, and the customer alternative names are explained.

Some common defects are associated with the arc welding process, resulting in a lower weld quality. Part of the training for welders consists of a catalogue with the common defects of welding. The defects are divided into two categories that compromise the strength of bonding, namely the defects that compromise the quality of the weld itself and the ones that are caused by misplacement of the weld.

4.1.1 Quality of weld

4.1.1.1 Porosity (zinc porosity)

Porosity can be caused by a lack of shield gas (caused by leakage, draught or contaminated gas) or due to surface contamination. This defect can often be seen on the exterior of the weld, as clustered tiny holes. Zinc porosity is similar, only caused by zinc gas. This latter type is only possible on zinc coated surfaces and is often not (entirely) visible because of internal pores.

4.1.1.2 Cracking (hot and cold)

With hot cracking, a crack occurs often near the center of the weld during solidification. They may or may not be visible at the surface and often require sectioning to become visible. Often occurs due to an excess gap or excess penetration.

Cold cracking can only occur in materials containing a high carbon percentage in the Heat Affected Zone (HAZ), combined with hydrogen in the weld material and high shrinkage stresses. Often not visible to the eye and can occur several hours after the weld is complete.

4.1.1.3 Misplacement of weld

Too short / too long weld. Too short will result in a lower strength of the bond. A weld that is too long can have negative effects of the parent material or can affect the fit with other parts.

4.1.1.4 Off-seam

Due to a misplacement of the weld, the weld is not on the intended location on the seam. It is often caused by a positional variation of one of the stampings in the clamping.

4.1.1.5 Undercut

Undercut welds appear as a groove in the parent material after welding. Often caused by too high travel speeds, incorrect wire angle or too high wire feed speed.

4.1.1.6 Not fused

Welds can be biased to one of the parent materials (upper or lower panel) or is not fused on both panels. Often can be associated with off-seam placement of the weld. Also a poor grounding might be a possible cause.

4.1.1.7 Burn through

A burn through, visible as holes or gaps within the weld bead, is caused by 'melting through' the parent material. It is generally a result of too much penetration caused by supplying too much heat.

4.2 Overview of current standards in Visual welding Inspection

There are various standards that can be used for testing of welds and welders. A start has been made of inventorying these standards before the project ended with a change to another assignment. The result can be found in Table 2 and the following paragraphs.

Table 2: Summary of standards used in the arc welding process.

STANDARD	NAME	SCOPE
ISO 9606-1	Qualification testing of welders – fusion welding – Part 1: Steels	Specification of the requirements for qualification testing of welders for fusion welding of steels.
ISO 17637	Non-destructive testing of welds – Visual testing of fusion-welded joints	"This International standard covers the visual testing of fusion welds in metallic materials. It may also be applied to visual testing of the joint prior to welding." BRON

4.2.1 ISO standard 9606-1

Title: Qualification testing of welders – fusion welding – Part 1: Steels

Scope:

"It provides a set of technical rules for a systematic qualification test of the welder, and enables such qualifications to be uniformly accepted independently of the type of product, location and examiner or examining body. …. It does not cover fully mechanized and automated welding processes."

Summary:

This standard covers many different types of welds and material types (pipes, plates and such). Within the arc welding process at Gestamp, not all these welds and material types are present. Qualification should only be on basis of the used weld and material types.

In this standard, a description of the to be used test samples, the to be used inspection methods of the welds and the various welds and positions is given.

Confirmation of the validity is done by the person responsible for welding activities at least every 6 months. Revalidation of welder qualification shall be done either by retesting the welder every 3 years or by testing two welds made in the last 6 months by radiographic/ultrasonic/destructive testing every 2 years.

A qualification test certificate is described in the standard and a recommended format is shown in annex A of the standard. If any other test certificate is used, it shall at least contain the information shown in this annex.

Annex B of this standard outlines the job knowledge that a welder should have in order to ensure that procedures are followed and common practices are complied with.

4.2.2 ISO standard 17637

Title: Non-destructive testing of welds – Visual testing of fusion-welded joints

Scope:

"This International standard covers the visual testing of fusion welds in metallic materials. It may also be applied to visual testing of the joint prior to welding."

Summary:

For the test conditions, one shall have a minimum illuminance of 350lx, whereas 500lx is recommended. The extent of visual testing should be determined by e.g. a product standard. One should recognize visible imperfections and shall report any imperfection so that remedial action can be taken. Standard is brief and general in most topics. Annexes of this standard show visual testing equipment.

5 Conclusion & Discussion

As this part of the internship is abruptly ended by the change to a different location and project, no conclusions can be drawn on the work done so far. Most of the work was reading current material of the project and getting to know Gestamp.

A conclusion however can be drawn on personal basis, as part of the change was the result of me not able to adapt to the working culture. I can say that I have learned a lot on this level. A more elaborate explanation can be found in Appendix A: Change of Assignment.

On the next pages of this report Part 2 of the internship can be found.

Part 2 – Gestamp Technology Institute

6 Introduction

This part of the report is the result of a new assignment performed within the same company, Gestamp, but on a different location with a different mentor. As stated before, the reason behind the change can be found in Appendix A: Change of Assignment.

Before the problem description, the reader needs some information about the Gestamp Technology Institute (GTI). GTI started in September 2015 as a training center for employees and new hires of Gestamp, as part of the Gestamp Global Learning program. It is located in the Automotive Intelligence Center (AIC) in Boroa, close to Bilbao, Spain. GTI focuses on the 'learning by doing' method with many different learning paths. Both a workshop plus quality laboratory for practical training and several classrooms for theoretical training are present.

More information can be found on their website: http://gti.gestamp.com.

6.1 My position

The supporting staff of GTI currently consists of 5 employees. The functions are basically as follows: responsible for IT, responsible for Administration, 2 employees responsible for the workshop and one manager.

I was located in the workshop office and mentored by the main responsible of the workshop. As the team is small, side tasks are performed by every member of the team, including me. Side tasks include preparing classrooms for new programs, writing monthly management reports, handing clothing and lockers to students and various other tasks.

7 Problem definition

As GTI and with that the productive classroom are only one year old, all machines and the tools are new. As everything is placed recently, there are not set standards for tool acquisition, tool storage, incoming goods, storage of goods and related subjects.

This means that in the current situation, there is no information available about the inventory, making reordering before items or tools are out of stock difficult. Also, students and teachers spend large amounts of time searching for tools. The storage location of incoming goods has no order, every item is placed randomly, making it difficult to see if goods have arrived or not. In short, no standard way of working is yet established within GTI.

Lean is of great importance in the automotive industry and is used extensively in all the production locations of Gestamp throughout the world. As GTI is a training location that serves the purpose of simulating the working environment in the production locations of Gestamp, GTI wants to start implementing the lean principles.

7.1 Objective

Investigate the possibilities for implementing and implement the lean methodology and corresponding tools in GTI with a focus on the productive classroom.

7.2 Scope

For this project the scope is limited to the productive classroom, the storage location and the laboratory. The traditional classrooms and the office are not considered in this project.

7.3 Approach

First of all, the current situation is described in the problem analysis. After that, the implementation of lean is described. The start is made with implementing a single tool of lean, 5S, one of the basis of lean. The focus here lies on a specific part of the productive classroom, the workbenches. To support this implementation, an inventory database is constructed and employees are educated in lean thinking.

The report is finished with conclusions and a discussion combined with suggestions for further research, as suggestions for further research are keen in the continuous improvement thinking.

A part of the complete planning for the project of Part 2 is given in Appendix B: Planning of Part 2. A diary is used to write about the daily tasks that have been performed. This can be found in Appendix E: Report of tasks.

8 Problem analysis

Gestamp Technology Institute is situated within the Automotive Intelligence Center in Boroa, where 22 different firms in the automotive sector are located. “The AIC-Automotive Intelligence Center is a unique value-generation center for the automotive sector based on a concept of open innovation in which companies improve their competitiveness through cooperation. Using a market-oriented approach, AIC integrates knowledge, technology and industrial development under one umbrella.” [11]

8.1 Layout of GTI

GTI shares a building with Megatech, a producer of plastic car components (mostly dashboard components). There are common areas like a dining area and a kitchen, shared among the employees of Gestamp and Megatech. The areas of GTI itself are spread over two floors as described below.

The ground floor, as shown in Figure 4 has the following areas:

- Practical classroom, also referred to as workshop
- Quality laboratory
- Workshop office
- Changing rooms
- Two storage areas of 155 m2 and 280 m2 each that can be occupied by more technologies in future. Currently one is used as a provisional classroom and the other for storage of inventory.

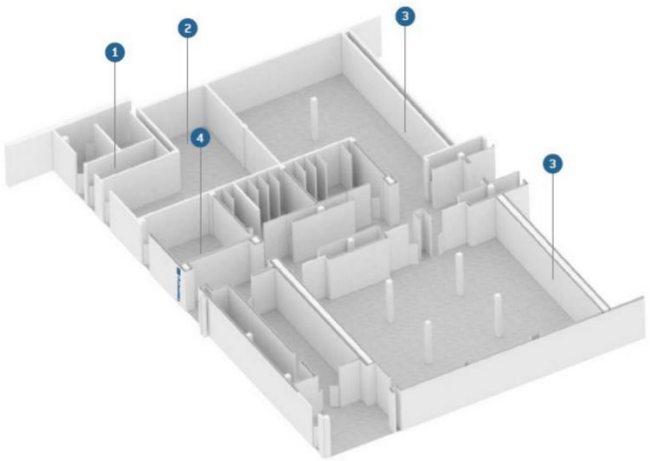


Figure 4: The ground floor. 1: Meter room, 2: Quality laboratory, 3: Storage areas, 4: Workshop office. [12]

The upper floor, as shown in Figure 5 has the following areas:

- 6 Classrooms for theoretical training
- Offices for staff

Figure 5: The first floor. 1: Classrooms, 2: Administration area, 3: Meeting room, 4: Teachers room, 5: Restrooms. [12]

The workshop consists of one single hall containing machines and workbenches, separated in different areas with lining on the floor, corresponding to the standards used in the Gestamp manufacturing plants. Two EOT cranes with a 15 t lifting capacity mounted close to the sealing allow easy material handling. A rough layout of the workshop is shown in Figure 6.

