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DEPARTMENT OF MECHANICAL ENGINEERING

Continuous Improvement

Dissertation presented to obtain the masters in Industrial and Management Engineering

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Institutional Collaboration

LT ELECTRONIC technological partner

LT Electronic

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“Growth is a process of trial and error, experimentation. The ‘failed’ experiments are as much a part of the process as the experiment that ultimately works.”

Unknown

Thanks

I want to thank all the workers of LT Electronic, in special to Eng° Joana Freitas to give me the opportunity to do this internship and helping with this project.

To Professor Doctor Cristovão Silva for his input and suggestions during the development of this dissertation.

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To all my other friends and colleagues, which I can’t enumerate because they are many, thanks for being there for me when needed and for having so many adventures along all these time.

Resumo

O objective desta dissertação é a implementação da cultura de melhoria continua na LT Electronic. Todo este trabalho foi feito em colaboração com a LT Electronic.

O propósito deste trabalho é a implementação de ferramentas que melhorem a produtividade. As ferramentas que foram/estão a ser implementadas são 5S, *Yamazumi*, *Takt Time*, etc. Houve também a implementação de um novo layout fabril para minimizar o Muda.

Depois de todas as melhorias, ou não, eu escreverei o que se passa nas linhas de produção

Palavras-chave: Lean, 5S, Layout, Continuous Improvement.

Abstract

The purpose of this dissertation is the implementation of the culture of continuous improvement in LT Electronic. This work was all developed in cooperation with LT Electronic.

The purpose of this work is the implementation of tools that improve the productivity. The tools that are being implemented/were implemented are 5S, Yamazumi, Takt Time, etc. There was also the implementation of a new factory layout to minimize the *Muda.*

After the implementations I'll post the improvement, or not, that occur on the production lines.

Keywords: Lean, 5S, Layout, Continuous Improvement.

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ACRONYMS

Acronyms

LTIM – LT Immobilized

EPC – *"Equipamento Produtivo Cablagem"*

EPE – *"Equipamento Produtivo Electrónica"*

ESD – Electrostatic Discharge

WIP – Work In Progress

1. INTRODUCTION

LT Electronic was born in May of 2006. It has an area of approximated 1000m^2 and produces cabling, electronic boards and assembly/manufacturing of products. The company also does repair of a product that produces, it doesn't matter if it is in-house or out-house.

They don't have many competitors that can do all three processes, which is a strength that the company has. Also they have many clients, some of them that work for the automobile industry. It's common knowledge that the automobile industry is rigorous with the specification of parts that are shipped to them, so LT needs to have good quality standards to keep evolving their strengths and mitigate their weakness.

1.1. Motivation and Work Goals

The work presented in this dissertation is the start of the implementation of continuous improvement in the company philosophy. This came from a suggestion of a multinational client that visited the production floor and disliked what they found. They told that a nice way to start would be with the 5'S methodology. After starting implementing they saw that this way of think added value to the overall production floor.

There was a wide range of lean methodologies that were introduced, some already implemented and others waiting to be implemented, mainly because of the lack of productions orders.

The primary goal of my work was, first of all, people starting embracing the change, giving ideas, practice continuous improvement. This is the primary challenge when we start to implement this kind of work. The secondary goal was to see productive gains in the on the three main areas.

In the second chapter will be about the various methods that were used in this internship (5S, production leveling, etc.), while in the third chapter is already some field work, applying the 5'S methodology. The next chapter is about implementing a new layout on the factory floor and what were improvements gained. The second to last is about some

various implementations that could improve the area affected, leaving the last one to conclusion of the work, leaving the last one for a small conclusion.

2. CONTINUOUS IMPROVEMENT

In this chapter it's going to be introduce the main theoretical methods that were applied in LT Electronic. These are 5'S, production leveling, Yamazumi chart and process capability. This is only going to be a light introduction about these subjects since in the next chapters shows examples about these subjects.

2.1. 5S Methodology

This methodology came from Toyota in Japan after World War II. Sakichi Toyoda and other two representatives from Toyota visited a Ford factory in the United States They noticed that the workers were waiting for one step to be completed. After they returned to Japan they implemented 5S methodology in Toyota and to apply they offered some importance and encourage to each employee, because every job was important to the product.

This is a method to help organize the workspace environment and reduce the waste. There are five steps that are always being applied:

SEIRI (Sort): In this point we remove what isn't necessary on the workspace, removing unnecessary tools, items and some cases products. This point also tries to prevent to that any unnecessary tools appears.

SEITON (Straighten): The second point is to pick what's necessary and put them in order. This means arrange all the items that are necessary so that they are easy to found and pick up. This prevents loss of time searching for what's necessary to make the job.

SEISO (Shine): This third point is about to make the workspace clean. This prevents the equipment to deteriorate and keeping the workspace safe and free of all the garbage that can damage the raw materials, for example the dust on the electronic boards.

SEIKETSU (Standardize): In this second to last S, the purpose is to maintain everything that's was done in the first three Ss. This step is done by creating tools, routines and teaching everyone how to work.

SHITSUKE (Sustain): In last S, the objective is to all the people be self-disciplined, so that they don't need to be told what to do. This keeps the work running fluently.

2.2. Production Leveling

Production leveling is a technique to reduce the waste that assembly lines have. The primary objective is to produce at a constant rate so that the final product is also produced at a constant and predictable rate. When the production isn't constant there is waste that's created.

In this case the demand was known so the leveling wasn't difficult. But when the demand isn't always constant there are two approaches to solving the problem: demand leveling and production leveling.

This allows the production be steady along all the different jobs, meaning that aren't any big differences in the jobs, allowing a smooth production of the product and reduce any waste between jobs.

2.3. Yamazumi Chart

The Yamazumi chart is a stacked bard chart. This chart is usually used in the optimization of a production line. Normally each task is measured in time and the stack of the jobs can't pass the cycle time.

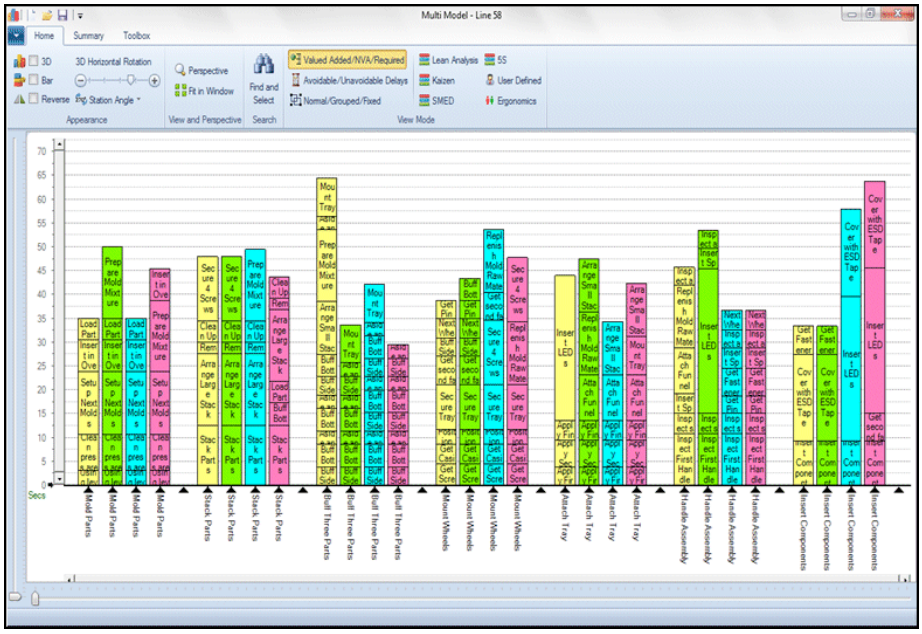

Figure 1 – Example of a Yamazumi Chart

2.4. Process Capability

Process Capability it's a measurable property of a process to the specification. Normally is expressed in C_{pk} or C_{pm} if it's a process capability index or P_{pk} or P_{pm} if it's a process performance index.

To measure a process at least one property is need to be specified. The outputs from the measurement show a normal distribution, which can be described by an average and a standard deviation. After getting these variables, it's time to know if the process is in control. To know this a control chart is done.

There isn't a number of how many data it's needed to produce some results, but as many statistical measurements, the more the merrier. This means that there is a more approximated reality.

After getting all outputs it's easy to check if the process is in control. If the C_{pk} is lower than 2 then the process might not be in control. If it's bigger and the process is in statistical control then the process is in control.

3. BEFORE THE NEW LAYOUT

At the start of this project was decided to start implementing the 5'S methodology in the various areas of the factory. To better understand the implementation of this methodology there's going be a little presentation of the layout at the time that this project started on LT. In the following chapter there will be a deeper description of the layout.

To implement the 5's the company defined two pilot areas: *Teste e Reparação* and *Soldadura Manual.* These areas were the main focus of the 5'S methodology.

3.1. The old layout

When this project started at LT there was seven areas of production. They were *Reparação de Electrónica, Soldadura Manual, Montagem, Embalagem, Teste, Cravação* and *Soldadura por Onda.* These seven areas were from the three processes that LT has. To complement the processes there are also two warehouses, one of them especially for electronics. Finally there is an area that's unusable because belongs to the landlord, and it's currently occupied that LT can't move.

The annex B shows a scheme of the layout areas when the 5's methods started being implemented. The black areas are the ones that can't be moved.

3.2. Before the Implementation

The first thing that was done was trying to get the attention of all the people at the company for the 5'S. Started by making posters and announcements at strategic places in the factory. One stayed in the entrance of the plant, one in *Teste e Reparação*, because as we are going to see is going to be the first place where the methodology is going to be applied, another in *Soldadura Manual* and the last one for hanging efficiency graphs, weekly production schedules, etc. outside the control room.

Next was done a chronogram so that this would help us guide through all the work that was going to be done. Also helped everyone to know what and when was happening. Each quarter, this chronogram, would be revised to know which jobs weren't accomplished and new goals that could be done in the next quarter.

Third and last, is important to know that each process has a manager. Each manager is responsible for any materials and tools that are in their area. To better help the maintenance of the tools, they were all identified as LTIM (immobilized material) or if they were testing tools are identified as EPC or EPE *(Equipamento Produtivo de Cablagem* and *Equipamento Produtivo de Electrónica,* respectively). This data is save in an informatics platform called ISIMILL. It also warns the users if there is a need of some sort of maintenance.

3.3. Teste e Reparação

After saying to all the persons in LT what was the 5'S about, the company decided that the starting point was *Teste e Reparação*. This was because there was already applied some of the points of 5'S. This area requires some special care because needs to be ESD, so not everything solution could be applied.

3.3.1. Issues found

The area was poor maintained and there weren't any guidelines to that people could follow. This allowed thing like in the following photos happen.

Figure 2 – *Teste e Reparação* after work

This photographs shows how the workplace was left after the laboring hours. There are products without the reference and all spread around. Every material must have a reference associated to him. This prevents swapping with other materials that look identical thus preventing errors with swapped parts. There were also testing tools that weren't identified, material that wasn't used inside of boxes, the documentation all spread, etc.

Another problem is that there isn't a defined place to save the electronic samples. If there are various batches along the year, normally it's created a sample product. This sample needs to be kept in good conditions so that be checked if there is any doubt. Also in the rejected materials shelf there was some materials that weren't identified.

And, one time, while there was some looking around to check the area after labor hours, a pack of crackers was even found. This is just to show the area had little maintenance before starting this internship.

Figure 3 – Pack of crackers that were left after work

3.3.2. Proposal to solve the issues

The first decision was put in a box or in the trash the things that weren't used. After doing a search for what wasn't needed, some spare parts were found. Some of them were damaged parts that didn't have repair so they went to the garbage. All the other things that weren't needed, but were still in good conditions were saved in a box. This was a bit difficult to do because the people who work there don't know what they are going to repair, in a week or two, so they don't know what's going to be needed.

After doing the first S, SORT, the products, tools and materials that stayed in the area needed a place to stay. There were four shelves, plus 2 workbenches to put them. The methodology was to put anything that was frequently used in the workbench and the thing that were less used in the top of the shelves. With that thought in mind, was defined that the soldering tools needed to stay in the workbench. The measuring tools, power sources and materials that with frequent use were put in the lower shelf, and the testing machines and documentation on the upper side of the shelves. This type of storage allows that the more frequent pieces used are the closest to all that work on this area.

Figure 4 – Raw materials and Testing tools area

In the photographs above were taken in the beginning of the implementation of the 5'S.

After identifying the test tools and putting a standardized cardboard identifying the shelves, it was time to start with the third S, SHINE. First thing was the removal of the scotch tape of the workbench. Then we created a small area to put some cleaning materials so that people that used that area could clean after the work was finished.

