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OPTIMIZATION OF LAYOUT, PROCESSES AND TRACEABILITY

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1.0. Introduction

1.1. Problem Statement

Nowadays, in a world where the customers are always more informed and demanding, the good organizing of a company's methods of labor is the most important factor in the well development of the working procedure and the quality of the finalized products. A company should be work in according to a organizational development in which a series of actions are taken by a process owner to identify, analyze and improve existing business processes within an organization to meet new goals and objectives, such as increasing profits and performance, reducing costs and accelerating schedules. However, the absence of these useful methods in different sections can lead to an improper working environment and less match of customer and consumer needs.

1.2. Objective Target

The aim is to Optimize the production. There were three projects assigned at Roulunds Braking. The first one regarding the measurements of an Extruder, where a reduction of the amount of fins was required. In the second one the purpose is to implement a system of Traceability for the raw materials. The third one is about creating a new layout for the pilot plant. Each project is discussed individually further.

1.3. Procedural Method

The outline of the project consists of the following topics which will be answered in the subsequent text as far as possible: the presentation of Roulund Brakings and the project team, the illustration of project management tools, the description of the current process and the lay-out of the pilot plant, the analysis of the extruder and measures to find a way to improve its performance and finally the implementation of a system of traceability of the raw materials. Thus the report is divided in three major chapters that are the presentation, the project management tools and the procedures that we have used in order to improve the current situation.

2.0. Presentation

2.1. Presentation Of MAT Holdings

MAT Holdings, Inc. is a global manufacturer and strategic supplier to home improvement centers, mass merchants, hardware and farm cooperatives, wholesale distributors, food and drug, original equipment manufacturers and original equipment service providers.

MAT Holdings, Inc. was established in 1984. The global headquarters are located in Long Grove, IL USA, while having several production facilities in Asia, Europe and the United States. Their services include U.S. and overseas engineering, quality assurance, logistics support, strategic warehousing, bi-lingual sourcing, and in-house customer service, marketing, packaging design and product development teams. With manufacturing operations on three continents and 210,000 sq. m. of U.S warehousing and manufacturing space, MAT offers a matrix of supply chain management solutions to meet every need[1].

2.1.1. Roulunds Braking ApS

Roulunds Braking was founded in 1736 in Denmark. Started braking activities in 1926 and finally became Roulunds Braking in 2003 after joining MAT group. Is one of the world's leading manufacturers of high quality friction materials to the automotive industry, with sales and customers worldwide.. As an integrated friction manufacturer of brake pads, brake shoes, brake plates, brake linings and shims, Roulunds Braking supplies some of the world's leading vehicle manufactures and aftermarket brands; with over 2,500 employees worldwide, with steady growth. Manufacturing facilities are located in Europe, Asia and North America. Their products are sold by private label customers in the North American market and the

[1] cf.(authorless MAT holdings 2011)

European market. Among the customers served by Roulunds braking we have BSCH, Ford, Jaguaar, Land Rover, Volvo , Suzuki, Volkswagen and many other.

In the industry in Denmark they produce brake pads and brake linings, designed and developed to have an excellent braking performance. The R&D department is also located in Denmark with a chemical lab, pilot plant, dynamometer test and vehicle test facilities. The strategy of the R&D department is to be at the forefront of developing products that minimize environmental impact. Roulunds does not manufacture any formulas with lead compounds or asbestos for any market place, this ensures not only a "safe" product but also eliminates possible cross contamination[2].

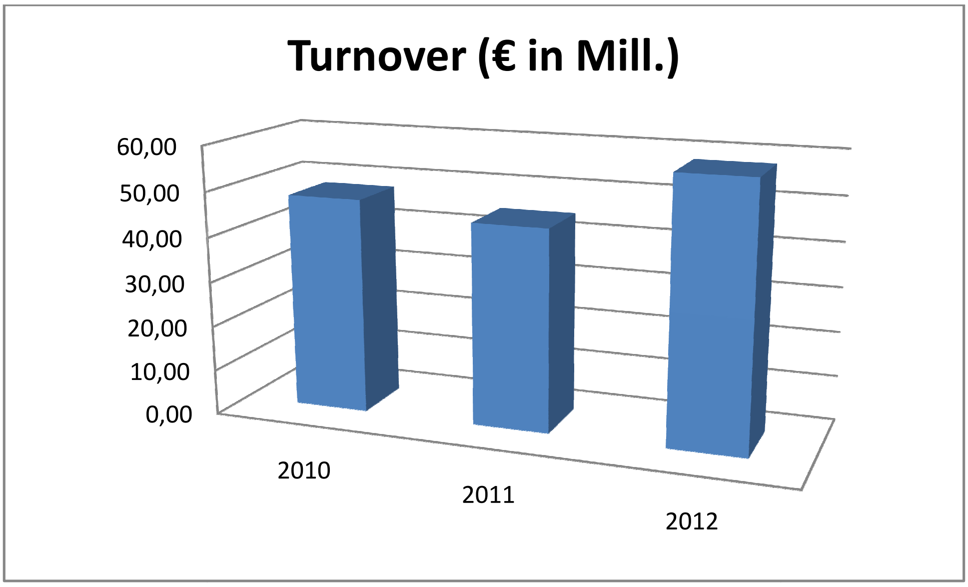


Figure 1 Turnover Roulunds Braking

[2] cf.(Authorless roulunds braking 2011)