In the workshop, the following items are present:

- A 600kN press, used for hot and cold stamping, combined with 2 robots for loading and unloading and a furnace to heat the metal parts before forming.
- Large 5 axis CNC machining center
- Grinding machine
- Smaller 5 axis CNC machining center
- Standing drill
- Lathe
- Mill
- 18 Workbenches for manual work

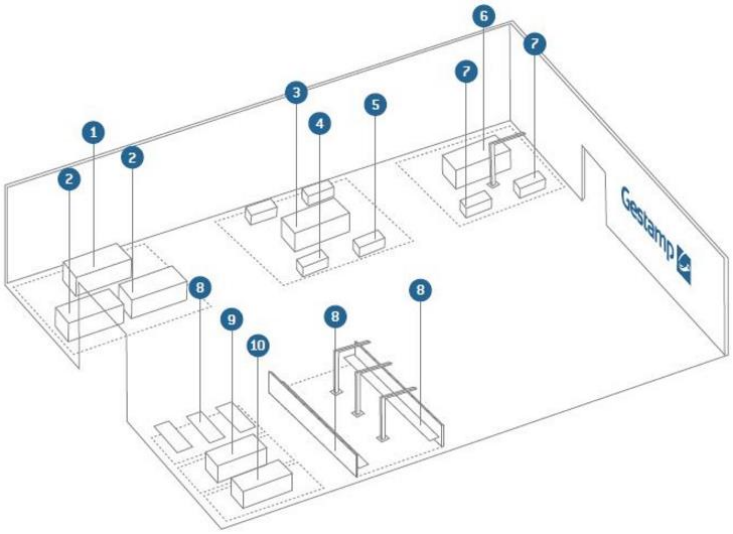


Figure 6: Layout of the workshop. The door on the right shows the entry to the laboratory. The workshop office is located on the right of this door. 1: Press, 2: Robots. 3: CNC machining center, 4: Lathe, 5: Grinder, 6: Drill 7: Mill, 8: workbenches, 10: Big CNC machining center. [12]

8.2 Tool cabinets

Each machine has a free standing cabinet containing the tools used for that machine. Some tools of machines are combined in one cabinet in order to save space, as some machines do not require many specific tools or parts. Within these cabinets, tools are placed without order, of which Figure 7 is an example. Some parts are still in their containers or boxes, some are without packaging.

For both the students and the teachers, it is difficult to find specific tools, as some tools do not have part numbers or references on them and no standard location is indicated. Also tools can be used at other locations than the intended use, after which they are not always returned to their correct cabinet.

Figure 7: Tool placement in the cabinet belonging to a 5-axis CNC mill.

8.2.1 Workbench area

This area serves the purpose of teaching students how to do manual work. There are currently 18 workbenches with each 7 drawers and a small cabinet. Also, each workbench has a pegboard above the wooden worktop and a bench vice mounted on this worktop.

In these workbenches, there are several tools present in the different drawers. There are no dividers or indicators where these tools are located. Also personal items like clothing, personal documents (paper), bottles of water and personal protective equipment are present in the workbenches. There is no order in the drawers and items are not marked. If drawers are opened or closed, tools move around freely in the drawers.

When students are working at the workbenches, tools are sometimes returned to different drawers or even workbenches than the tools are taken from. This means students and teachers are constantly looking for missing tools.

Besides the 18 workbenches, there are 3 cabinets, one for the storage of miscellaneous tools, one for the storage of cleaning equipment and one that contains consumables like oil, grease and sanding paper. Here, a start is made with an inventory and numbering the items. As this system is not sustained, items are not returned to the correct location.

8.3 Storage area

The storage area is used to store items like sheet metal and metal used to produce dies, tools that are not directly required in the workshop, consumables like oil and grease and cleaning equipment. There is no standardized way of locating where to place the items and there is no knowledge about what exactly is present in the storage area. As there are too few lockers for all students and teachers, some clothing can be present as well.

A photograph of a part of this storage location is shown in Figure 8.

Figure 8: Photograph of the storage area of GTI (21-11-2016).

8.4 Ordering items

To determine the handling of orders, the current situation and flow of information is determined. The information flow for ordering goes as follows:

1. Teacher contacts the workshop responsible in the workshop office for items that require ordering.
2. Workshop responsible puts together an order and sends it to the responsible of administration.
3. Administrator checks order and places order at supplier.
4. Supplier sends quotation to Administrator.
5. Administrator sends acceptance to the supplier.
6. Supplier ships order (possibly in multiple shipments) to GTI, where a teacher, one of the supporting staff in the workshop or a student accepts the order. Items come together with a list of ordered items, but without price.
7. Items are placed in the correct location by one of the previous mentioned persons.
8. Supplier sends invoice (can take up to 4 weeks) to Administrator.

The current method has some inconsistencies that impede sustaining a database and a correct level of inventory. First of all, teachers often tell the workshop office about items that require ordering if the items are completely depleted. When delivery times are taken into account, there is a certain period without stock. This is combined with the fact that it is difficult to check if the items are definitely required or placed in a different location.

When the items arrive at GTI, teachers, students or supporting staff accept the order and place the items in the correct location. This makes tracking orders and confirming the arrival of goods difficult, as the arrival is often not communicated. The locating of the arrived items is then also difficult to track.

9 Method - Implementation of lean

As stated before, Gestamp wants to introduce the lean method within GTI. It is assumed that the reader has (basic) knowledge about the lean methodology and its corresponding tools.

The problem analysis revealed various inefficiencies within GTI. In the lean methodology, these are referred to as wastes. Before selecting appropriate tools to eliminate the wastes, the wastes are identified.

After that, but before implementing tools of the lean methodology, there needs to be a stable basis, as can be seen in Figure 12. This means knowledge about the available inventory and a standard way of ordering items is required. For this reason, the choice is made during this internship to construct a database for all the tools, equipment and consumables in GTI.

As knowledge of the current inventory with the aid of the constructed database results in a stable basis, the choice is made to start the implementation of 5S in the workbenches area. This area is used as a trial before implementing 5S in the rest of GTI.

In order for lean to be an effective methodology for improving working efficiency, quality, safety and so forth, cooperation of all employees is a must. This means that all employees and the students need knowledge about the working principles of lean. The decision is made to create a presentation with a small game to introduce lean to the students, supporting staff and teachers.

9.1 Identifying wastes

In lean there is often referred to the 7 or 8 Wastes, also known as Mudas (Japanese). The most important part in reducing wastes is identifying the wastes. In this case, 8 wastes are analyzed. An easy way to remember the 8 wastes is that the first letters spell TIM WOODS. In the problem analysis, some wastes became apparent, which will be analyzed and categorized further in

Table 3: Summary of the most important wastes that can be found in GTI.

TYPE OF WASTE	**EXAMPLES IN GTI**
Transport	People: students are constantly moving around in the workshop looking for tools. Teachers are coming in the workshop office, asking for tools on a daily basis. Information: Information on orders, on required items, invoices etc. gets lost in some cases. In other cases, nobody knows the current status or tasks are not delegated.
Inventory	Storage of parts in the inventory. Not all of the inventory is known. Also some parts that are ordered wrongly are stored without knowledge about future use.
Motion	When looking for tools in workbenches, students open each drawer of the workbench until the tool is found. The tools are not fixed in the drawer, what means that after opening or closing, the tools are in the back of the drawer. This both results in unnecessary motion in the form of reaching.
Waiting	As there is no inventory, no items are ordered to the correct stock levels. Often items are depleted before they are reordered, meaning students or teachers have to wait for their items or tools.
Over production	Not applicable.
Over processing	Not applicable.

Defects	Defect tools or equipment is not reported in some cases, but tools are used from other workbenches instead. Defects can also occur due to inadequate storage.
SKILLS	As students are looking for tools, consumables or losing time in any other manner, their full learning potential is disturbed.

9.2 Inventory database

A database for the different tools is required for various reasons. Before giving every item a location (step 2/5 of 5S), one has to know what items are available and what items to order before the 'stable basis' is complete. This will also reduce wastes like transport, inventory etc.

As we found out during the internship, performing further steps of the 5S methodology are difficult or even impossible if there is no knowledge about the inventory and the orders. Constructing the database and gathering data was a major part of the internship at GTI.

The first steps of the establishment of the inventory database are determining the requirements and selecting the software / hardware.