The main problem here was that the people that were working at *Teste e Reparação* were very resilient to the change. They were always "fighting" so that things would stay the same. Because of this problem it took a long time to apply these kinds of improvements.

3.4. Soldadura Manual

This area was the main focus for two reasons. First is a very dirty area since there are soldering and cable leftovers. Second it was one of the cabling areas that LT wanted to improve, since there an option of a multinational to give production orders that would involve this area.

3.4.1. Issues Found

The main problem that was seen in this area was that the people could do electronics or cabling so the area needed to be prepared for both, like the solutions.

After a quick tour the most important step was in this area was cleaning it and how to maintain clean. One of the areas that were dirtier was the weld pot because there

were little pieces of weld that jumped and felled in the mat. The second problem that caught an eye was the tools that the people were using were spread around the company. This meant that people were always asking where some tools where.

Another big problem was that many of tools that tested the cables weren't identified, making harder for the new people to know which box tested which cable.

3.4.2. Proposal to solve the issues

Unlikely what happened with the first S in *Teste e Reparação*, in this area we know the exactly what's needed in each workbench. That was a soldering iron, a pistol to remove the soldering, a little coil of solder, a heat dryer and a magnified glass with light. There was also a soldering pot and a recipient of flux that the four people who worked there needed to share. With this list, anything that didn't belonged needed to be removed.

The second thing to do was to identify everything. Every tool, raw material, finished product, etc. The problem, at least for the materials, of this was that materials, WIP and finished goods were all together. The solution found was to divide the shelves for each of the kinds of product. The next thing was to teach the people how to work with this.

Using the in-house references (LTIM, EPC and EPE) all the tools were inputted in the ISIMILL. Like what happened in the *Teste e Reparação*. There was also some important information that needed to be inserted, like if needs to be calibrated (in case of affirmative answer put the last calibration and when is the next).

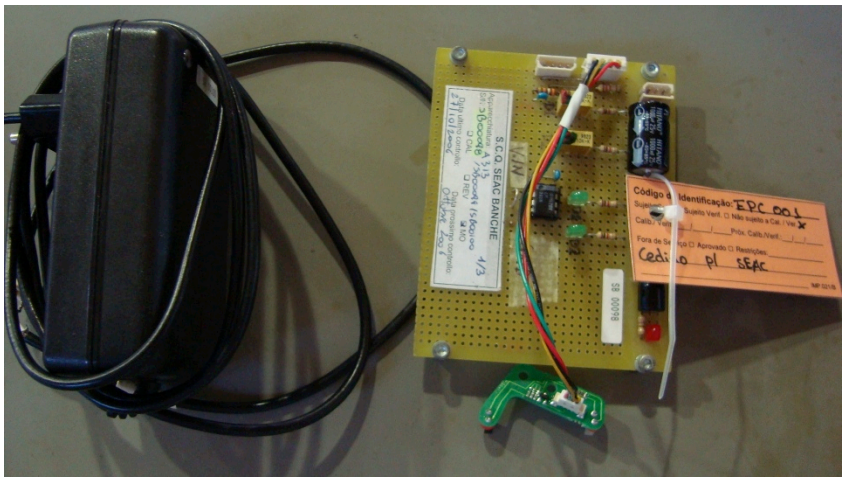

Figure 5 – Example of a testing tool (EPC)

Another thing that was treated with little care were the samples of the cables. Each day there was at least one person asking where the samples were. To prevent this to

happen, a space in the electronic warehouse was created for that purpose (it's right next to this area). To help organize a simple method was implemented. A box should take n number of samples of a client. Since to implement 5'S the budget was low, the solution was to use the card boxes that come with the printer paper with the client's names in front of the box. Many of the clients have more than twenty samples, keeping it hard to track. So for every 10 samples there was a bag, which in the top would have the references of each of sample that was inside the bag.

Figure 6 – Stored samples from Cabling

Like the samples there was at least one person asking for a specific crimping tools. To solve this solution was implemented a board for all crimping tools that were needed and the other tools needed in *Soldadura Manual*. To help the people put the correct tool in the correct place a photograph was hanged.

Figure 7 – Tool's panel

After awhile, was noticed that only hanging the photograph wasn't enough. Couldn't do a shadow of the tool because there was a fear that if the shadow needed to be removed it would damage the panel. The solution was to put the LTIM reference in each place so the tools wouldn't mix.

Figure 8 – Closer look to the tool's panel

There was a closet that wasn't needed so it was used to organize any material that was in the manual soldering area. After putting all the boxes identified in the closet there was still some space left. The remain space was then occupied with the datasheets of the cables and some other tools that helped soldering some cables like gauges or some tweezers.

This area was though to maintain it clean because there weren't any proper tools to clean. A thing to do was buying brooms and shovels so that people could clean the floor.

There were some complaints about how the ESD mats were in bad shape and some with resin from the cables that were being soldering. To clean the workbenches some cloths and alcohol would suffice, but to remove the resin wasn't enough. The solution was to clean with acetone. These cleaning products were put in the area so that people would start cleaning everyday after finishing work.

To standardize this area was simply done by teaching the people what to do when a new thing was done.

To maintain this area, at least in the beginning, everyday someone would pass to see if everything were in the right place. If they weren't in the right place a picture was taken and in the next day someone would ask why that tool or product wasn't in his place.

After the people got used to this method of working instead of doing this everyday it was done two in two day, until it was ready to only do a weakly audit.

Figure 9 – General view of *Soldadura Manual* in the old layout

3.5. Cravação

In this area is where someone would do the crimping of the cable. There are four machines that work with an air compressor, while there were some crimping tools on the panel that was hanged in manual soldering.

3.5.1. Issues Found in the Crimping area

In the crimping area there were many raw materials that weren't used in a lot time, with some not being used anymore. There were also some boxes with dust (this could damaged some items). If anyone went there he or she couldn't tell which cables were already finished to go to the next step or needed some rework.

Figure 10 – Dirty boxes from *Cravação*

The workbenches from the crimping were in bad shape. There was a lot of scotch tape and had ink on the table. It was an area that showed that LT wasn't doing a good job cleaning.

Figure 11 – Crimping workbench

Another problem was that some crimping tools for the machines and they needed to be safe from the dust so they could last longer. Because they were in old boxes and didn't have identification, some times there was confusion about which tool to use. Also since there were two references for each tool, causing some problems. After asking around, the problem was that some tools would have the reference of the terminal and on the datasheet was the reference of the tool. Since all the work in that area was made for one person since LT opened this errors were mitigated, because she knew which tool to use. These could create waste if there was a new person and didn't know which reference to see.

3.5.2. Solution proposed in the Crimping area

The first thing done was selecting what materials, tools and boxes that weren't needed. With this selection there was a lot of gain in the bookshelves, since most of them weren't needed.

After releasing the space the next step was define what was going to be in every shelf. Every shelf was defined for each type of material. Since the empty boxes were used to put cut cables it was optimal to put in a bookshelf that was the nearest of the cutting machine. In the bookshelves of the middle was for the materials that were going to be transformed in the area. The last bookshelves were for the product that was finished and was waiting the next job.

There was a closet that nobody wanted so it was a good point to save the crimping tools. The closet has four drawers, with the lower and higher drawer not being very ergonomic. So the two in the middle are being used to keep the tools. This would protect from the dust.

Figure 12 – Closet with the crimping tools

Every crimping tool would have is own place, identified outside of the closet and in the inside. In the inside label it has the LTIM and the terminal references, so it would be easier to choose the right one. There are also two cardboards, one with a cut of the form of the tool (Poka Yoke) and another below so the tool won't scratch the closet.

After choosing a place for each thing the next step was cleaning the front bookcases and the workbench since there a lot o white scotch tape.

To keep the area clean was also defined a place to put the broom and the shelf so after work the people could clean the area.

3.6. Audits

After knowing that the minimum work was done to maintain a good workplace it was time to maintain the work that was made and find new things that could be improved or that were bad implemented. With this in mind, the quality department decided to create an audit to check if the people maintained what was implemented.

This checklist was made with a copy that was given by a consultant that was helping the quality department. It was then adapted to the needs of each area that 5'S was being implemented. An example for each area is in the annex A. Later an Excel worksheet was created to publish the results. There was some treatment done to the data that was harvest. Then there was a graph with the total score of the 5's. The results were hanged so everyone could see it.

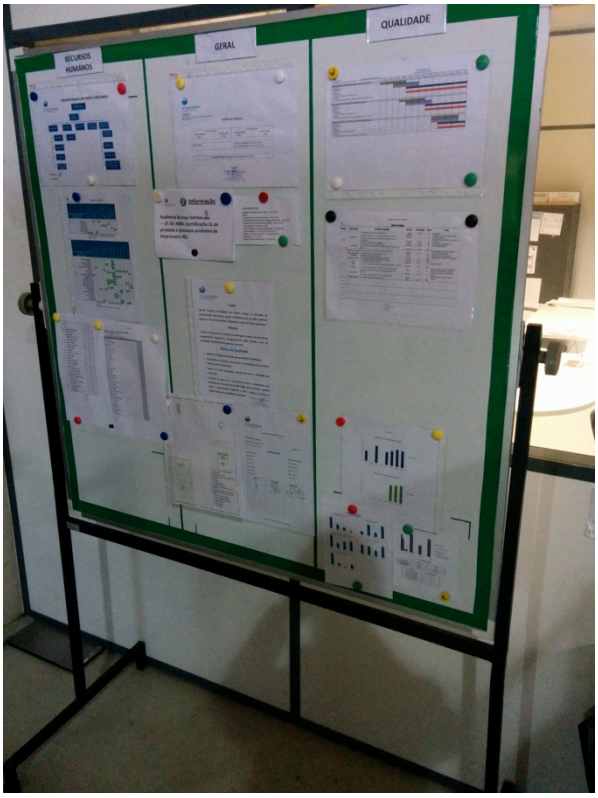

Figure 13 – Result of the audits

After getting the results, internally there was a discussion about how to improve even more that area and how to repair what was wrong with it. This was done with the guidance of the data that was gathered during the audits.

4. THE NEW LAYOUT

While implementing the 5'S methodology I was getting a good picture how LT Electronic was working. I realized that doing only the 5'S wasn't enough, so I spoke to management about changing the layout since was a proposal that already was in the table.

4.1. About the space

The factory has about 1000m^2 of useful space. There were some things that couldn't change: the warehouse, the landlord area, the control room and the electronic warehouse. Overall there was about 700m^2 free to the productive area.

4.2. The Old Layout

The old layout was defined when the company started. The company started only manufacturing for one main client. Almost all the production was for that client, but in the present days there are wider variety of clients. There were many reasons to change the layout but most it was an old fashioned layout since it wasn't serving the purposes for today's production. Also when applying the 5'S methodology in each area, the people doing it noticed that the overall factory wasn't itself organized.

There was a change between when this project started and the introduction of the new layout. The electronic warehouse changed its place. In the annex B is the oldest layout while in the annex C is the layout after the electronic warehouse change it's place.

4.2.1. Production Flow

In a printed copy with a scale of 1:100 the space traveled was measured. This measurements ware made for a normal route of each product, meaning that they would have to pass in every job.

Table 1 – Old Layout Travel Distance

Process	Cabling	Electronic	Assembly
Travel (m)	88	88	90

4.2.2. Cabling Area

The cabling process includes these jobs: cutting, crimping, manual insertion, manual soldering, test and packaging. These all areas were spread across the production floor. There are two jobs that would simultaneous produce cabling and electronics and two jobs that even didn't have the places defined. This could be a problem because that places could be occupied with other jobs and could create some confusion for the people. One of the jobs that didn't have a defined place was Manual insertion and the cable test workbench.

Other problem that caught the attention was when anyone would had a doubt they would call the responsible of the process. Most of the times the responsible was cutting cables on the other side of the factory and to clarify the doubt he would need to walk all way over where he was called. This would be a loss of time for each party involved.

Figure 14 – Old Cabling areas highlighted

4.2.3. Electronic Area

Like the cabling process, the electric process was also spread across the plant. The process includes manual insertion, wave soldering, manual soldering, testing area and packaging.

When a question was raised, the responsible of the process needed to get out of his job and walk so he could clarify. Since the areas were spread this would be a lot of lost time. Also the testing and repair area could be bigger cause they needed more space since they test and repair, if needed, all the products that are produced.

Other problem was suggestion from management. If they wanted to fully equip the electronic area what could be done in terms of space. The best thing was aggregate all. This is a project that stayed on stand-by since there aren't enough orders of production that make this viable.

Figure 15 – Old Electronic areas highlighted

4.2.4. Assembly Line Area

At the time of this change there were 6 main lines of production. Four belonging to the client A, one to client B and the other one for jobs that LT didn't had a regular production. The last one is called seasonal line.