The minimal requirements for the functions were determined by consulting the supporting staff in GTI and the teachers. The following list is a summary of the functions:

1. Inventory
    a. Add item
    b. Remove Item
    c. Edit Item
    d. View item details
        i. Item details combined with a photo of the item
        ii. Supplier information (price, arrival date, reference code)
        iii. Location of item
    e. View complete inventory
        i. Filter on location
2. Orders
    a. Add orders
    b. View orders
    c. View list of ordered but not yet arrived goods
    d. Check items that arrive easily
3. View amortization
    a. Per time period
    b. Per location
4. Print checklists or audits for 5s
    a. Per workbench
    b. Per cabinet
    c. Per work area

The database should contain a graphical user interface (GUI) that allows usage by employees unfamiliar with database software.

The choice of using software for this database instead of a paper version was made quickly because of the vast amount of functions and information. After consulting different options, the

choice was made to use Microsoft Office Access. This is because the software is already available on the current systems, is consistent with the requirements and both I and the other Gestamp employees have basic knowledge about using this software.

9.2.1 Order handling

The method of ordering should be consistent and data should enter and leave the database system at a specified and set moments. As mentioned in the problem analysis, this is currently not the case. The following standard for ordering is therefore proposed and will be used as a basis for structuring the database:

1. In the workshop, checklists are used to determine what is missing / what is depleted and are given to the workshop office (every time interval, later to be determined).
2. In the workshop office, an order is made and send to the administrator. This order is also entered in the database (or made with the aid of the database).
3. The administrator sends the order after checking and approval to the supplier.
4. Supplier sends a quotation to the administrator.
5. Administrator sends approval to the supplier.
6. Supplier ships items to GTI, where the workshop office receives the shipment.
7. At the workshop office, items are checked, entered into the database and released to the workshop.
8. Supplier sends invoice to the administrator (can take up to 4 weeks after shipment of the items).
9. Administrator sends the invoice to the workshop office.
10. Workshop office enters price information in the database.

A visual representation of the proposed ordering standard can be seen in Figure 9.

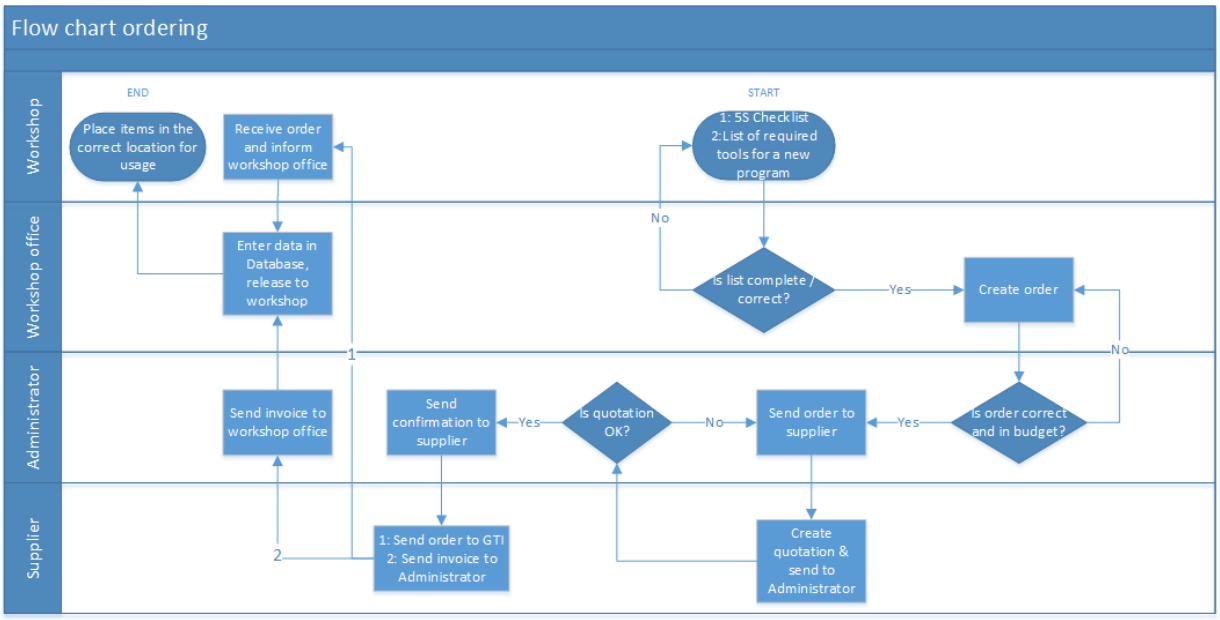


Figure 9: Suggested flow diagram of the process of ordering for the productive classrooms within GTI. On the left, the different departments / locations are shown.

The following steps are; deciding the table structure and fields, determining relationships between tables, building and implementing the database and filling the database with information.

9.2.2 Table structure

The information is split up in different tables to reduce redundancy and create a better overview in the database. Basically, the database consists of a table with items that contains field with relations to other tables with information about their corresponding location, order and specifications (details).

The following tables are present in the database:

1. ItemList
   This list contains separate entries for each item present in the workshop. Each record is linked to a location, order, and item details.
2. ItemSpecifications
   This table contains columns with detailed information about each item. Each entry holds information about the producer, specified name, attachment in the form of a picture.
3. LocationTable
   This table contains information about each location. Locations are workbenches, storage locations and tool lockers. This table contains detailed information about the locations, combined with a photo for easy recognition.
4. OrderList
   After making an order, this order is added to the database, combined with details as the arrival date, comments and attachments in the form of scanned invoices or orders. The table is linked with the table that contains information about suppliers.
5. SupplierTable
   This table contains information about suppliers in the form of contact information, a logo and comments.

The tables need underlying relationships to reduce redundancy of information. The 'main' table, ItemList, has relationships with 3 tables: Itemspecifications, Locationtable and Orderlist. The latter has a relationship with the SupplierTable that contains contact information about suppliers. The complete structure can be seen in Figure 10.

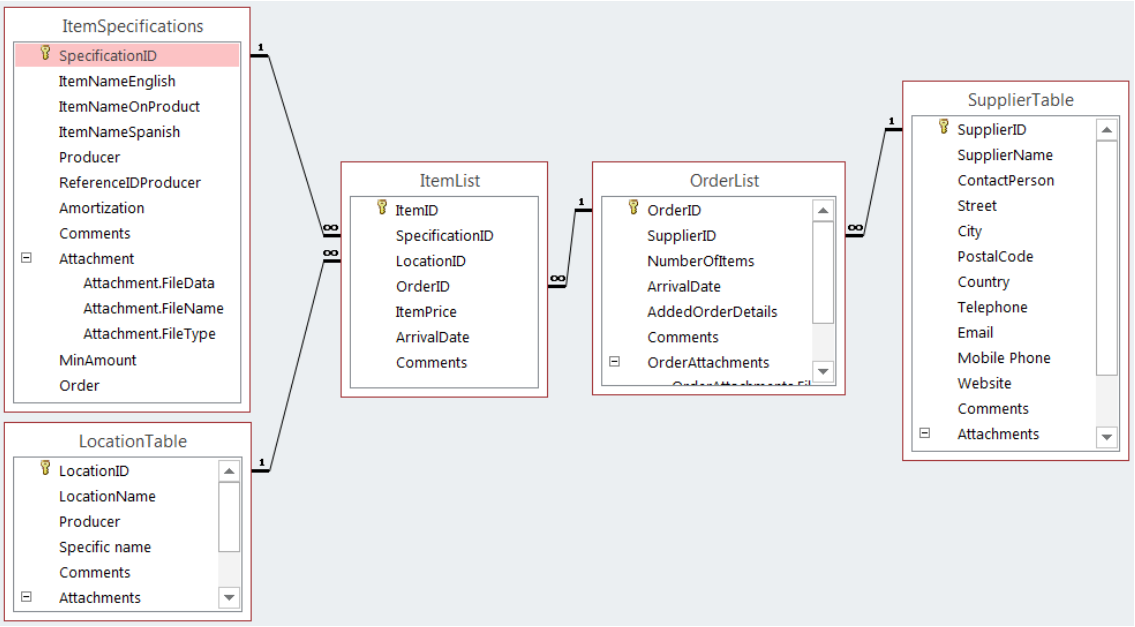


Figure 10: Relationships between the 5 tables in the inventory database.

9.2.3 Graphical User Interface

In the graphical user interface, two sub-forms are used to present 1: orders that require attention and 2: Items that require ordering. The buttons and functions are divided into two categories, Database and Reports.

The Database category holds buttons that are used to alter information in the database, whereas Reports only show 'filtered' data for information purposes or usage outside of the database.

The orders requiring attention are orders that are not completed, in other words, information is missing. This might be information about the prices of the items (as the invoice can be up to 4 weeks later than the arrival of the items) or an order that is not yet (completely) received.

For each item, a required minimum is entered at the Item Details. If the current quantity is lower than the required minimum, the item is shown in the 'Items Requiring Order' sub-form.

A screenshot of the navigation form can be seen in Figure 11.

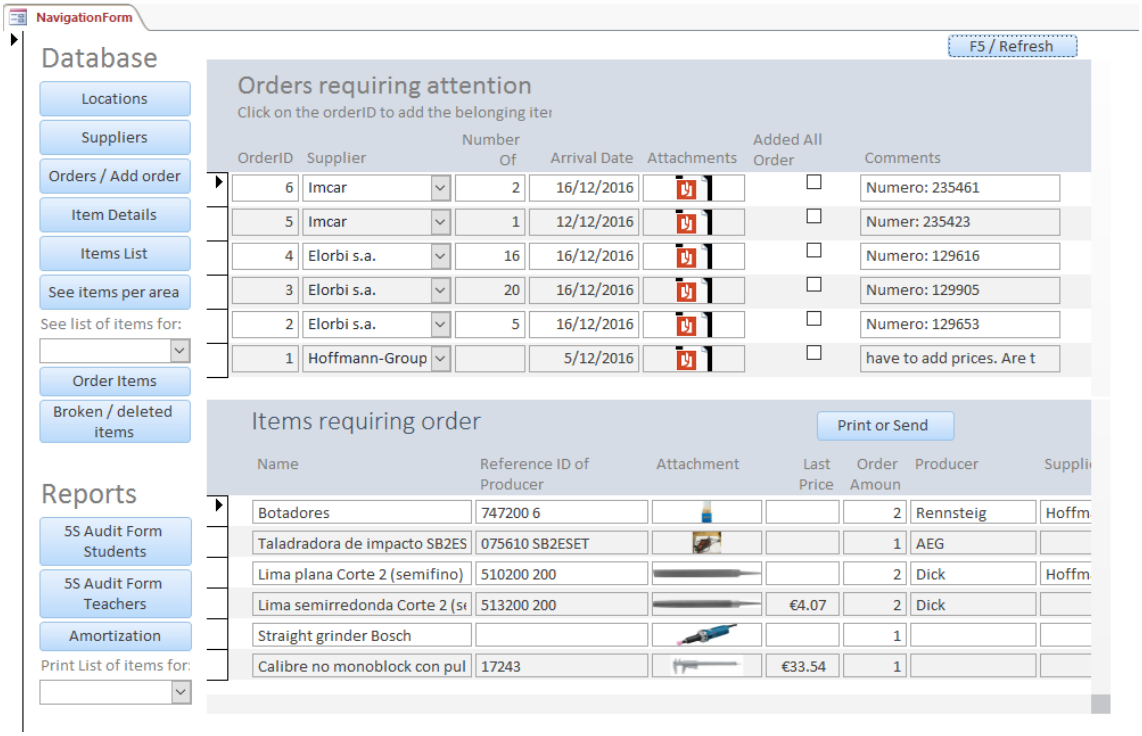
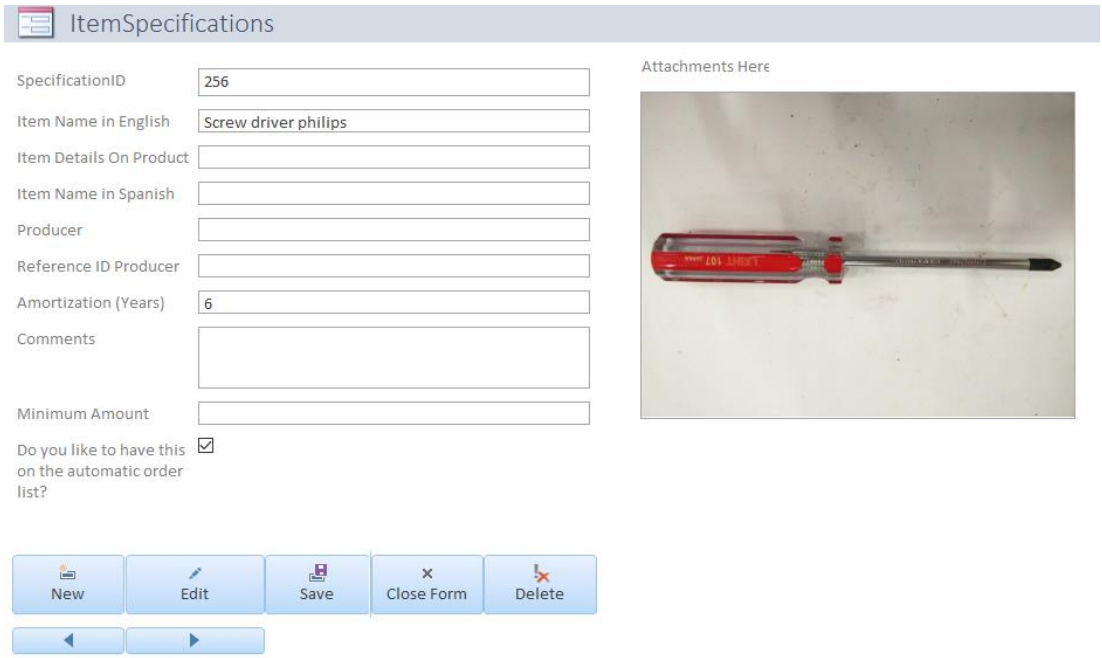


Figure 11: Screenshot of the navigation form. This GUI shows buttons and two subforms that require attention.

Each function of the database has a corresponding form that allows the user to edit information easily. A screenshot of the Item Details form can be seen in figure…. Here, buttons are placed at the bottom for easy navigation. If a form is closed, the user is automatically sent back to the navigation form.



9.2.3.1 Database interaction

The buttons under the heading Database allow the user to interact with the database and alter information stored in the database. A short description of each function is given.

NAME	FUNCTION
Locations	Here, physical locations of items can be edited, added or deleted. Examples are cabinets at specific machines or separate workbenches.
Suppliers	Here (contact information of) suppliers can be edited, added or deleted.
Orders / add order	Here orders can be added or deleted. After adding an order, you can click on the order to add details (a new form opens). Details are the items corresponding to the order, comments or attachments like invoices.
Item details	Items can be added or deleted, or item details can be added. Things like name, producer, reference ID and attachments.
Items list	Here, all items are grouped on SpecificationID and shown with their corresponding quantity, photo, last ordering price and last ordering date. A click on a single item shows all locations of the corresponding items.
See items per area	Here, an area can be selected to filter the list of items. Only the items at e.g. Workbench1 can be shown.
See list of items for: 'dropdown'	Same function as See items per Area, only requiring less button clicks, as a dropdown list can be used to select a certain location
Order items	The form that opens when clicking on this button shows a list of items that have to be ordered together with the required number. The button 'Print or Send' in this form
Broken / deleted items	If an item is deleted or broken, it shows up in this list. This list is required for two reasons. First of all, one can see the history of certain items and how often they are deleted. It is also used in the calculation of the amortization, as items that are broken or depleted might still count towards the amortization.

9.2.3.2 Reports

Report display information from the database without allowing you to edit the information. This is used to print checklists for 5S and to print a list that shows the amortization of all items.

NAME	FUNCTION
5S Audit form students	This form is used by students that work at one of the 18 workbenches. The form contains a checklist on the front with questions for each step of the 5S methodology. On the back, a list of all items present at that specific workbench (taken from the ItemsList) is printed, allowing students to specify the missing items, if any.
5S Audit form teachers	This form is set-up in such a way that it makes the teachers check if the checklists of the students are filled in correctly. On the back, a list is given that allows the teachers to specify which items have to be ordered. This checklist is then given to the workshop responsible in the workshop office.
Amortization	Here, a total for the amortization (after entering start and end date) is given. After that, the amortization is specified with a list of all items that contribute to the amortization.
Print list of items for: 'dropdown'	Here, a list can be printed for a specific location, allowing supporting staff or teachers to perform checks on the current inventory.

9.2.4 Manual

A manual is written to support the users of the database. The manual (21 pages) shows all possible forms and reports with the aid of screenshots. All actions that can be performed are explained in detail. This manual is not added as an appendix because of the vast amount of information.

9.2.5 5S Audit forms

Two audit forms are present in the database. One will be used by the students working at the workbenches, while the other one is used by the teachers to perform checks on the inventory and the checklists of the students. More information can be found at 9.4.1.5.

9.2.6 Content

At the moment of writing, there are 1148 records in ItemList, this means items with a location, details (including photograph), supplier and purchase date. Entering and gathering this vast amount of data was a big challenge during this internship.

Not for all items the purchase date and price is known. A start was made to enter all this information in the system, but not all data was provided before the finish of the internship. This is yet to be finished.

9.3 The 5S methodology - Theory

5S is a methodology originated in Japan. All steps in the Japanese language (after translation to the Latin letter system) start with an S, hence the name. Some suggest adding an extra S for safety, resulting in 6S. 5S is a methodology with five steps and serves the purpose of improving the efficiency of the workplace. This method is often said to be the basis of lean, before continuing with more advanced tools. Without a good standard or basis, one cannot implement any other improvement tool, as improvement is impossible to compare to a standard. In Figure 12, one can see that 5S is the basis of the 'house of lean.

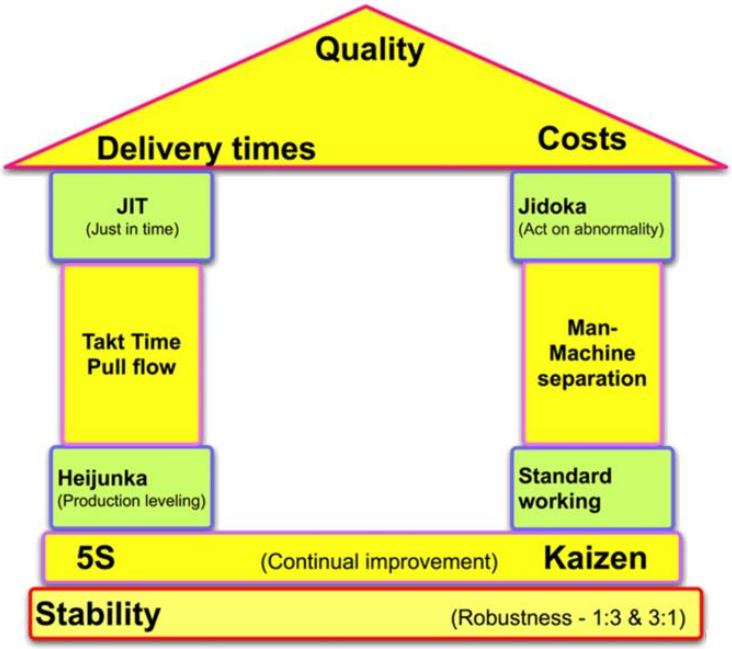


Figure 12: House of lean, a graphical representation of the lean methodology with corresponding tools. [13]

Below, the each step of 5S is explained in short.