In the case of the assembly lines for the client A there was a space for the pre-assembly and only after that the main assembly was made. Two of the client A lines had one product, one of them had two products being produced and the last one had a discontinued product. The last line, since this project started, never worked. It was there only for replacement parts.

The line for the client B already included the pre-assembly in assembly line. This specific line will be the focus later on the paper since some modifications were made.

The last line it's only used when a project appears and the client only asks for a small number of units and then never asks again or asks in a year. To this kind of products don't need a specific line to them because LT don't produce regularly.

Figure 16 – Old Assembly areas highlighted

4.2.5. Assembly Testing Area

After the product was ready from the assembly it would came to the testing area. This is where the burn-in and some other tests like configuring the machine, install firmware, etc. are made. The next step is the packaging.

Figure 17 – Old Testing area highlighted

4.2.6. Packaging

The last step before the product is ready to be shipped is the packaging area. This area receives all the products that need to go to the clients (cabling, electronic and assembly) and does the packaging.

Figure 18 – Old Packaging area highlighted

4.2.7. Equipment Configuration

This is a very special area, since isn't connected to any process in particular. In the old layout, it was included in *Teste e Reparação*. This area is where is done the configuration of some GPS boards. It would have a very small space to work because was occupied mostly by *Teste e Reparação* and the cable tests.

Figure 19 – Old Equipment Configuration area highlighted

4.3. New Layout

Since there were a lot of processes mixed with each other, the main focus was to separate all the processes. So everything that belonged to cabling should be in a cabling area. The same thought was applied to the other processes.

The management asked to present two layouts; one with the packaging after the assembly lines or at the end of the processes and the other with a dedicated packaging area.

This new layout would give a look of an organized factory. This is important because there are many new clients that like see the plant.

While designing this layout the warehouse also grew. A slice of 2 meters wide in the top wall went to the warehouse. With this new addition, a space of $4m^2$ for the emergency doors was needed.

4.3.1. Method

To start, the main concern was to know which space would be available to make the change. The management answer was that all the space could change except the warehouse and the control room build (it includes the electronic warehouse). Also the wave-soldering machine could be moved if there was the need to. Since the management didn't know if they are going to change to a new building or not, changing the machine was out of the question. Change this kind of machine would be too expensive since it's very heavy and after changing was needed to change the exhaust tubes, glasses, etc.

The second point was that every job of a process needed to be inside of his process area. With this point it was expected to decrease the travel distance of a product and the area would be better suited to make improvements. With an area designated to each process was also easier for the manager to what the people were doing and correct some mistakes that could happen.

It's important to highlight that all the work done was done with the help with each of the process managers. With their input in the construction of the layout helped prevent any unforeseen problems with the flow of their work area.

Before starting designing the layout, there was a counting of how many tables of different sizes were in the entire factory. This will help determine the sizes and the flow of the areas, because these tables were going to be reused.

4.3.2. Layout with the packaging area inside the assembly line

This is the layout that was thought that was more beneficial to LT, since it would try to prevent too much WIP (waste). The main reason to this assumption was that there was a limit that the people could put also in the packaging area in front of each process. This also helped the person who was doing the packaging since it was a visual information for the packer, when was starting to see lots of machines, that she/he should start packing.

Also there will be a separated manual soldering, one for cabling and the other for electronics. This are three more workbenches to workbenches added to this kind of job.

The layout will be described for each process because it helps to explain why was done that way. The expedition and receiving site stayed the same, so that areas aren't being explained. This happened because there wasn't a need or space to make them bigger.

4.3.2.1. Cabling Area

There was a lot of experimenting with this area because the electronics and assembly line areas determined its size. The design of this area was made flowing the normal jobs that a cable would follow. After a lot of experiments it came up to this layout:

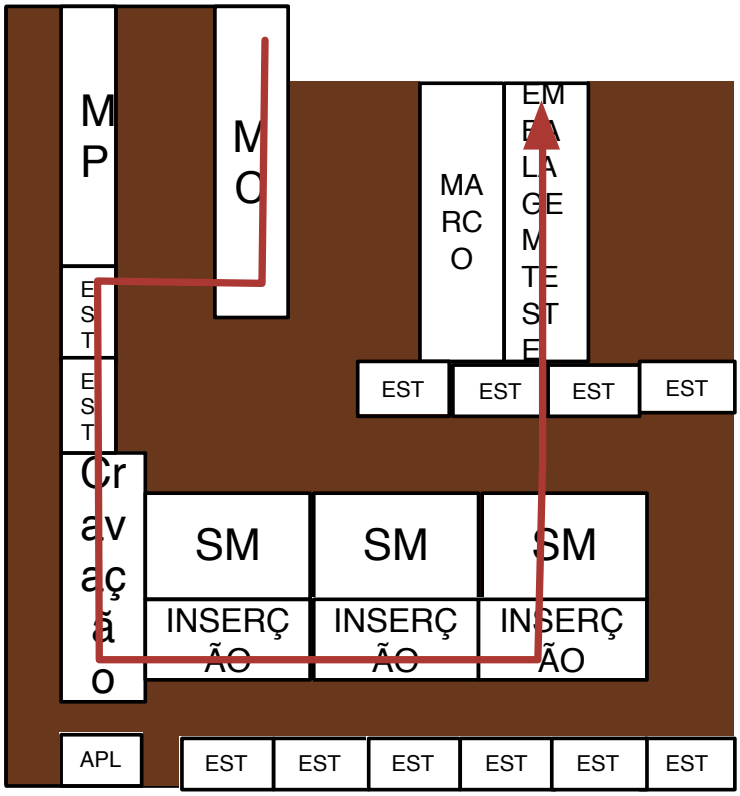

Figure 20 – New Cabling area

This U shape layout would minimize the space needed in the cabling area and also allowed all the jobs to be included. It had also allowed enough space to store all materials and tools.

On the left of the cutting machine (MC) there are coils of the most used cables in the products made. Following the red arrow (the flow), the cables were cut in the machine and the stored in WIP bookshelves before the crimping. Behind the crimping

stayed the panel with the tools that were needed. This allowed saving time because the distance was small from the workbench to the panel. After the cable was crimped it could go to manual insertion or manual soldering (depending on the cable). The both jobs were right in front of the crimping. In both jobs there are the raw materials specific to each job. After the cables were all finished, they go to a bookshelf waiting to be tested and packaged. When the bookshelf was almost full was a sign that the cables needed to be tested and packed. Finally they would go to the expedition area or the warehouse.

This format also allows that the process manager to be in the centre of the area, allowing him to clarify faster any doubt that could occur in the products.

4.3.2.2. Electronic Area

The electronic area was ease to design because it's area was already defined by the wave-soldering machine. Since the machine belonged to the electronic process and it wasn't moving, all the other electronic jobs needed to go there. After some experiments this became the final design:

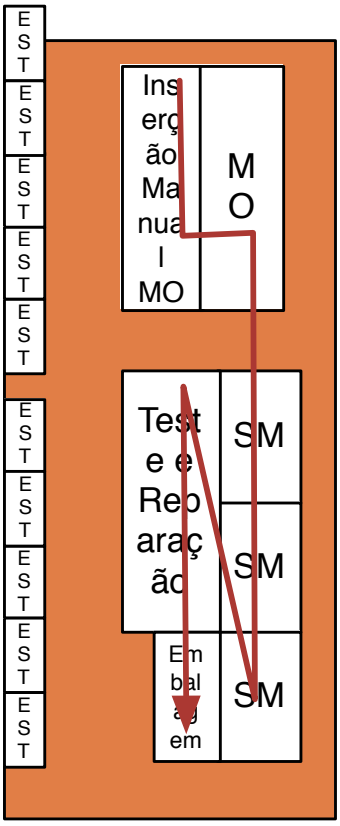

Figure 21 – New Electronic area

Like in the cabling area, the cabling area was design taking into account the flow of product. The first job was manual insertion for the wave-soldering machine or the manual soldering. Behind the manual insertion there are bookshelves that have raw materials to support the manual insertion. After the wave-soldering machine, the electronic board can go to be tested to the testing workbench or be retouched in the manual soldering. After passing the test they go to the packaging area. If not, she wouldn't leave the area so that can be repaired first and then finally sent to the packaging.

4.3.2.3. Assembly Line

In the assembly line area there were 3 different lines assign to client A, with the possibility of a fourth line (the one with blank rectangles) for an upcoming project that was in development. It was likely that the project would come to LT. The main improvement was at the end of the line include the test of each product followed by the packaging area. This meant that the final product didn't have to "walk" to the testing area and packaging, like would happen in the old layout.

Figure 22 – New Assembly line area with packaging

The blank rectangle row, while there isn't the new project, it's now for seasonal products.

The company B also had he assembly line reworked, and that's something that is going to talk in one of the following chapters.

In the bottom part of the picture is the seasonal production with, like the other assembly lines, the packaging at the end. This seasonal line has some shelves that are used to support for the various raw materials and tools.

The management requested an area that could some reunions. Weekly, or if there was a important subject, there is a reunion to talk about what was going to happen in that week and for the Production Manager could know about some problems that happen the past week.

4.3.2.4. Equipment Configuration

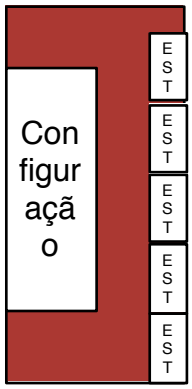

Figure 23 – New Equipment Configuration area

This area was a "black sheep" since it isn't included in any of the previous processes and doesn't almost any similarities with them. To prevent that the line wasn't put in the middle of the other process, there was a decision to create an area for it. This area has all that it needs. The space was doubled (from the old layout) and has bookshelves so that all the required parts would fit. Also there is enough space to proper configure, test and do the packaging all in this area. Something that couldn't be done in the previous area.

4.3.3. Layout with the assembly without packaging

The main difference in version of the layout is that includes an external area for packaging the products from the assembly area. Since the cabling and electronic area stayed the almost the same, they aren't going to be addressed.

4.3.3.1. Assembly Line area without packaging

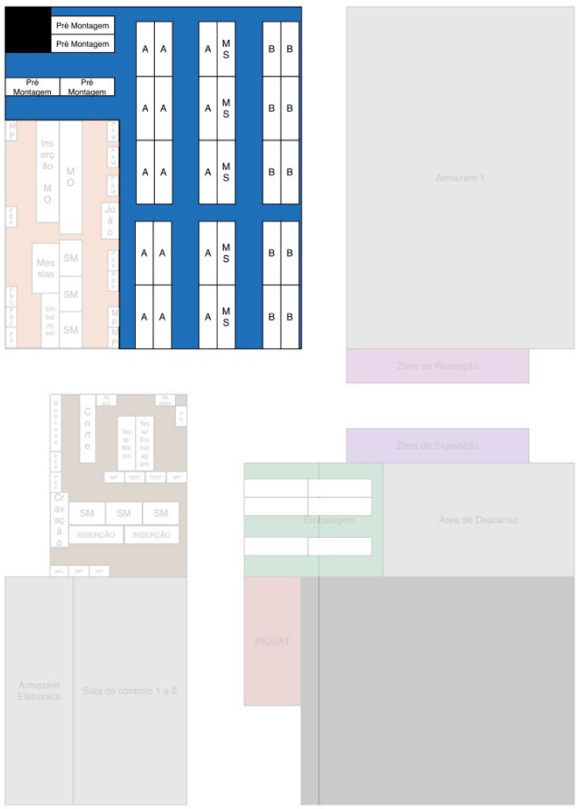

Figure 24 – New Assembly line without packaging

Like the other assembly line layout there was a space only for the pre-assembly and the test was done after the last assembly job. This second assembly line has less useful space than the first because the packaging was occupying a big chunk of m^2. It could only have one seasonal assembly line, and if the upcoming project came there was no line left to do seasonal work.

4.3.3.2. Packaging area

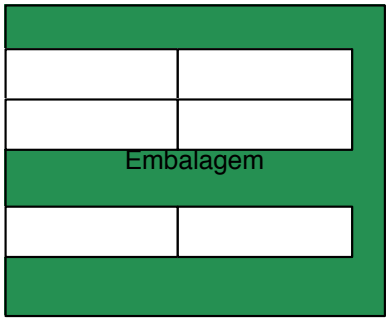

Figure 25 – New Packaging area

Since the old packaging area hadn't much space, the new packaging should have more space available to be more efficient and more organized. This area would have one line for every kind of products that could come off the assembly line. One line for client A, one for client B and the last for the seasonal products.

4.4. Deciding the Layout

The two layouts were presented in an early meeting. This meeting included the Quality manager, Production manager (one of the partners of the company) and the other partner. After presenting the two ideas, the second layout was put aside since it didn't have as much benefits as the first. Since the idea of the second layout was abandoned, the main focus turned to the first layout. There is an A4 layout in annex D.