1. **Sort** (from the Japanese *Seiri*)
   In this step, a division is made between useful items and unnecessary items in the workshop. Often Red-tags are used on items which are supposed to be unnecessary. Unnecessary items can be disposed by scrapping, selling or storing in the storage area.
2. **Set in Order** (from the Japanese *Seiton*)
   In this step, the goal is to place all the items in logical locations, where anyone can find them instantly and can return the item to the same place with ease. A place for everything, and everything in its place.
3. **Shine** (From the Japanese *Seiso*)
   Deviations from the 'standard situation' are clearly visible when everything is clean. This means that all machines, areas and storage locations have to be cleaned.
4. **Standardize** (From the Japanese *Seiketsu*)
   This step is to create standards in the workplace with the ultimate goal of making the best way the easiest way.
5. **Sustain** (From the Japanese *Shitsuke*)
   Once the standards are set, everyone has to follow these standards. Suggestions / actions must be constantly undertaken to keep improving the 5S standards.

6. **Safety**
   Often, an orderly and clean workplace means a safer workplace. No items in walking paths or slippery oil on the work floor makes the workshop a safer place. One must pay attention that 5S standards and improvements may not compromise the safety in any way.

This tool is used as a guideline to improve the workflow, productivity and safety in the workshop. Each step is elaborated in greater detail further in this report.

9.4 The 5S methodology – Implementation

The implementation is split up in different locations for the easy of understanding. First, the area with workbenches is covered, followed by the cabinets at different machines and the storage area.

9.4.1 Workbenches area

In GTI, 18 workbenches are present, used to teach the students to work with hand tools. These workbenches each have 7 drawers and a small cabinet. Also, each workbench has a pegboard above the wooden worktop and a bench vice mounted on this worktop. It has two power sockets and connections for compressed air. Each workbench can be locked with a separate set of keys.

As stated before, there are currently tools in the workbenches, but not all workbenches have the same tools and sometimes students at other workbenches borrow tools from different workbenches. Also, the amount of tools per workbench is very little, meaning only the upper two and the lowest drawer are used.

In dialogue with the teachers, the conclusion was drawn on how to create a more consistent way of working and implementing 5S in the workbenches. First of all, groups of four students are formed. The groups work on two workbenches. As there are not many tools present, one workbench will be empty and locked, and the other workbench will contain all the tools.

9.4.1.1 Sort (Seiri)

Every odd numbered workbench contains tools, every even numbered workbench is completely empty. The sort step for the even numbered workbenches is simple, removing all the tools, documents and personal protective equipment. After this is finished, the workbench's drawers and cabinet is closed.

For the odd numbered items, the teachers proposed a list of required tools per group. All the tools that were not on the list were removed from the workbenches. Also all personal protective equipment and documentation is removed from the workbenches.

9.4.1.2 Set in order (Seiton)

Items are categorized in roughly 4 different categories, which are located in a separate drawer. In the table below, a summary of the drawers is given. This makes finding items easier and the drawers more structured.

CATEGORY	EXAMPLE OF TOOLS
Drawer 1: Measurement equipment	Ruler, gauges, bevel square, dividers
Drawer 2: Hand tools	Hammers, files, allen keys
Drawer 3: Cleaning equipment	Brush, compressed air hose and pistol
Drawer 4: Electrical tools	Angle grinder, straight grinder, working light

All items are placed in the drawers according to their category and marker with a number that corresponds to the workbench number.

9.4.1.3 Shine (Seiso)

As the workbenches are cleaned every now and then by the cleaning staff and most tools are new / relatively new, cleaning in this stage is not necessary. Each workbench is perfectly clean. At the first step (sort), all waste that was present in the workbenches is thrown away.

9.4.1.4 Standardize (Seiketsu)

In this step, the tools are organized in a standardized way. As no separators are present in the drawers, the tools move around freely. There are several options to create a standardized method. First, making encirclements with a permanent maker around every tool is tried. This did not solve the problem of freely moving items, making it necessary to re-organize the tools every time you open and close the drawer. Although this is inefficient, it already makes it easier to see if a tool is missing after placing the tools in their correct location.

In one workbench, a trail is set up with the use of foam where shapes of tools are cut out. This allows the students to see in a single glance if tools are missing due to empty spots in the foam. In the future, all workbenches should have drawers completely filled with two-tone foam that makes missing tools even more visible. This is not yet implemented due to a lack of time during the internship.

On the face of the drawers, a small strip with the names and photographs of all items is placed to increase the ease of finding tools without opening drawers.

Figure 13 and Figure 14 show a comparison between the situation before (left) and after (right) the standardize step.

Figure 13: Photograph of Drawer 1: Measurement tools before making a standard layout

Figure 14: Photograph of Drawer 2: Hand tools after making a standard layout with foam.

9.4.1.5 Sustain

There are 18 workbenches present in GTI. The choice is made to make groups of 4 students, working at two workbenches. One of the workbenches contains all tools required for the group in the drawers below the workbench. The other workbench that belongs to the group is empty and locked.

To prevent tools from disappearing, the choice has been made to perform checks with the aid of an audit form. Every two weeks (or another preferred time interval), another member of the group is made responsible for workbench with corresponding tools and filling in the audit forms. This way, we would like to increase the sense of responsibility for a personal workstation, a principle also used in the manufacturing plants of Gestamp.

The Audit forms have to be checked to increase effectiveness. This check is performed by the teachers. The time interval of these checks is yet to be determined, this could be daily or weekly. Both audit forms are added in APPENDIX D: 5S Audit Forms.

Part of sustaining the inventory of the workbenches and other locations is the use of an inventory database. This can be found in paragraph 9.2.

9.4.2 Cabinets

9.4.2.1 Sort (Seiri)

In this step, all unnecessary items are to be eliminated. This step is fairly easy in this particular case, because all machines and tools are new and specifically bought for the current training programs. This means almost no unnecessary tools are present in the cabinets.

However, as all tools are new, most of them are still in their original packaging or the original packaging is still present. This makes the storage overfull and unorganized. During this step, the first thing that is performed is removing all the unnecessary packaging, plastics and paperwork.

Common in this step is to make use of so called 'red tags', which are attached to items that are unneeded or not belonging in this particular area. As there are not such items in this particular case, this step is omitted.

9.4.2.2 Set in order (Seiton)

To set items in order, every item should have a place. Before allocating a particular space to an item, it is needed to have an inventory of all the parts present at the workbenches. During this step, it is not only important to make an inventory of the current items, but as GTI is starting up, one should also take into mind the new tools that will be ordered and added to the current ones. As there was no stable situation during the internship, plus the fact that the time frame for implementing lean here was too small, no further progress has been made here.

9.5 Storage area

During the internship, no progress has been made in the storage area. The only thing that has changed is a row of new lockers that ensures no clothing will be left in the rest of the storage area. In the suggestions for further research, remarks are given about implementing 5S in the storage area.

9.6 Employee training

Awareness and knowledge about lean is the key factor of succeeding in creating a more lean work environment. It is often said that lean can only work if it is a combined effort of every employee. In this case, employees within GTI are categorized in 3 groups. First of all, the supporting staff of GTI of which I was part, second are the teachers and the final and largest group are the students. All three groups need to have an understanding of the lean principles.

For this reason, the decision is made to create a presentation that could be used for all three groups to explain the origin and the basic principles of lean thinking and working. The staff and teachers will be present at the same presentation. The teachers require some practical training afterwards in working with 5S checklists.

9.6.1 Student training

In order to train the students in basic knowledge about lean and 5s, the decision is made to make a presentation that will be given on the first day of their program. The presentation starts with an introduction about lean, the 7 or 8 wastes and the origin of lean, after which the House of Lean together with 5S is introduced. Also the importance of lean in the (automotive) production industry is explained. Each step of 5S is elaborated in the context of GTI with examples that can be seen daily. The steps are explained during a small game with numbers or letters as an easy example. The presentation is made in English (as I don't speak Spanish) and will be given to all the new hire programs (currently 4). Here two of the programs have international students, where the presentation has to be in English. For the non-international programs, the presentation is done in cooperation with a student that speaks both English and Spanish. This has the advantage of training one or more students with more expertise on the field of lean and 5s that can serve as an information source for the other students.

To sustain this training, Jaime de la Maza, Industrial L&D Engineer and responsible for Maintenance & H&S in GTI, will perform this lean and 5S training in combination with the Health and safety training at the beginning of each program.

9.6.2 Employee training / Training of teachers

Both employees and teachers will have to be present at the presentation and game used to teach the students. This is not only for themselves to gain insight in the lean principles, but also to answer questions that arise from students.

The teachers require extra training in working with the checklists that are used for the 5S method. This training is not yet designed or given, but should contain elements like goal of 5s, goal of the checklists and how to fill in those checklists.

10 Conclusion

A good start has been made with the implementation of lean and its corresponding tools. The results have a positive influence on the wastes identified in chapter 9.1. The implementation is focused in three fields.

A database has been made to establish a stable basis, on which 5S builds. This database contains a large percentage of the items present at GTI, but in order to function to its full potential, all items in all locations should be added to the database, with full information like prices and purchase dates. Advantages of this implemented database are traceability of tools, control over inventory levels and the ease of printing audit forms. The database reduces wastes like the transport of information, waiting and unused skills.

5S is implemented in the workbench area as a trial. This trial will show if further implementation of this method is favorable. It has the advantage that the students will learn the lean principles on first hand. It is also an improvement on the ease of working. This implementation of 5S will reduce motion, defects and waiting, as all tools will be checked and feedback is given to the database with the aid of audit forms.

Both students and some teachers received a training on lean and 5S. This has been an introductory training to introduce the students with the principles of lean. The presentation is accepted with great interest from both parties.

As the main principle of lean is continuous improvement, implementation of methods or improvement of currently employed methods is never finished. Suggestions for this further improvement are given in the next chapter.

11 Discussion and Suggestions for further research

A start has been made by introducing parts of lean in GTI. Continuous improvement is the most important ideology within lean. Here, some suggestions are given for improvements on the work I did, but also on other parts that are not covered in this report.

Implementing lean in a productive classroom instead of where it is more known to be used, the production plant, has been a challenge. When people hear about lean, the first things that pop up in their minds are things like takt-times, six sigma and theory of constraints. In the case of a productive classroom, there is no production. Efficiency improvement should be thought of differently and should be searched for in other methodologies. As GTI only exists relatively short, the 'stable basis' required for implementing more difficult methods was not present, which posed the other challenge for implementing different methods of lean. This resulted in the choice of the creation of a database and implementing lean as a trial at the workbenches.

At the end of this project, the question arose why there has not been a trip to a real manufacturing plant to identify the implementation of lean, 5S and inventory management. This would have had three advantages, as I would have gained a bigger understanding of lean and 5S and the implementation, the implementation would be sped up and the implemented method would look more like the standards within GTI.

Database

Currently, not all items are recorded in the database. In order to use the database to its full extend, all items should be recorded, including prices and purchase dates. During the internship, all suppliers are asked the complete history of purchases, but some suppliers did not respond to this request.

The database could be elaborated for usage in other parts of GTI, e.g. the laboratory, the other classrooms (furniture and such), licenses and laptops. Also the stock of clothing and shoes that are given to the students could be added to the database.

11.1 Workbench area

The pegboards on top of the worktops could be used for quick access to tools, but as there are no enclosures that can be locked, tools are not secured and could be used by other students or other teachers. The usage of this pegboard could be put to a test to see if the assumption of lost tools is indeed correct.

In the workbench area, a small piece of (packaging) foam was used to create an example in one of the workbenches. I would suggest using two-tone foam. One option is to order this already cut from the supplier of the tools, or to order clean sheets of foam to cut yourself. One option might be to give this task to the students that work with the workbenches.

An example of this two-tone foam that can be ordered at the tool supplier and customized in an online editor is shown in Figure 15.

Figure 15: Tool foam that can be used in the drawers of the workbenches. [14]

11.2 Machine cabinets

Unfortunately, no time was present during this internship to fully implement 5s in the cabinets that belong to machines. As there is almost no structure in locating and returning tools, implementing 5S would be a good way. During the internship, a start has been made as most unnecessary items are removed, together with adding almost all items in the database.

A good idea is thinking about creating different categories for tools and making separate shelfs inside each cabinets that correspond to a single category.

11.3 Storage area

As there is no structure in locating and using items, 5S could be used here as a start. Especially the first step with the red-tag method would make a big improvement. Adding all items that will be left after this first step in the database would be a good addition.

11.4 Training of personnel

Personnel has received a presentation introducing lean and the 5s method. In my opinion, personnel could receive more elaborate training on this subject.

There currently no standard method for ordering tools for new programs. Teachers should be told to hand over a list of required tools, at least two weeks before the start of a new program. This makes the process of ordering tools for a new program easier and the tools can be placed in the correct location before the start of the program.

12 Personal reflection

On a personal level, I have learned a lot in various ways. First of all, there was no clear assignment, but a wish to implement 5S in GTI. During this internship, I have learned to set goals for myself and to make a planning accordingly.

As the team consisted of 5 employees only, all personnel has side tasks that become individual responsibilities if a company / location grows in size. This means I performed various tasks[1] that I would normally not do, giving a good view of everything that is needed to run a (small) company. Amaia Elorriaga often quoted: “GTI is different from the normal Gestamp locations. GTI is like a small company on its own”.

Part of the side tasks was interaction with students, both on individual level and by giving presentations in front of a classroom with students that are older than myself. The first time, I was tense and nervous, but after a few presentations I felt more comfortable standing in front of a classroom full of students.

I have seen various differences between working cultures in Spain and the Netherlands. The most apparent are the relatively long working days with long lunch breaks. As I experienced during this internship is that also hierarchy is more important in Gestamp than what I was used to. I am not sure if this is a cultural difference or specific for Gestamp.

The conclusion that can be drawn is that not only for my professional skills this internship is valuable, but also on the level of personal development. As some parts of the administrative work in Spain were difficult to understand, I have written a summary in Appendix C: Practical information for internship students in Spain that might be helpful for future students.

[1] Examples of side tasks are: Management reports, making a user agreement for laptops and presenting this in front of the classroom, interviewing students, changing layouts of classrooms, helping with (technical) translations into Spanish etc.

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Appendices

Appendix A: Change of Assignment

Before explaining why we came to the conclusion of a change in the assignment during this internship, one needs among other things understanding of the structure of the company. The Learning and Development (LD) department, of which I had the favor to be part of, is part of the corporate division of Gestamp (internally known as Gestamp servicios). The corporate department works together with the different divisions (e.g. North Europe, South Europe, Mercosur) and the different plants within these divisions. The LD department is located in the corporate office in the city center of Madrid. In this location, no production site is present.

As the Learning and Development department has the objective of rolling out an Arc Welding training, the LD department has to collaborate with all the divisions and plants where this welding process is present. As the LD department does not force their training upon the different division, one has to see the divisions as (internal) clients of the LD department. This makes the communication process delicate and subject to influences from all the parties as described above in the form of communication, agenda's and approval.

During the first two weeks of the internship, it became more and more clear that the schedule for the duration of the internship was due to these influences highly unpredictable. This made foreseeing the future in the form of tasks to be performed nearly impossible.

During these first two weeks, another thing became more apparent to me. At Gestamp, one thing really differs from other companies I have experience with. The corporate vision and principles within Gestamp are at the core of every decision and of high importance. There are five main principles on which Gestamp is build:

1. The client as the center of the business
   As Gestamp is a supplier of large car manufacturers, remembering your position by staying humble and building solid, honest relationships is of high importance. To stay a global leader, Gestamp should provide the best solutions to keep their clients prosper.
2. Operating excellence as a regular practice
   In order to stay within a competitive sector as the automobile industry, Gestamp has to keep operating excellence. It focuses on the importance of constant improvement of every task performed within Gestamp.
3. Innovation as a means of progress
   To provide a differential value to its clients, Gestamp has to stay at the forefront of technical innovation. An example of this is the 12 different R&D locations within Gestamp, working with Carbon Fiber Reinforced Plastics, composites and advanced welding techniques including laser welding and welding of aluminum.
4. Sustainability to ensure permanence in time
   To remain growth and to stay as a Global leader, Gestamp respects the different environments in which it operates. Also part of sustainability is cautious risk management and financial strength.
5. People as architects of success
   Employee's talent is of special importance within Gestamp. Every employee within Gestamp is considered a professional in his or her job, being vital to the existence of a well running corporation. Part of this is promoting personal development. As the project

for this internship is performed within the Learning and Development division of Gestamp, this fourth principle is of special importance within this internship. [15]

The combination of the delicacy of the communication with the high importance of staying humble (first principle), makes formal and professional communication mandatory. I personally have a relatively direct personality and experiences in the Netherlands where direct communication is more of a standard. This means I had to get accustomed to this delicate way of communication. This resulted in the fact that Marta (internship supervisor at Gestamp) was more reserved in handing over important communication tasks to me.

Also, Marta Urdiain had the expectation of me being able to speak and review Spanish, whereas I only have a very basic level of understanding and reading Spanish. This also resulted in fewer tasks for me to perform.

On top of all, I myself was concerned about the overlap of this internship with my masters; Mechanical Engineering (Production management). Within conversations together with Wieteke de Kogel (my internship supervisor at the University of Twente), we came to the conclusion that it would be value adding to add a component of a production environment.

All this resulted in the fact that continuing the internship in the current form was not an option. I am very grateful that Gestamp was able to give me the opportunity to change my assignment to an assignment within the Gestamp Technology Institute in Bilbao (situated 400km north of Madrid). Within this Technology Institute, production lines are build, used mainly for training purposes.

This meant some changes like moving to a new city, finding someone to take over my room in Madrid, finding a new room in Bilbao etc. for that reason I would like to recommend the following concerning internships. I would recommend students to have a perfectly clear picture of the internship and the assignment description. For me, the assignment description was approved by my Supervisor of the University, but it was not completely clear what my daily tasks would be, as in most assignment descriptions. This resulted with different expectations from all parties within this internship, me, the University of Twente and Gestamp.