One of the things that were asked was how much time was needed to make this change. Nobody had any kind of experience with this area. Because of the lack there was an estimation of 120 man/hours to change the main layout. The little stuff like the cabling management that needed to be done (this included change the electric and network jacks) was estimated at least 40 man/hours were needed.

4.5. Getting the hands dirty

This change could be made in two ways: stopping the production lines or changing without stopping the production lines. The management decided to pick the later one so that production wouldn't stop.

These changes started in the middle of March and lasted until the end of April/early May. This includes mounting the new warehouse. There was a stoppage during

the change because were some clients visiting (about two weeks. Overall, it was about 2x the time that was estimated (included the cable management). Without the stoppage, overall it took about 4 weeks to change everything. After this time there were still some things that need to be done, like arrange the cables so that people wouldn't fall.

To make the factory more appealing, LT decided to invest in a grey mat to cover the workbenches. This allowed the area to get cleaner, mainly because the workbenches were hard to clean. Also, with this change, all the people didn't had any excuse not to clean their working area.

After the 3 weeks of work the factory floor appear like this:

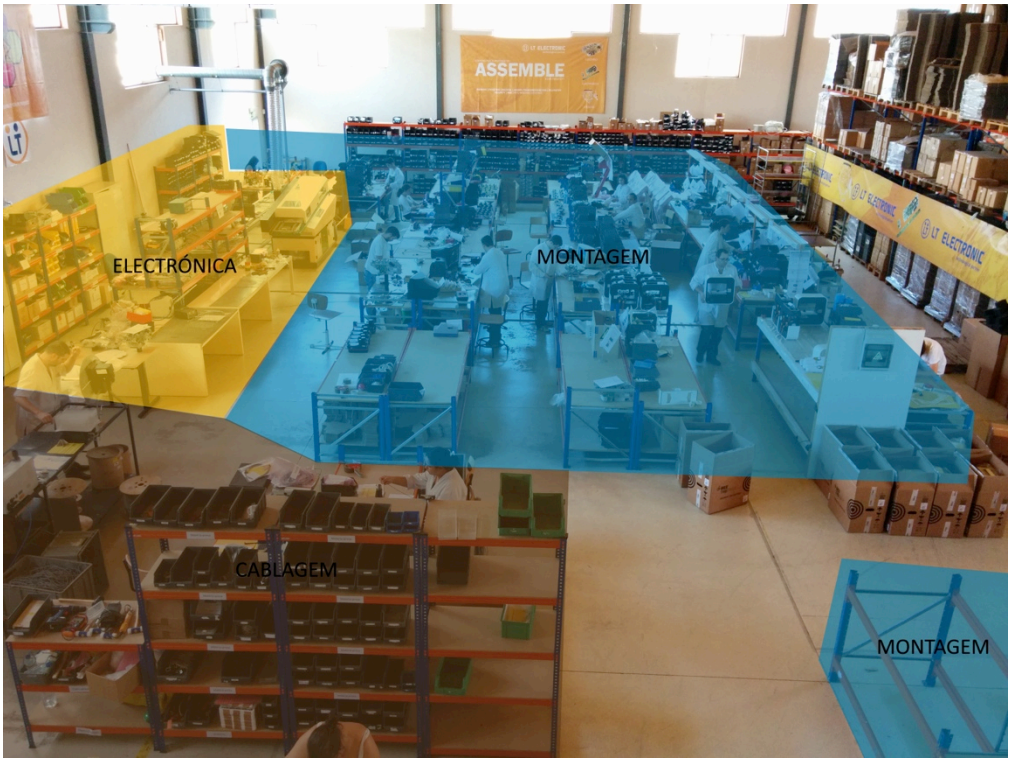

Figure 26 – Photograph of the new layout

A closer look to the cabling area:

Figure 27 – Photographs of the new Cabling area

Now the electronic area:

Figure 28 – Photographs of the Electronic area

4.6. The Result

Like the photographs shows, the overall company appears to be more organized. It's not only that but there are real gains of the travelled distance.

Table 2 – Improvement of the distance traveled

Process	Cabling	Electronic	Assembly
Old (m)	88	88	90
New (m)	54	71	77
Improvement (m)	34	17	13
Improvement (%)	38.64%	19.32%	14.44%

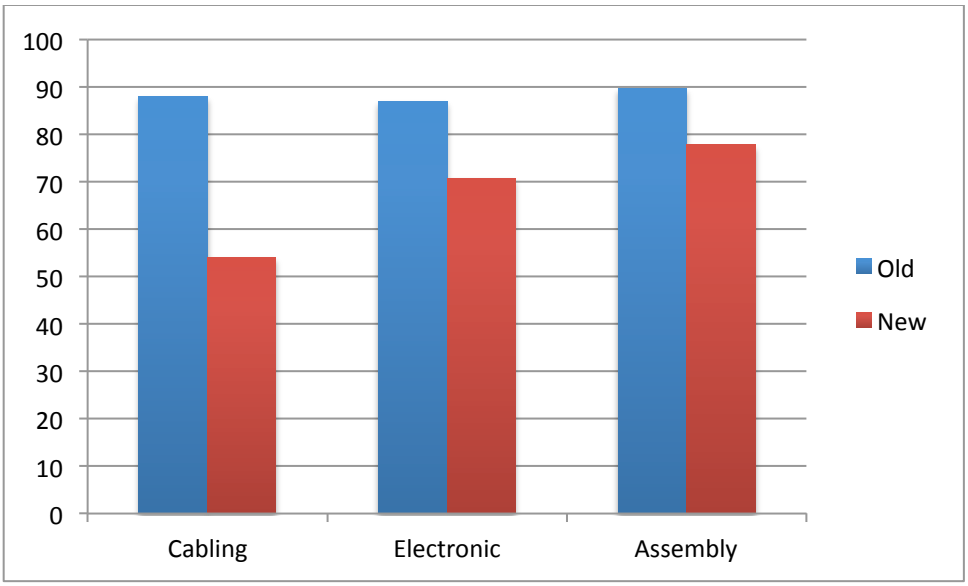

Figure 29 – Graph of the improvement travel distances

For the measurements of the both assembly lines, old and new, the travel route includes the packaging and testing.

4.7. Reactions

Since this project is going to affect all the people that work on production, it was is good to know what people thought about this new design of the production floor. Most reactions from the people that worked in LT were positive, so most people were happy with the change. For example:

"To me it's good. Now it's only missing retouch some details, for example the electric "tomada" on top of the table" – Carmo

"It's way better now than before. It's more organized" – Lisete

"I think it's good. I can't say more because it's needed more time to see. But in overall it's better. There is a change to be more tidy up" – Messias

"The space has a better usage and it's more organized" – Daniel

There were also two negative reviews:

"The cabling area gives a messy look. The fact that is all squeezed. But appears better overall" – Bruna

"It's prettier (the layout). But in terms of movement I think it's worse." – Vitor

5. CONTINUOUS IMPROVEMENT COMPLEMENTARY WORK

In this chapter there will be some work that was done while doing the design of the layout or the implementation of the 5'S methodology. It will be present the balancing of a production line, a system for new ideas, process capability and improve the performance in the configuration line

5.1. Leveling a Production Line

One of work proposed was balancing a line that supposed would had an increase and steady production. Until the conclusion of this dissertation the line was stopped because they didn't have enough sales. So if someday there is the need to restart the line, most of the work was already done.

5.1.1. Jobs Precedent and times

The first thing to do was seeing which jobs should be next to each other. This allows to know the sequence of each job.

Table 3 – Jobs precedent and times

Job	Time (m)	Precedent
Cabling	22	
Electronic	11,6	
A	18	Cabling
B	10	
C	19.5	Cabling, Electronic
D	15	
1	40	D, Cabling
2	30	1, D, A Test, C Test
3	48	2, B, D, Cabling
C Test	12	C
A Test	12	A
Bee Test	25	3
Prep. for the 5h test	6	Bee Test
5h Test	600	Prep. for the 5h test
Cleaning	10	5h Test
Packaging	22	Cleaning

In the table is also presented the time of each job that is needed to complete the job.

This allows reducing the space that the product travels in the assembly line, simply putting the jobs in the right position.

5.1.2. Leveling the Line

In the first instance, there are going to be calculus about which is the minimal amount of people needed in the line.

The request was to balance the line for 304 units per month. Doing the math using twenty days and eight hours per day, each month. This gives 160 working monthly hours.

$$x = \frac{304}{160} = 1.9\ machines/hour$$

$$y = \frac{60}{1.9} = 31.57\ takt\ time\ (min)$$

The x gives how much printers have to be completed in each hour, and the y is the takt time for each printer.

Adding the times of only the assembly line, since the cabling and electronic are a separated process, we get 267.5 minutes. The 5h test doesn't need people on that stand. Its test is to know if everything works fine. All the work that's needed to do it is in the preparation for the 5-hour test. To make the math easier, it's going to be used the time of 31.5 minutes. (31 minutes and 30 seconds).

$$z = \frac{267.5}{31.5} \approx 8.5\ persons$$

We now know that we need at least 9 persons for maintain the monthly production.

5.1.2.1. Solution #1

Using already the new layout, the first solution found needs 10 people.

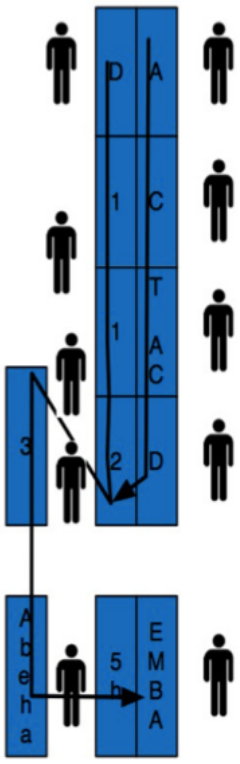

Figure 30 – Graphical presentation of the 1st solution

The jobs positions were design using the precedent table. With this data is possible to do a Yamazumi chart to better show how each person used his/her time.

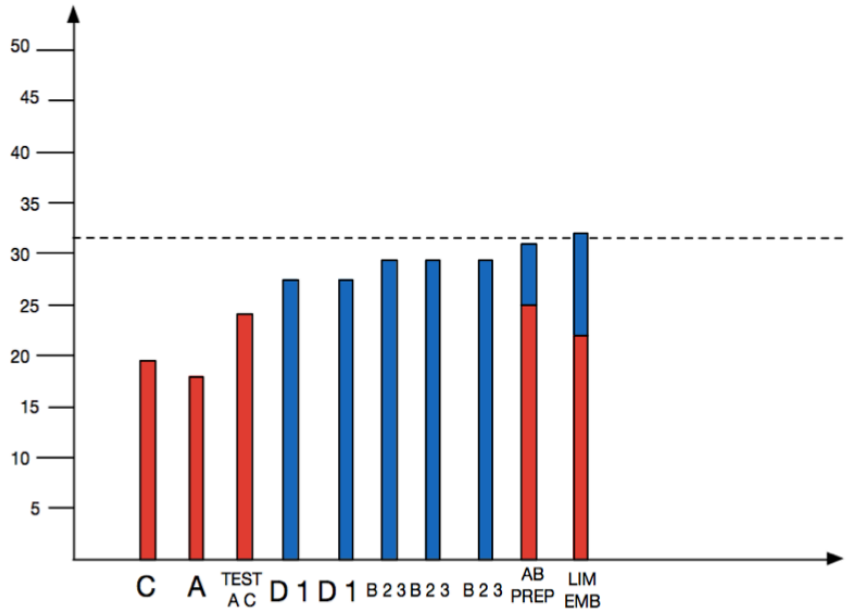

Figure 31 – Yamazumi chart for the 1st solution

This solution needs 10 people. There is at least one that can be allocated to another process or assembly line. This happens mainly because the A and C test can't be done right separately.

In the chart it's possible to see that in the last job there its passes the cycle time (thirty seconds more). The problem was that these times were measured on the old layout and had the handling from the 5-hour test to the packaging. Since now they are followed by each other the times diminish, maybe reaching the 31'30''.

5.1.2.2. Solution #2

If there was a way of doing the test of each component individually the number of people could be reduced in one.

After asking to the person who did the test about the issue, they responded that they could do two tests if they were using two machines. Each machines, if we were getting as the end user, it would cost two thousand euros. This is the worst possible solution.

A good way to know how long it takes to the returning the investment is doing a payback. The payback would be around four months.

This solution also allowed having one less table, gaining some space in the seasonal line.