On a personal level, I must say that this difference in professional cultures and working in a corporate environment of a global company is a major experience for me on a professional / career level. I have learned that I must be more delicate, that I have to make more use of my senses and that I have to know my place within a team or department better. Also, informing about the working culture beforehand and about the costumes in a different country would be useful. The same holds for difficult administrative tasks, which I only knew about after my first week of work.

As the change of location and assignment had a big impact on the time available during the second part of the assignment, the choice was made to write part of the report outside the internship frame. This way, some lost time is made up for.

Appendix B: Planning of Part 2

Filter / Task id	Progress	Task Description	Alert: mo-1	Alert: Due date	Real: Start	Real: End	Real: Duration	Planned: Start	Planned: End	Planned: Duration	Resp.
	57%	5S implementation			1/10/2016	15/11/2016	45	8/10/2016	19/12/2016	72	
	57%				1/10/2016	15/11/2016	45	8/10/2016	19/12/2016	72	
	88%	Product inventory			1/10/2016	21/10/2016	20	8/10/2016	19/12/2016	72	
	50%	Training of people			4/11/2016	15/11/2016	11	8/10/2016	16/12/2016	69	
	33%	Standardizing 5s			20/10/2016			8/10/2016	27/5/2016	7	
	88%	Product inventory			1/10/2016	21/10/2016	20	8/10/2016	19/12/2016	72	
	100%	Inventory database structure design			1/10/2016	20/10/2016	19	8/10/2016	25/10/2016	17	
	100%	Decide on functions			1/10/2016	8/10/2016	7	8/10/2016	13/10/2016	5	
	100%	Select software			8/10/2016	8/10/2016	0	8/10/2016	13/10/2016	5	
	100%	Decide table structure and fields			8/10/2016	20/10/2016	12	13/10/2016	16/10/2016	3	
	100%	Determine relationships between tables			8/10/2016	20/10/2016	12	16/10/2016	21/10/2016	5	
	100%	Create tables			20/10/2016	20/10/2016	0	21/10/2016	23/10/2016	2	
	100%	Create relationships			20/10/2016	20/10/2016	0	23/10/2016	25/10/2016	2	
		Write manual			19/12/2016			19/12/2016	19/12/2016	1	
	76%	Inventory content			14/10/2016			25/10/2016	4/12/2016	40	
	100%	Locations			20/10/2016	21/10/2016	1	25/10/2016	30/10/2016	5	
	90%	Items			20/10/2016			25/10/2016	29/11/2016	35	
	90%	Photos			20/10/2016			25/10/2016	29/11/2016	35	
	50%	Spanish names			20/10/2016			25/10/2016	4/12/2016	40	Jaime
	50%	Prices / purchase date			20/10/2016			25/10/2016	4/12/2016	40	
	50%	Training of people			4/11/2016	15/11/2016	11	1/11/2016	16/12/2016	45	
	100%	Training of students on 5S basics			4/11/2016	15/11/2016	11	1/11/2016	15/11/2016	14	
	100%	Identify training needs			4/11/2016	8/11/2016	4	1/11/2016	4/11/2016	3	
	100%	Creation of a training			8/11/2016	14/11/2016	6	4/11/2016	6/11/2016	2	
	100%	Giving the training			14/11/2016	15/11/2016	1	6/11/2016	15/11/2016	9	
	0%	Training employees					0	1/11/2016	16/12/2016	45	
	0%	Identify training needs					0	1/11/2016	11/12/2016	40	
	0%	Creation of a training					0	11/12/2016	14/12/2016	3	
	0%	Giving the training					0	14/12/2016	16/12/2016	2	
	33%	Standardizing 5s			20/10/2016			0/1/1900	31/12/2016	42735	
	86%	Standard visual 5s in workbenches			20/10/2016			3/11/2016	31/12/2016	58	
	90%	sort			20/10/2016			1/12/2016	31/12/2016	30	
	90%	set in order			20/10/2016			1/12/2016	31/12/2016	30	
	80%	shine (clean)			20/10/2016			1/12/2016	31/12/2016	30	
	70%	standardize			3/11/2016			3/11/2016			
	100%	sustain (audit form)			20/10/2016			1/12/2016	31/12/2016	30	
	12%	Standard visual 5s in storage area					0	1/12/2016	31/12/2016	30	
	30%	sort			22/10/2016			1/12/2016	31/12/2016	30	
	30%	set in order			22/10/2016						
	0%	shine (clean)					0				
	0%	shine (clean)					0				
	0%	sustain					0				
	0%	Standard visual 5s in Cabinets					0	0/1/1900	30/1/1900	30	
	40%	sort			19/11/2016			1/12/2016	31/12/2016	30	
	30%	set in order			20/11/2016						
	0%	shine (clean)					0				
	0%	standardize					0				
	0%	sustain					0				

Appendix C: Practical information for internship students in Spain

This appendix serves the purpose of explaining some formal administrative tasks to give future internship students insight in the Spanish governmental administrative tasks.

13.1.1 Número de Identidad de Extranjero (NIE)

Número de Identidad de Extranjero (NIE) is a personal number needed in Spain to open bank accounts and is needed for most companies to be able to pay you. There are several ways to get this NIE, but none of them are easy. I learned this the hard way. Be careful that the level of English is very low or non-existent at any of these governmental offices.

1: Make an appointment through internet. Before going to your appointment, you have to pay the administration fee (Modelo 790, €10.60) at any local bank in Spain and take the copy of your payment with you. Also fill in in form EX-18 twice, take a copy of your passport, copy of your international insurance card and a copy of your contract (of the company you will do your internship) with you. Also take the real passport and insurance card with you. This way, you can get a permanent NIE. However, as I found out during the online appointment making, the first available slots for this appointment can be 1 month away. When I arrived at this office one month later, it appeared that I needed a completely Spanish contract, while mine was in English. They did not accept this contract and they send me to 'Brigada de extranjeria S.A.C.E.'.

2: Brigada de extranjeria S.A.C.E. Here you can apply for a NIE if you are maximum of 3 months in Spain, by saying you need to open a Spanish bank account. You don't need an appointment and the waiting line (in my case) is around 30 minutes. I was going to stay in Spain for 4 months, but they told me this was not a problem. If you say you need it 'temprano' or fast, you don't have to come back, but they will call you on your (Spanish!) phone number to inform you about the NIE number you will receive. You still need a copy of your Passport, your real passport and this Modelo 790 (€9.45), paid at any bank. This second way is the easiest and fastest was to get your NIE.

13.1.2 Numero de seguridad social (NUSS)

The NUSS is necessary for tax purposes as well as contracting and all procedures related to labor and work. It is basically a registration for the Spanish pension and unemployment system.

This number was also requested by Gestamp, but it was easier to get. No appointment is needed. One can go to Administracion de la seguridad social (find the closest one by googling). You will need to have a filled in version of the TA.1 form, a copy of your passport and the real passport. You will receive a paper with the social security number on it, not an actual card.

APPENDIX D: 5S Audit Forms

5S AUDIT FORM FOR STUDENTS

Week Number	
Program:	
Group Number:	
Name Responsible:	
Name Teacher:	
Workbench Number:	

Sort

	L		M		X		J		V	
	Si	No	Si	No	Si	No	Si	No	Si	No
Are all the tools present? Checkliston the back										
Are all unecessary items removed? (PPE, papers, clothing)										

Comments

Set in Order

	L		M		X		J		V	
	Si	No	Si	No	Si	No	Si	No	Si	No
Are the tools in the correct location?										
Are labels correct and easy to read?										

Comments

Shine

	L		M		X		J		V	
	Si	No	Si	No	Si	No	Si	No	Si	No
Are all drawers clean?										
Is the worktop clean?										
Is all waste disposed correctly?										
Is the area around the workbench clean?										
Are all tools clean?										

Comments

Standardize

	L		M		X		J		V	
	Si	No	Si	No	Si	No	Si	No	Si	No
Is any tool broken or missing?										
Was the 5S audit form present?										

Comments

Sustain

	L		M		X		J		V	
	Si	No	Si	No	Si	No	Si	No	Si	No
Was the previous Audit form filled in correctly?										
Are the 5s principles followed by all group members?										
Are previous comments / improvements solved?										

Comments / improvements suggestions

5S AUDIT FORM FOR TEACHERS

GESTAMP TECHNOLOGY INSTITUTE

Date + week number:

Program:

Name Teacher:

Signature

*This audit form is used to sustain the 5S method in the area of the workbenches. This form has to be filled in by the teachers every last day of the week and placed in the organizer located in the tools cabinet. If any tools or consumables needs reordering or is broken, please mention on the back side of this form.