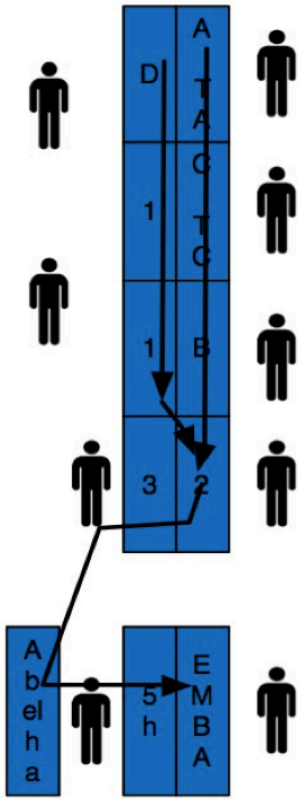

Figure 32 – Graphical presentation of the 2nd solution

Like the first solution, to show how the time was distributed in each person, a Yamazumi chart was created.

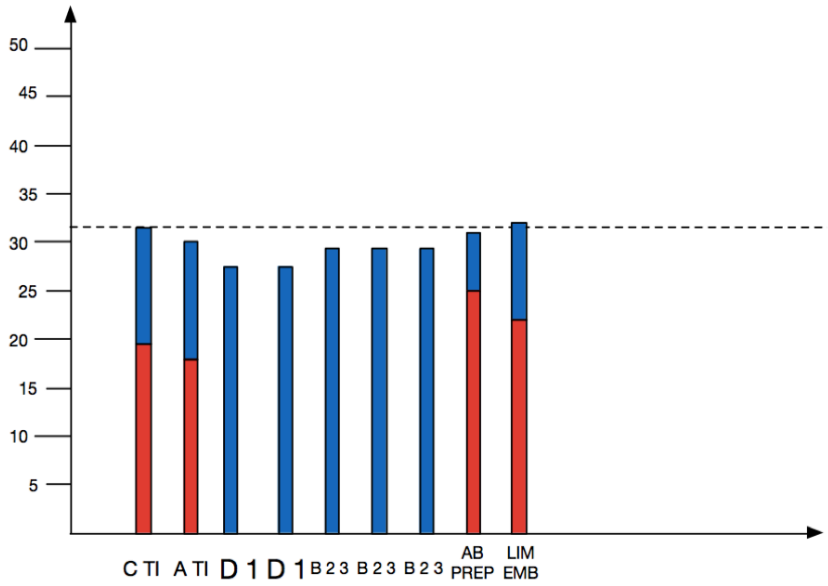

Figure 33 – Yamazumi chart for the 2nd solution

Like in the first solution, the packaging passes the cycle time. But with some solutions is possible to diminish the overall time.

5.2. Process Capability

Other thing that was done in the quality department was the process capability of the cable-cutting machine. The cable in which this test was made is a cable that has a steady monthly production and the client is in the automobile industry. That's go without saying that they are very rigorous about the quality of the cable.

The whole product includes two cables, one blue and the other red. Here are the size specifications:

Table 4 – Average, lower and upper limits for the cables

	Red (mm)	Blue (mm)	Strip (mm)
Average	143	157	5
Lower limit	138	152	5
Upper limit	148	162	5

5.2.1. Measurement the cables

To make the test, a random fifty cables for each colour were picked. Each part of the cable was measured, to check not only the size of the overall cable but also the stripping.

5.2.1.1. Red Cable

After measuring the fifty cables this were the results obtained for the red cable:

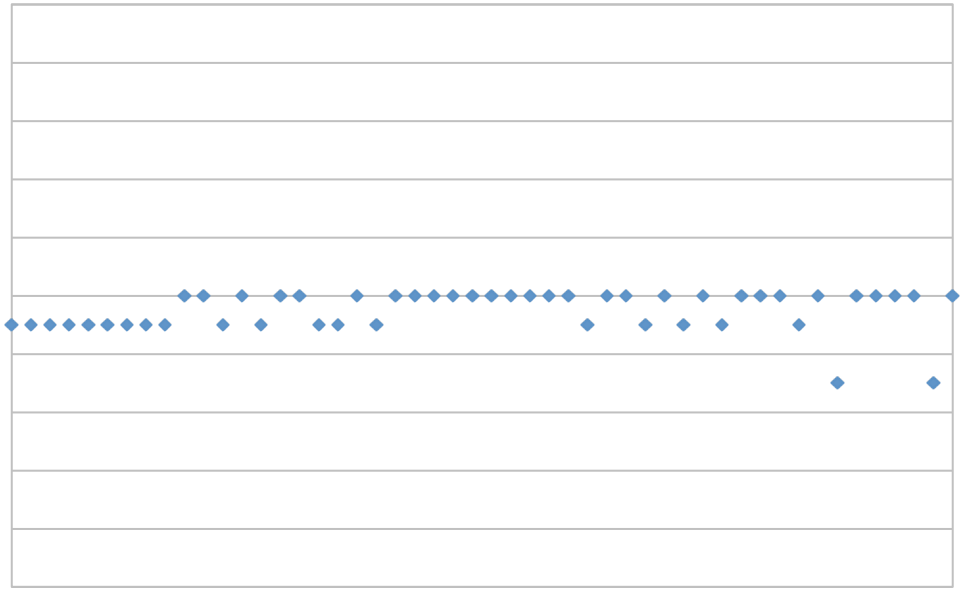

Figure 34 – Length of the red cable

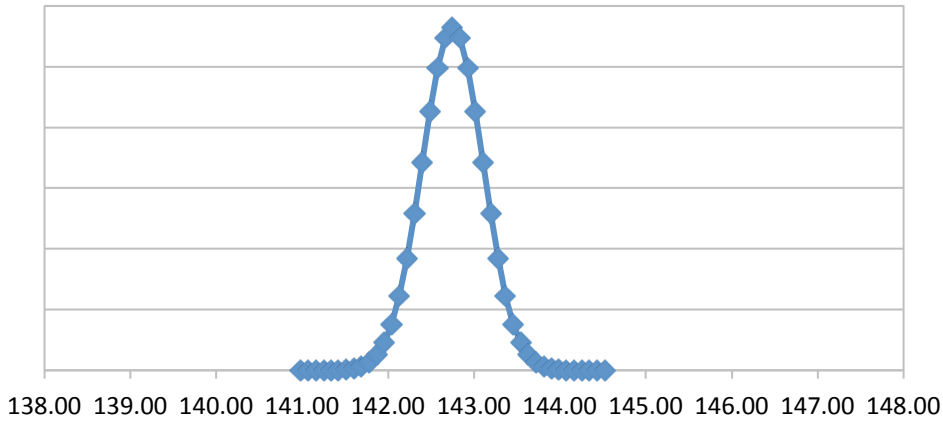

Figure 35 – Normal distribution for the length obtained for the red cable

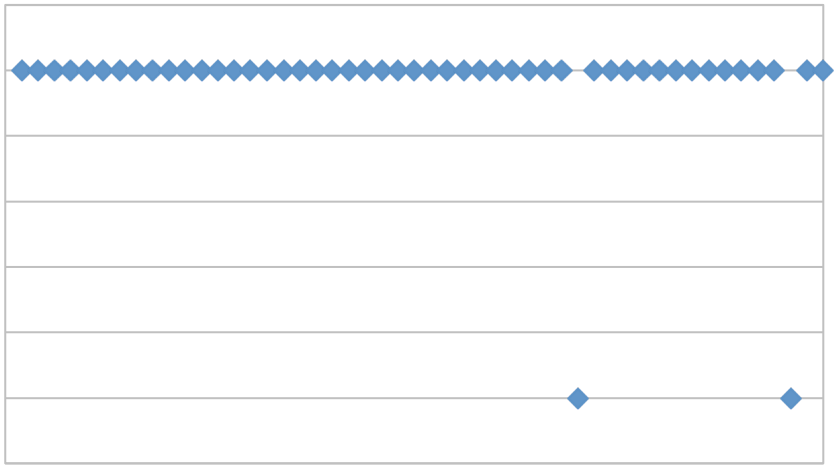

Figure 36 – Length of the strip (in mm)

Table 5 – Process capability values for the red cable

Cp	4.714045208
PPL	4.478342948
PPU	4.949747468
Cpk	4.478342948

5.2.1.2. Blue Cable

With the fifty cables of the blue colour this were the results obtained were almost the same:

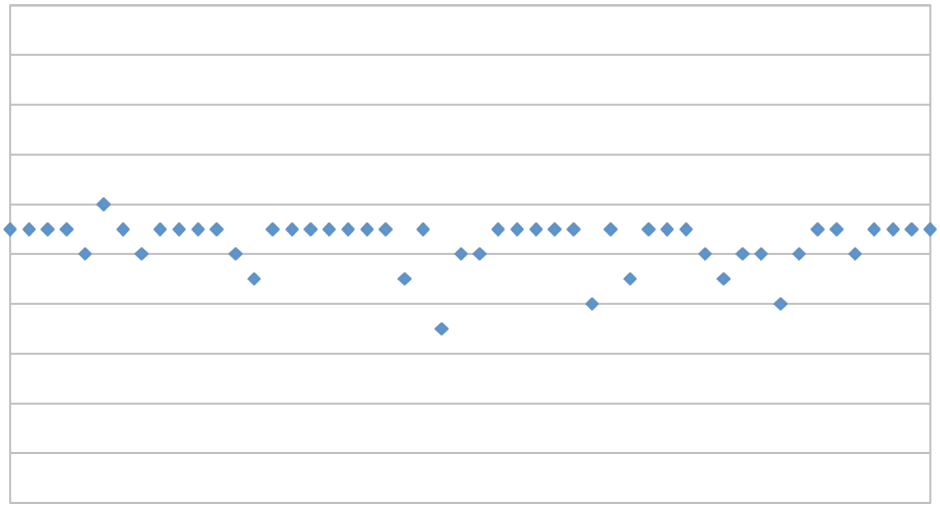

Figure 37 – Length of the blue cable

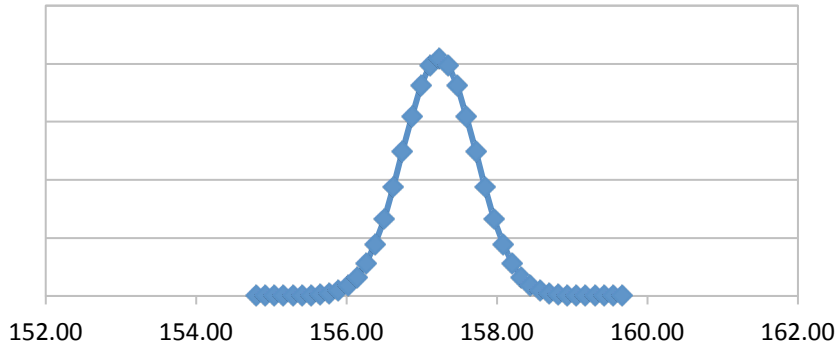

Figure 38 – Normal distribution for the length obtained for the blue cable

Figure 39 – Length of the strip (in mm)

Table 6 – Process capability values for the blue cable

Cp	3.424713275
PPL	3.582250086
PPU	3.267176465
Cpk	3.267176465

5.2.2. Conclusion

Even thought the values of C_{PK} give a number greater than two, there is a 4% of rejection on the strip. This means that the size of the cable is in control but the size of

the strip isn't. The advice that was given was every cable should be checked for the strip size.

5.3. Improving the Configuration area

This subchapter is about the configuration area before changing the layout. All the work could be applied in the new area.

There are two main kinds of configuration, the National one and the Global. The board configuration is almost the same for the two types, only changing some small details how the SIM cards are configured. The configuration is simply putting the firmware on each board and configuring the GPS and GSM modules.

5.3.1. Configuring the Global board

The main problem about this area is that the person who is doing this job isn't doing anything while the boards were configuring. So was decided to take the times of each task to know if there was anything that could be done to improve this area.

Important also to refer that these times are for a batch of 10 boards. This happens because there are only ten antennas and ten SIM cards (the SIM cards are provided by the client). The computer can handle as many simultaneous configurations as needed without increasing the time of this task.

Table 7 – Tasks needed to configure the Global board

Task	Time (s)
Remove the boards from the box and unwrapping them from the plastic	44.96
Cut and glue the serial numbers	128.21
Remove the SIM cards from the boards that are already configured	95.66
Insert these SIM cards on the new boards	177.21
Insert the serial number and SIM card data in to the pc configuration application and in an excel worksheet	144.43
Execute the pc application	**1285**
Insert the boards inside the external box	195.16
Do the packaging	581.77
Total	2652.4

It's easy to check that the bottleneck is the application running. This occupies almost 50% of the time. There were two solutions: improve which tasks to do while the boards were configuring or increase the number of boards in each batch.

Following the first suggestion: the tasks were divided for what the person could do.

Table 8 – Tasks that can be done while the board is configuring

Tasks	Time (s)
Remove the boards from the box and unwrapping them from the plastic	44.96
Cut and glue the serial numbers	128.21
Insert the boards inside the external box	195.16
Do the packaging	581.77
Total	950.1

With this division, instead of the operator only wasting 1285 seconds, he/she would only be wasting around 335 seconds, improving the overall performance.