Sort

	Yes	No	Why?
Are all the student audit forms present?	☐	☐	
Is the workplace clean of unnecessary items?	☐	☐	
Comments			

Set in Order

	Yes	No	Why?
Did you put the audit forms in the organizer?	☐	☐	
Are all audit forms filled in correctly?	☐	☐	
Are all the tools returned to the right location in the cabine	☐	☐	
Comments			

Shine

	Yes	No	Why?
Are the cabinets clean?	☐	☐	
Is all waste disposed correctly?	☐	☐	
Is the area around the workbenches clean?	☐	☐	
Comments			

Standardize

	Yes	No	Why?
Did any group mention a tool broken or missing? If so, add to the other side of this form	☐	☐	
Were the 5S audit forms present?	☐	☐	
Do any tools/consumables need reordering? See other side	☐	☐	
Comments			

Sustain

	Yes	No	Why?
Was the previous Audit form filled in correctly?	☐	☐	
Are the 5s principles followed by all group members?	☐	☐	
Are previous comments / improvements solved?	☐	☐	
Comments / improvements suggestions			

Appendix E: Report of tasks

Weekday	Date	Morning	Afternoon
Monday	5 September 2016	Meeting the Learning and Development team. Reading about the project; Arc welding & the human factor in arc welding.	Meeting with Marta (mentor) about the project. Filling in official documentation. Start with reading the part of the defects catalogue that is finished
Tuesday	6 September 2016	Corporate game to learn the corporate principles, history etc. Read & sign code of conduct. Reading defects catalogue.	Meeting about the project
Wednesday	7 September 2016	Meeting about the working principles of Lectora (online course creator). Went to office to find out about the N.I.E. (official documentation)	Look and discuss about the existing planning of the project. Fill in information on SMS, mailed Wieteke about arrival.
Thursday	8 September 2016	Talking with Marta about planning. Corporate vision + principles. Introduced to contact persons. Writing a document for contacting all HR	Writing draft mail for contact in a formal way. To learn formal way of having contact.
Friday	9 September 2016	Meeting with Marta about formality and corporate structure. Revising draft email and a presentation to inform the divisions about this global project.	Meeting with Victor (Global learning environment expert) to learn about creating learning paths, user groups etc. for the online learning environment.
Saturday	10 September 2016	Weekend	Weekend
Sunday	11 September 2016	Weekend	Weekend
Monday	12 September 2016	Meeting with Marta about planning. Visit of factory in Bilbao is postponed. Creation of training / learning action in the test environment	Continuation of working on online training path.
Tuesday	13 September 2016	Reading on lean learning. Meeting about assignment. Discussion about introducing more engineering in the project. Sounds promising, different possible options.	E-learning environment practice
Wednesday	14 September 2016	Helping with the translation of some documents for Beatriz (training content developer).	Miscellaneous tasks
Thursday	15 September 2016	Training content development. Skype meeting with Wieteke about the issue of 'engineering contents'.	Meeting with Maite about internship content.
Friday	16 September 2016	Day off	Day off
Saturday	17 September 2016	Weekend	Weekend
Sunday	18 September 2016	Weekend	Weekend
Monday	19 September 2016	Literature research on lean learning. Writing report	Spanish classes
Tuesday	20 September 2016	Wedding friend (Netherlands)	Wedding friend (Netherlands)
Wednesday	21 September 2016	Wedding friend (Netherlands)	Wedding friend (Netherlands)

Thursday	22 September 2016	Wedding friend (Netherlands)	Wedding friend (Netherlands)
Friday	23 September 2016	Start with e-learning content on cold stamping	End of day at 14:30.
Saturday	24 September 2016	Weekend	Weekend
Sunday	25 September 2016	Weekend	Weekend
Monday	26 September 2016	Meeting about the change in the assignment. Does not look promising	Spanish classes
Tuesday	27 September 2016	literature research on visual inspection	Maite has skype meeting with Wieteke about the change of the assignment. I get called in and get to hear that I have to change my assignment to Bilbao.
Wednesday	28 September 2016	Start literature research on Lean and 5S in a learning environment.	Meeting with Maite about the issues formed during the assignment in Madrid.
Thursday	29 September 2016	Preparing the trip to Bilbao	5S literature research
Friday	30 September 2016	5S literature research	End of day at 14:30.
Saturday	1 October 2016	Weekend	Weekend
Sunday	2 October 2016	Weekend	Weekend
Monday	3 October 2016	Report writing	Report writing
Tuesday	4 October 2016	End of PART 1	End of PART 1
Wednesday	5 October 2016	Changeover to Bilbao	Changeover to Bilbao
Thursday	6 October 2016	Changeover to Bilbao	Changeover to Bilbao
Friday	7 October 2016	National Holiday	National Holiday
Saturday	8 October 2016	Weekend	Weekend
Sunday	9 October 2016	Weekend	Weekend
Monday	10 October 2016	Start of day at Bilbao. Introduction, reading materials	Assignment introduction, planning.
Tuesday	11 October 2016	Getting to know the programs	Introduction into GTI
Wednesday	12 October 2016	Reading lean and 5S literature	Miscellaneous tasks
Thursday	13 October 2016	Making a small inventory of the current clothes	Placing of new lockers
Friday	14 October 2016	Reading lean and 5S literature	End of day at 14:30.
Saturday	15 October 2016	Weekend	Weekend
Sunday	16 October 2016	Weekend	Weekend

Monday	17 October 2016	Analyzing situation in workbenches and cabinets	Meeting with staff
Tuesday	18 October 2016	Reading lean and 5S literature	Report writing
Wednesday	19 October 2016	Writing of user agreement for laptops	Handing over laptops to students
Thursday	20 October 2016	Interviewing students and taking photos	Writing management report
Friday	21 October 2016	Report writing	End of day at 14:30.
Saturday	22 October 2016	Weekend	Weekend
Sunday	23 October 2016	Weekend	Weekend
Monday	24 October 2016	Start of inventory (in excel)	collecting data for inventory
Tuesday	25 October 2016	collecting data for inventory	collecting data for inventory
Wednesday	26 October 2016	collecting data for inventory	Analyzing lean methods
Thursday	27 October 2016	Preparation of proposal for database	Miscellaneous tasks
Friday	28 October 2016	Start with database	End of day at 14:30.
Saturday	29 October 2016	Weekend	Weekend
Sunday	30 October 2016	Weekend	Weekend
Monday	31 October 2016	Meeting about requirements for database.	Translating requirements into database structure
Tuesday	1 November 2016	National Holiday	National Holiday, but working on structure of database.
Wednesday	2 November 2016	collecting data for inventory	Transferring data to database
Thursday	3 November 2016	Working on database	Working on database
Friday	4 November 2016	Reading about possibilities of reports in Access	End of day at 14:30.
Saturday	5 November 2016	Weekend	Weekend
Sunday	6 November 2016	Weekend	Weekend
Monday	7 November 2016	Meeting about change in requirements for database.	Analyzing requirements
Tuesday	8 November 2016	translating requirements into database structure	Create form for order adding
Wednesday	9 November 2016	Adding of photos and data to database. Invoices processed for information.	Adding of photos and data to database. Invoices processed for information.
Thursday	10 November 2016	Developing presentation on Lean and 5s with a lean expert in GTI.	Developing presentation on Lean and 5s
Friday	11 November 2016	Handing out clothes to students	End of day at 14:30.

Saturday	12 November 2016	Weekend	Weekend
Sunday	13 November 2016	Weekend	Weekend
Monday	14 November 2016	Database, adding suppliers / supplier form (combo box)	Preparing the presentation for the students together with one student to do the presentation in Spanish.
Tuesday	15 November 2016	Adapting / updating planning/ Adding information to the database.	Performing the presentation in front of the students. Together with 5S game.
Wednesday	16 November 2016	Santiago did the presentation in the classroom with Spanish students.	Miscellaneous tasks
Thursday	17 November 2016	Implemented the 'adding order details' to the access database.	Writing management reports.
Friday	18 November 2016	Updating structure of database, writing report.	End of day at 14:30.
Saturday	19 November 2016	Weekend	Weekend
Sunday	20 November 2016	Weekend	Weekend
Monday	21 November 2016	Writing report	Meeting
Tuesday	22 November 2016	Miscellaneous tasks	Report writing
Wednesday	23 November 2016	Working on database	Working on database
Thursday	24 November 2016	Add orders to database.	Miscellaneous tasks
Friday	25 November 2016	Adapting planning & Sending order of missing items to supplier.	End of day at 14:30.
Saturday	26 November 2016	Weekend	Weekend
Sunday	27 November 2016	Weekend	Weekend
Monday	28 November 2016	Report writing. 5S audit form in database.	Completing Inventory. Creating visual navigation menu
Tuesday	29 November 2016	Report writing / daily planning updated	Adapting 5S forms after feedback.
Wednesday	30 November 2016	Determining required tools and layout of workbenches	Determining required tools and layout of workbenches
Thursday	1 December 2016	Counting items in workbenches	Order missing tools
Friday	2 December 2016	Report writing	End of day at 14:30.
Saturday	3 December 2016	Weekend	Weekend
Sunday	4 December 2016	Weekend	Weekend
Monday	5 December 2016	changing audit forms from daily to weekly	Miscellaneous tasks
Tuesday	6 December 2016	Local holiday	Local holiday
Wednesday	7 December 2016	Working on database	Working on database

Thursday	8 December 2016	Local holiday	Local holiday
Friday	9 December 2016	Writing report	End of day at 14:30.
Saturday	10 December 2016	Weekend	Weekend
Sunday	11 December 2016	Weekend	Weekend
Monday	12 December 2016	Adapting database to new requirements & Amortization	Organizing student presence lists
Tuesday	13 December 2016	Preparing excel (VBA) sheets for student presence to improve working speed	Writing report
Wednesday	14 December 2016	Adapting database for deleted items	Miscellaneous tasks
Thursday	15 December 2016	cleaning out workbenches	filling workbenches with correct tools
Friday	16 December 2016	Foam insert for drawers	End of day at 14:30.
Saturday	17 December 2016	Weekend	Weekend
Sunday	18 December 2016	Weekend	Weekend
Monday	19 December 2016	finalizing database	making manual for the database
Tuesday	20 December 2016	Preparing presentation for the final day	Cleaning computer and server folders, making backups and Saving everything on USB.
Wednesday	21 December 2016	Final Day, presentation about the project & handing over	End of day at 14:30.
	22 Dec - 22 Jan	Report writing	