While measuring those times, another thing caught my attention. Is that the boards wouldn't end the configuration all at the same time.

Table 9 – Boards finished by minute

Minutes	Boards Configured Test 1	Boards configured Test 2	Boards configured Test 3
10	3	3	0
11	3	4	1
12	4	6	3
13	6	6	3
14	6	7	4
15	6	7	6
16	7	7	6
17	7	7	6
18	9	7	6
19	9	7	6
20	9	7	6
21	9	7	6
22	9	7	6

Defective Configuration	1	3	4

After doing checking 3 batches it's easy to see that after the 18 minutes (1080 seconds) mark no board wasn't getting configured. A solution was asking the application to stop at the 18 minutes mark, gaining about 200 seconds more. There are 2 problems with this; first is that the application is also from the client (LT doesn't have access to the source code) and the second is that this is a small sample of a monthly production. There are monthly productions that arrive to more than a thousand units, and 30 units isn't a big sample to conclude anything. This is only an alert to the company and the client that maybe is a good idea to save history about this subject so that could be further evaluated.

Other factor for the low performance was that there were many defective boards and/or SIM cards.

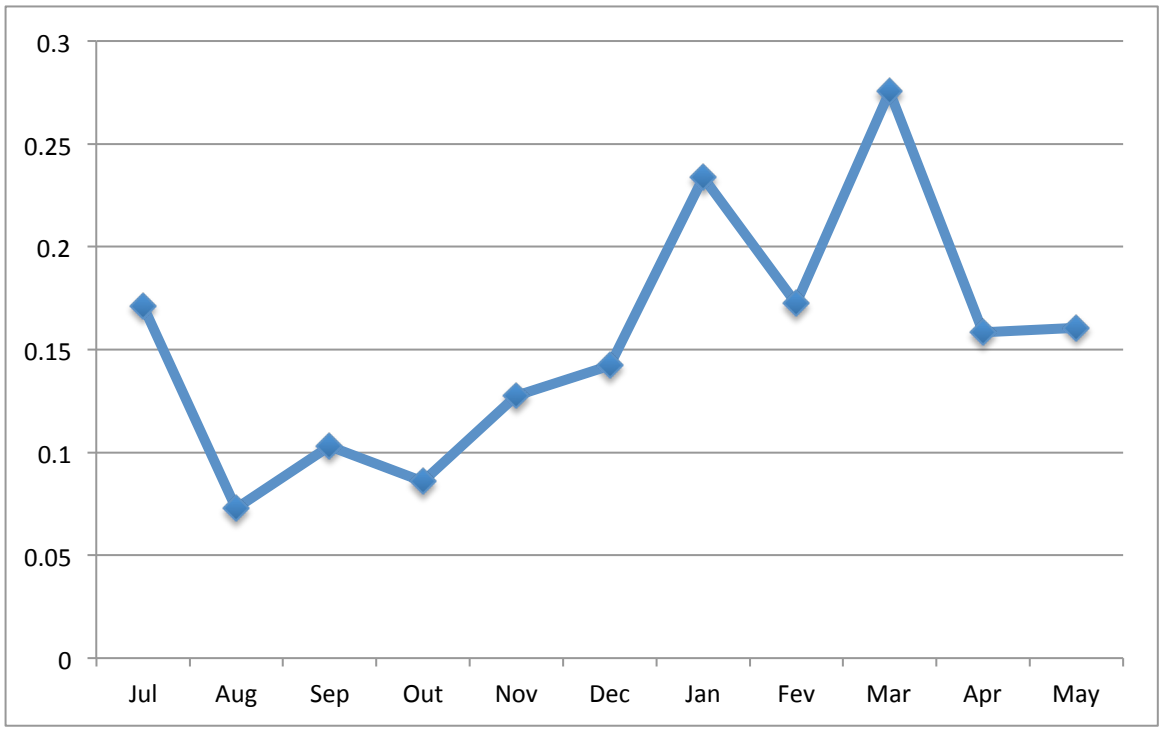

Figure 40 – Percentage of defects per month

Analysing the graphic is possible to tell that in the winter there is a higher rate of failure. This happens because of the bad weather prevents sometimes getting the exact coordinates or connecting with the mobile network.

There were also some problems that solving them could help improve the overall time:

1- The person that was configuring needed to get around the workbench to connect the boards; the solution was to an easier access to the antenna jack.

2- The person waits for the 10 boards to configure, even if all fail to configure; the solution was to make 2 batches of 5 instead a batch of 10.

3- The configuration workbench wasn't followed by the packaging; this problem was solved in the new layout.

5.3.2. Configuring the National board

The process is almost identical; the changes are that this one the SIM card goes with the board and the number of the card is put in Excel worksheet.

Table 10 – Task needed to complete the National Board

Task	Time (s)
Take the boards from the box and write the serial number	158.28
Write on the Excel, change the PIN number and write on the SIM card	647.88
Replace the old boards for the new ones	262.06
Put all the variables into the application	129.32
Execute the application	**1285**
Packaging	581.77
Total Time	3064.31

Dividing the tasks, like was done with the global board, we could get the following times:

Table 11 – Task that can be done while the board is configuring

Task	Time (s)
Take the boards from the box and write the serial number	158.28
Write on the Excel, change the PIN number and write on the SIM card	647.88
Packaging	581.77
Total Time	1387.93

It's possible to check that is possible to prepare and almost do the packaging while the boards are configuring, meaning that isn't any "dead time" by the operator.

Since, in this case, all SIM cards have all different numbers and are sent from the client, it's possible that a SIM card is already activated. This means that can occur another kind of error in the configuration process. Checking the defect from the current version of the board we got these graphs:

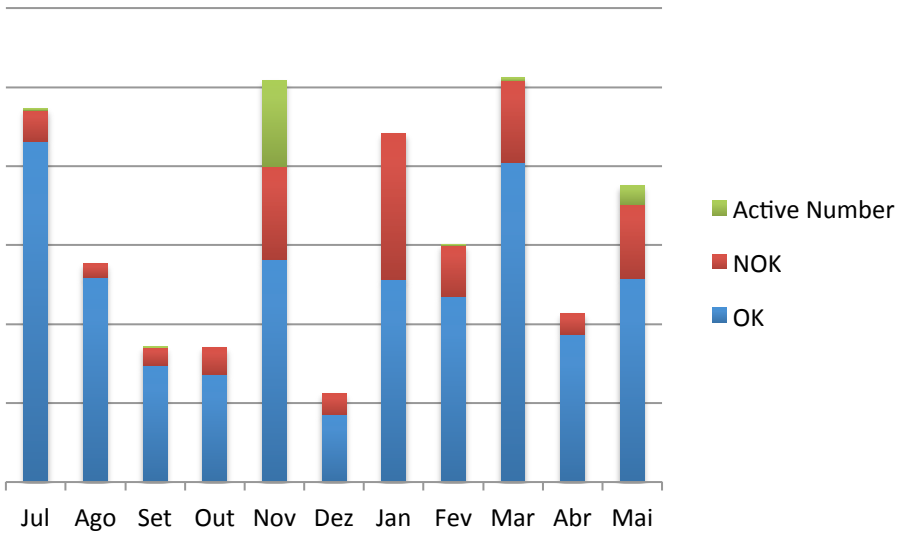

Figure 41 – Number of defects by category

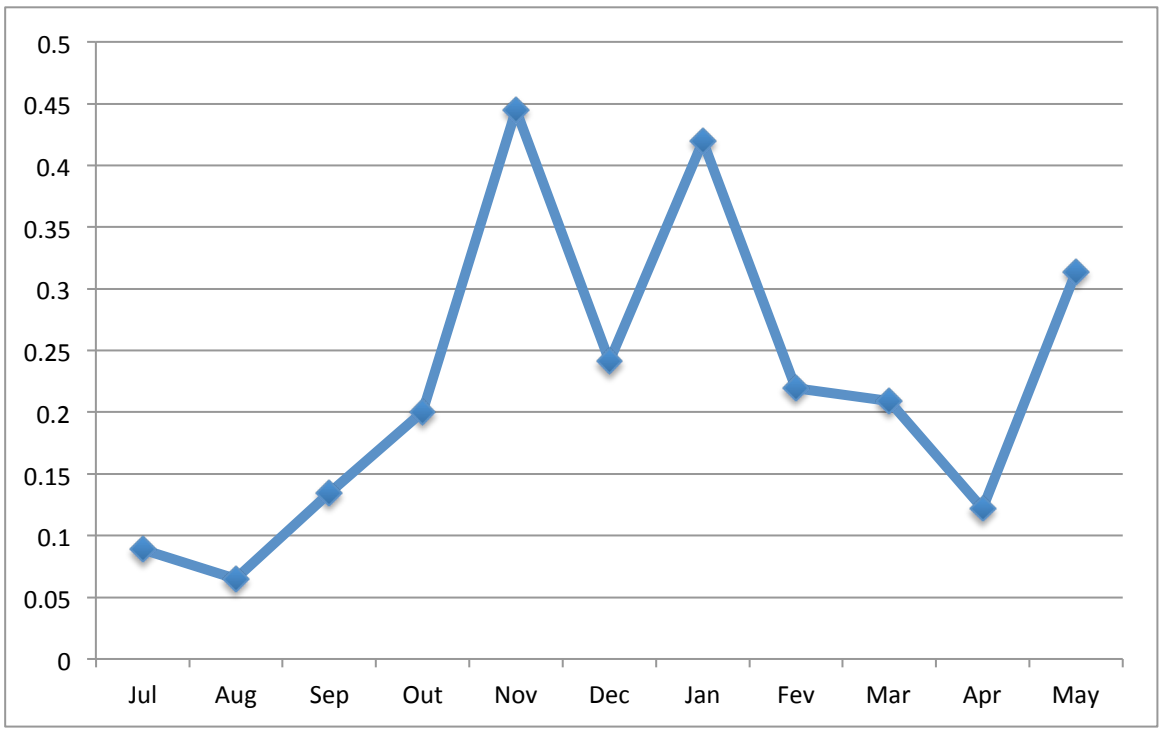

Figure 42 – Percentage of defects per month

Joining the information of the 2 graphs it's possible to see that in November there is a big spike of defects where the SIM card number was already activated. This

means that there was a lot time wasted. This is a loss for LT since was work done that went down the drain.

5.3.3. Conclusion

Since it's in the best interest of the company to reduce the defective products, since it wasting the operator time, thus loosing effectiveness. The company is in fact loosing money in each product that it makes, mainly because it takes too much time to produce one good unit. LT is losing about 10/15 cents in each unit, not counting the electric power and logistic processes.

To help prevent wasting money on active number error maybe was a good idea to do an agreement with the client.

5.4. New Ideas System

To make all the people in company participate on the continuous improvement philosophy, there was suggestion from the management to create a program where all people could give ideas to improve the company. These ideas could be about anything that anyone wanted.

Every quarter there was an updated to the ideas that people gave. These ideas were evaluated, and the best one was praised publicly. In the future is possible that whoever has the best idea would also get some other kind of compensation.

In the annex E there is the paper that was hanged so that everybody could check all the ideas and give an incentive to participate.

6. CONCLUSION AND FUTURE IMPROVEMENTS

In the beginning of this collaboration the main objective was to start the implementation of the 5'S methodology. All the other improvements came after knowing what makes the company tick.

The productive gains are still too early to tell because the change that would have the most impact only finished in the middle of May. But there are positive reviews, especially from clients. This new layout allows an easier integration of new tools, like FIFO of raw materials and Kanban, in each area. In case that there is a change the layout can be transported integrally to the new building.

All the other changes were smaller compared to the redesign of the layout, but also important for the line that they were made. Since most of the lines stopped or there wasn't time after applying the new layout is hard to know the gains of each optimization project. Only allowing calculating theoretical ones.

I think that the main purpose of the dissertation was concluded with success, since there were certain measured gains, and some unmeasured ones.

For future improvement the best thing is to improve how the internal logistics works, because there isn't a defined method. Now the people scream for the raw materials and most of the times are waiting for them to come. This stops the line and it's time that the people aren't doing anything.

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"Implantações". Acessed in the 2nd semester of 2014 in: inforestudante.uc.pt

ANNEX A

IMP.061/C CHECKLIST DE AUDITORIA 5S CABLAGEM								
Responsável da Área: Marco Vaz						Data:		
Auditores:								
Legenda: 1- Tudo mal; 2- Quase tudo mal (+ de 4 Falhas); 3- Metade bem (2/3 Falhas); 4 Quase tudo bem (1 Falha); Completamente bem; n.a.- não se aplica		1	2	3	4	5	n.a.	
1º S SEIRI – SELEÇÃO	- Não há qualquer tipo de material desnecessário nos postos de trabalho ou na área de cablagem?							
	- Existe material obsoleto na área de cablagem?							
	PONTUAÇÃO SEIRI							/ 10
Obs.:								
2º S SEITON – ORGANIZAÇAO	- A área da MÁQUINA DE CORTE encontra-se devidamente arrumada e com todas as ferramentas e caixas identificadas?							
	- A área de trabalho da CRAVAÇÃO encontra-se arrumada e com todas as ferramentas e caixas identificadas?							
	- A área de trabalho da INSERÇÃO encontra-se arrumada e com todas as ferramentas e caixas identificadas?							
	- A área de trabalho da SOLDADURA MANUAL encontra-se arrumada e com todas as ferramentas e caixas identificadas?							
	- Todo o material do TESTE/EMBALAGEM encontra-se arrumado e com todas as ferramentas e caixas identificadas?							
	- A documentação da CABLAGEM encontra-se em bom estado de conservação e organizada?							
	- Todas as matérias-primas encontram-se devidamente arrumadas e identificadas?							
	- Todas as matérias em curso de produção estão devidamente arrumadas e identificadas?							
	- As amostras de CABLAGEM encontram-se devidamente organizadas e identificadas?							
	- Todas matérias em curso de produção contém a etiqueta da fase do processo?							
	PONTUAÇÃO SEIRI							/ 50
Obs.:								
3ºS SEISO – LIMPEZA	- A área da MÁQUINA DE CORTE encontra-se limpa (sem restos de cabos, óleo no chão, etc) ?							
	- A área de CRAVAÇÃO encontra-se limpa (sem resto de terminais, cabos ou outros materiais) ?							
	- A área de INSERÇÃO encontra-se limpa (sem resto de cabos ou outros materiais) ?							
	- A área de SOLDADURA MANUAL encontra-se limpa (sem resto de terminais, cabos ou outros materiais) ?							
	- A área de TESTE/EMBALAGEM encontra-se limpa (sem resto de terminais, cabos ou outros materiais) ?							
	- As amostras de CABLAGEM encontram-se devidamente limpas ?							
	PONTUAÇÃO SEIRI							/ 30
Obs.:								
4ºS SEIKETSU – CONSERVAÇÃO	- A MÁQUINA DE CORTE encontra-se em bom estado (sem ferrugem, a funcionar bem, etc) ?							
	- O posto e as ferramentas da CRAVAÇÃO encontram-se em bom estado (sem fita-cola, ferrugem, etc) ?							
	- O posto e as ferramentas da INSERÇÃO encontram-se em bom estado (sem fita-cola, ferrugem, etc) ?							
	- O posto e as ferramentas da SOLDADURA MANUAL encontram-se em bom estado (sem fita-cola, ferrugem, etc) ?							
	- O posto e as ferramentas da TESTE/EMBALAGEM encontram-se em bom estado (sem fita-cola, ferrugem, etc) ?							
	- Os MEIOS DE TESTE encontram-se em bom estado (sem ferrugem, não estão partidos, etc) ?							
	PONTUAÇÃO SEIRI							/ 30
Obs.:								
5ºS – SHITSUKE DISCIPLINA	- A área da CABLAGEM é uma área em que os outros 4s estão a ser postos em prática, praticando melhoria continua?							
	PONTUAÇÃO SEIRI							/ 5
Obs.:								

(Auditor/a/es)

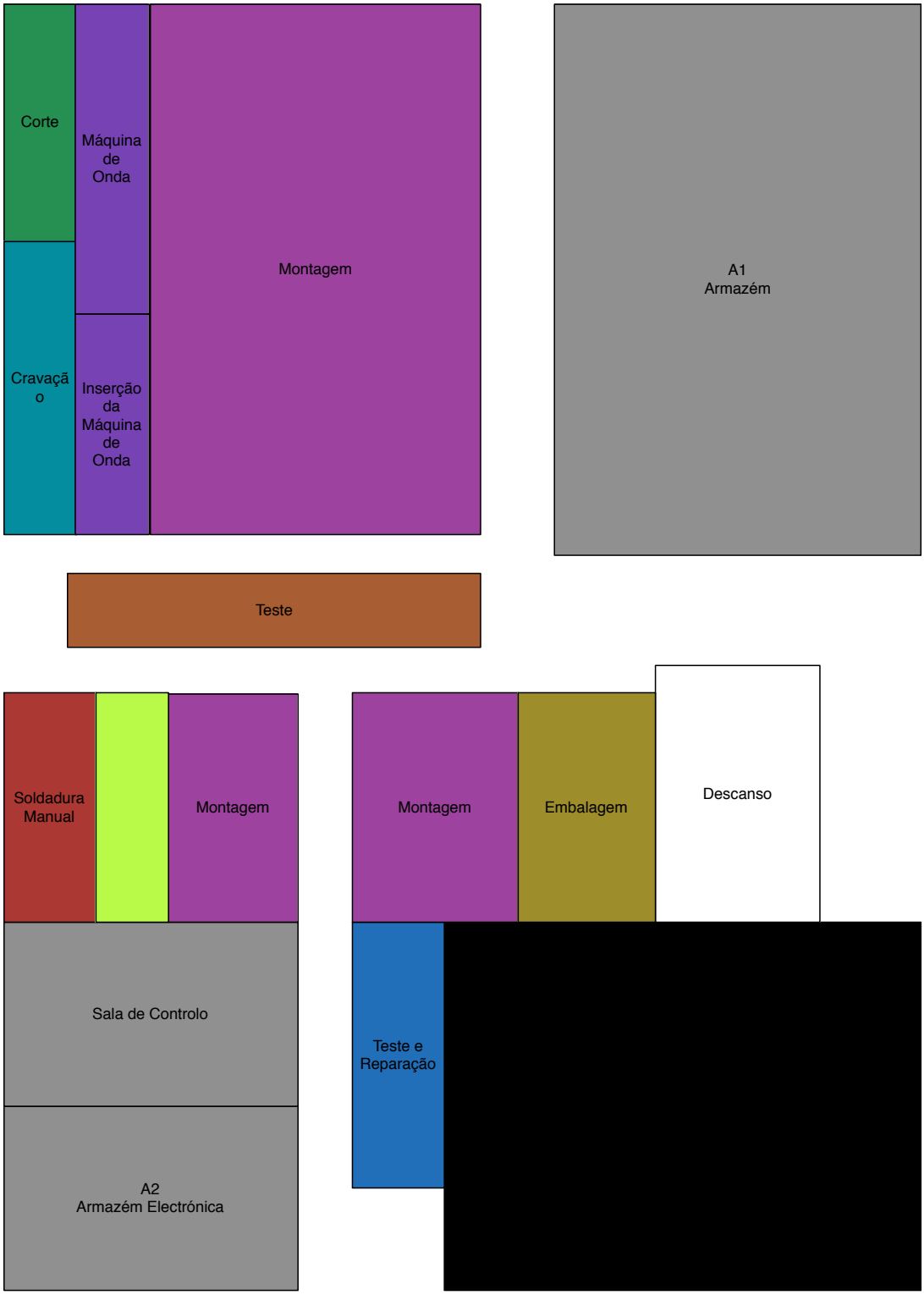
IMP.061/C CHECKLIST DE AUDITORIA 5S ELETRÓNICA								
Responsável da Área: Messias Mortagua		Data:						
Auditores:								
Legenda: 1- Tudo mal; 2- Quase tudo mal (+ de 4 Falhas); 3- Metade bem (2/3 Falhas); 4 Quase tudo bem (1 Falha); Completamente bem; n.a.- não se aplica		1	2	3	4	5	n.a.	
1º S SEIRI – SELEÇÃO	- Não há qualquer tipo de material desnecessário nos postos de trabalho ou na área de ELECTRÓNICA?							
	- Existe material obsoleto na área de ELECTRÓNICA?							
	PONTUAÇÃO SEIRI							/ 10
Obs.:								
2º S SEITON – ORGANIZAÇAO	- A área de trabalho da INSERÇÃO encontra-se arrumada e com todas as ferramentas e caixas identificadas?							
	- A área da MÁQUINA DE ONDA encontra-se devidamente arrumada e com todas as ferramentas e caixas identificadas?							
	- A área da SOLDADURA MANUAL encontra-se devidamente arrumada e com todas as ferramentas e caixas identificadas?							
	- A área do TESTE E REPARAÇÃO encontra-se devidamente arrumado e com todas as ferramentas, caixas e material não conforme identificados?							
	- A área da EMBALAGEM encontra-se arrumada e com todas as ferramentas e caixas identificadas?							
	- A documentação da ELECTRÓNICA está organizada e em bom estado de conservação?							
	- As amostras de ELECTRÓNICA encontram-se organizadas e identificadas?							
	PONTUAÇÃO SEIRI							/ 35
Obs.:								
3ºS SEISO – LIMPEZA	- A área da INSERÇÃO encontra-se limpa (sem restos de peças, pó, etc) ?							
	- A área da MÁQUINA DE ONDA encontra-se limpa (sem restos de solda, óleo, etc) ?							
	- A área da SOLDADURA MANUAL encontra-se limpa (sem restos de solda, peças, etc) ?							
	- A área de TESTE E REPARAÇÃO encontra-se limpa (sem restos de solda, pó de baixo das estantes, peças perdidas, etc) ?							
	- A área da EMBALAGEM encontra-se limpa (sem restos de peças, placas, etc) ?							
	- As amostras de ELECTRÓNICA encontram-se limpas?							
	PONTUAÇÃO SEIRI							/ 30
Obs.:								
4ºS SEIKETSU – CONSERVAÇÃO	- O posto e as ferramentas da INSERÇÃO encontram-se em bom estado (sem fita-cola, ferrugem, etc) ?							
	- A MÁQUINA DE ONDA encontram-se em bom estado (sem fita-cola, ferrugem, etc) ?							
	- O posto e as ferramentas da SOLDADURA MANUAL encontram-se em bom estado (sem fita-cola, ferrugem, etc) ?							
	- O posto e as ferramentas da TESTE E REPARAÇÃO encontram-se em bom estado (sem fita-cola, ferrugem, etc) ?							
	- O posto e as ferramentas da EMBALAGEM encontram-se em bom estado (sem fita-cola, ferrugem, etc) ?							
	- Os MEIOS DE TESTE encontram-se em bom estado (sem ferrugem, não estão partidos, etc) ?							
	PONTUAÇÃO SEIRI							/ 30
Obs.:								
5ºS – SHITSUKE DISCIPLINA	- A área de ELECTRÓNICA é uma área em que os outros 4s estão a ser postos em prática, praticando melhoria continua?							
	PONTUAÇÃO SEIRI							/ 5
Obs.:								

(Auditor/a/es)

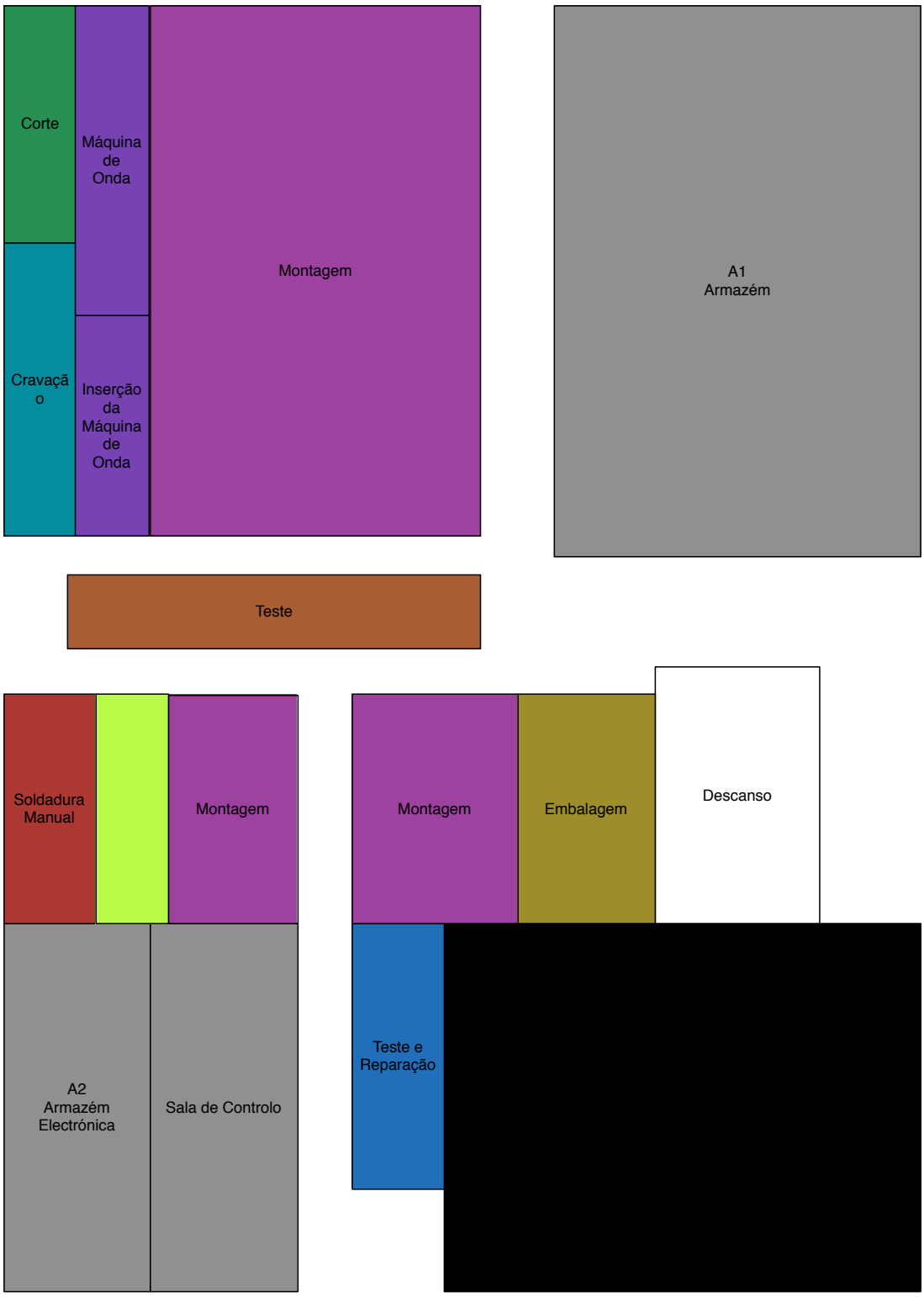
IMP.061/C CHECKLIST DE AUDITORIA 5S MONTAGEM								
Responsável da Área: ELIZABETE OLIVEIRA E VITOR SALGUEIRO							Data:	
Auditores:		Linha:						
Legenda: 1- Tudo mal; 2- Quase tudo mal (+ de 4 Falhas); 3- Metade bem (2/3 Falhas); 4 Quase tudo bem (1 Falha); Completamente bem; n.a.- não se aplica			1	2	3	4	5	n.a.
1º S SEIRI – SELEÇÃO	- Não há qualquer tipo de material desnecessário nos postos de trabalho ou na área da MONTAGEM?							
	- Existe material obsoleto na área da MONTAGEM?							
	PONTUAÇÃO SEIRI							/ 10
Obs.:								
2º S SEITON – ORGANIZAÇAO	- A linha de MONTAGEM encontra-se com as matérias-primas arrumadas e identificadas?							
	- A linha de MONTAGEM encontra-se com as ferramentas arrumadas e identificadas?							
	- A linha de MONTAGEM encontra-se com os produtos em curso de produção arrumados e identificados ?							
	- A linha de MONTAGEM encontra-se com a documentação organizada e arrumada?							
	- A linha de MONTAGEM encontra-se com as caixas bem dimensionadas?							
	- As amostras de PRÉ-MONTAGEM e MONTAGEM estão devidamente arrumadas e identificadas?							
	PONTUAÇÃO SEIRI							/ 30
Obs.:								
3ºS SEISO – LIMPEZA	- O chão da linha de MONTAGEM encontra-se devidamente limpo (sem resto de peças, pó, etc) ?							
	- A área de MONTAGEM encontra-se devidamente limpa (sem peças espalhadas, papeis espalhados, etc) ?							
	- As amostras de PRÉ-MONTAGEM e MONTAGEM estão devidamente limpas?							
	PONTUAÇÃO SEIRI							/ 15
Obs.:								
4ºS SEIKETSU – CONSERVAÇÃO	- O posto da MONTAGEM encontra-se em bom estado (sem fita-cola, ferrugem, etc) ?							
	- As ferramentas da MONTAGEM encontram-se em bom estado (sem fita-cola, ferrugem, etc) ?							
	- A área de MONTAGEM tem produtos semi-acabados sem estarem protegidos?							
	- Os MEIOS DE TESTE encontram-se em bom estado (sem ferrugem, não estão partidos, etc) ?							
	PONTUAÇÃO SEIRI							/ 20
Obs.:								
5ºS – SHITSUKE DISCIPLINA	- A área da MONTAGEM é uma área em que os outros 4s estão a ser postos em prática, praticando melhoria continua?							
	PONTUAÇÃO SEIRI							/ 5
Obs.:								

(Auditor/a/es)

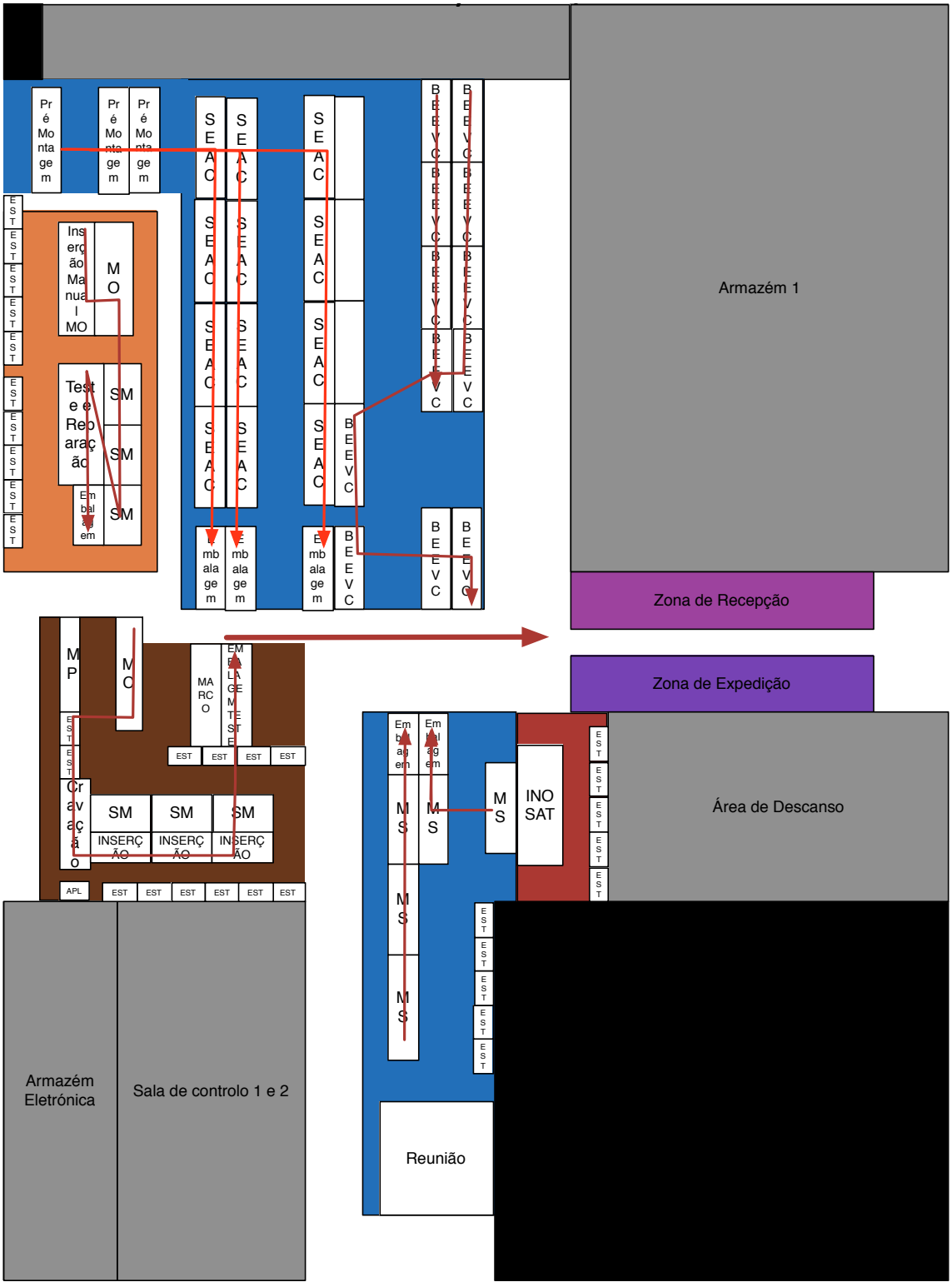
ANNEX B


Corte
Máquina de Onda
Montagem
Cravação
Inserção da Máquina de Onda
A1 Armazém
Teste
Soldadura Manual
Montagem
Sala de Controlo
A2 Armazém Electrónica
Montagem
Embalagem
Descanso
Teste e Reparação

ANNEX C


Corte
Máquina de Onda
Montagem
Cravação
Inserção da Máquina de Onda
A1 Armazém
Teste
Soldadura Manual
Montagem
Montagem
Embalagem
Descanso
A2 Armazém Electrónica
Sala de Controlo
Teste e Reparação

ANNEX D


Armazém 1
Zona de Recepção
Zona de Expedição
Área de Descanso
Armazém Eletrónica
Sala de controlo 1 e 2
Reunião
Inserção Manual
MO
Teste e Reparação
SM
Embalagem
SEAC
BEEVC
MP
MARCO
EMBALAGEM TESTE
Gravação
INSERÇÃO
APL
EST
MS
INOSAT

ANNEX E

Lista de Ideias

Trimestre	Colaborador/a	Descrição da sugestão	Processo	Classificação	Estado	Notas	Observações	Data proposta de fim
4T13	Bruna	1- Remodelar o escritório (Dividir em 2)	Geral	●●●●●	A	Realizado	Menção Honrosa	
		2- Registo também em papel das saídas do armazém	Logística/ Compras	×	R	Actualmente não acrescenta mais valia ao processo		
		3- Fazer verificação periódica das ferramentas de cada colaborador	Produção	●●●○○	A	A implementar no futuro (quando for oportuno)	Menção Honrosa	
		4- Adquirir um aspirador industrial	Geral	●●●●●	R	Analisa-se na sugestão 15)		
	João Melo	5- Tabuleiro para a máquina de corte	Produção	●●●●●	A	Em Implementação		30/04/14
		6- Aumentar a capacidade de guardar setups na máquina de corte	Produção	●●●●●	EA			
1T14	Messias	7- Caixas para armazenar amostras da electrónica	Produção	●●●●○	A	A implementar no futuro; requer análise de investimento		
	Dulcinea e Bruna	8- Suporte para os cartões de controlo	Geral	×	R	Não há espaço na parede		
	Laudelina	9- Melhorar a zona de descanso	Geral	×	R	Melhorar que aspecto? (concretizar)		
	Nelson e Tiago	10- Computadores mais rápidos para o teste	Produção	●●●○○	EA			
		11- Melhorar a luminosidade na área de teste	Produção	●●●○○	EA			
	Céu	12- Forrar as mesas de trabalho	Produção	●●●●●	A	Em estudo (5S)	Menção Honrosa	2T14
	Rute	13- Ajustar a altura das mesas de trabalho ao trabalho realizado	Produção	●●●●○	EA			
	Lisete	14- Armário para guardar os objectos pessoais para todos	Geral	×	R	Não há espaço, requer investimento; porque não partilhar os cacifos?		
	Bruna	15- No final de cada mês aspirar a fabrica (limpeza mais profunda)	Produção	●●●●●	A	Está-se a analisar fornecedores e preços		
		16- Fazer um segundo andar na zona de descanso	Geral	×	R	Não há espaço (devido à ponte rolante)		
	Lisete e Bruna	17- Fazer novos turnos para almoço	Geral	●●●○○	EA			
2T14	Bruna	18- Limpeza uma vez por ano dos baldes de lixo	Geral	●●●●●	A			
		19- Crachás para segurar os cartões de controlo	Geral	●●●○○	EA			
	Cidália Roseiro	20- Haver uma passagem na cablagem (inserção e soldadura)	Produção	●●●●●	EA			
	João, Nelson e Marco	22- Arranjar o exterior	Geral	●●●○○	EA			
	Marco	24- Pintar o chão das áreas com as cores dos processos	Produção	●●○○○	EA	Em análise a solução de atribuição de cores para cada processo produtivo		
		25- Esquentador para a casa de banho	Geral	x	R	Situação da responsabilidade do senhorio		
		26- Paineis solares	Geral	x	R	Situação da responsabilidade do senhorio		
		27- Reformular parque de estacionamento para mais carros	Geral	●●○○○	R	O modelo actual é o que tem maior capacidade de estacionamento		
3T14								
4T14								

A- Aprovada
PA - Parcialmente Aprovada
R - Rejeitada
EA - Em Análise