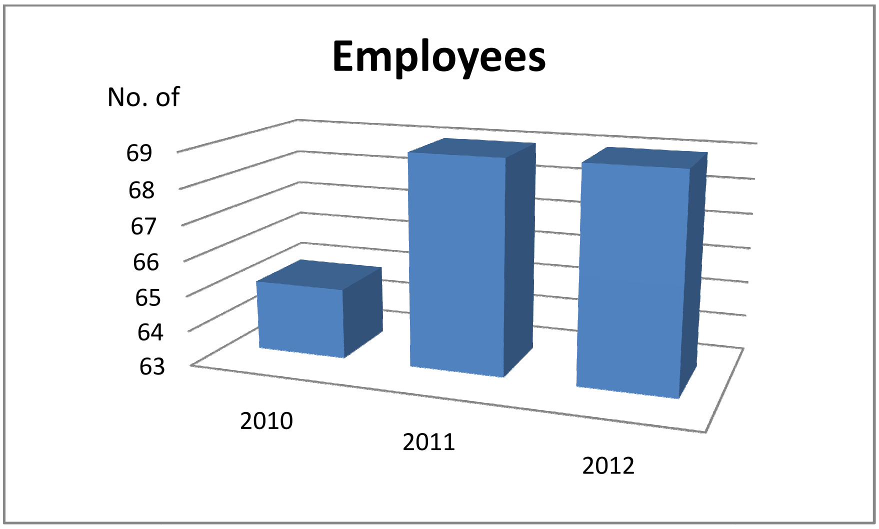


Figure 2 Employees Roulunds Braking

As it is possible to see in the Figure 1 and 2 above Roulunds Braking had a slight drop in the last year (with a reduction of 3 million of euro of the turnover), but the prevision for this year are very encouraging, it aims to achieve a turnover close to 60 million. This data appears to be confirmed and correlated also to the number of employees that in the last year are increased of the 6%.

2.2. Description Of The Project Task

The projects were determinated in cooperation with Nicholas Ishii-Dodson, manager of Research and Development at Roulunds Brakin. The goal of all three projects is Industrial Optimization and enhancement of existing machines or production flow.

The first project is measurements of the extruder. The machine is an ALTEC roll former. Its physical parameters are not defined and there is an excessive amount of waste, which is called "fins" for short. The task is to find a way to measure those physical parameters and see if they are the reason for the surplus material. The goal is to find a way to reduce the surplus material by 50%.

The second project is traceability. Claims and production process problems cannot be handled/executed the right way since raw materials, processes and production parameters cannot be traced through the process. The task is to establish a way to make a large and organized system for labeling. The goal is to document the labeling, weighting, which sub goals include collection of the existing data, finding a way to transfer the data to a system, create label barcode and search for suppliers which can do all of the above.

The third project is Pilot Plant Layout. Working in a pilot plant area involves a lot of unnecessary handling and movements of raw materials, tools and finished goods due to lack of flexibility process wise and flow wise. The task is to create a new Pilot plant Layout with the goal of achieving a very visual process flow.

2.3. Presentation Of The Project Members

2.3.1. Alessandro

He is a 24 years old student from the University of Florence, Italy. He graduated in the April of 2010 in Management Engineering and now he is doing a master's degree in Management Engineering. He did a internship when he finish is bachelor where he has analyzed the degree of implementation of PLM (product-lifecycle-management) in the Italian shipyard. In his last year of studying he decided to come to the SDU, obviously to improve his English skills and also because a lot of people of his university recommended it to him. He thinks this exchange study is important both in terms of university education and life experience. He was here also in the first semester and he did a project in Coop where the aim was to improve the current packaging methods that are applied inside the warehouse and create a better working strategy that can increase productivity and satisfaction of the customer demand.

2.3.2. Angel

He is a 22 years old student and studies Industrial engineering in Technical University of Sofia. At the moment he is in his final 8th semester, doing an intership at Southern University of Denmark, where he takes a course in Supply chain management and does a project in Roulunds Braking. He decided to come and study abroad, because he wants to improve his english skills, meet new people and change the atmosphere around him. Next year he wants to sign up for a master program in Industrial Engineering/Manufacturing abroad.

2.3.3. Ignacio

He is 25 years old and he is doing his final project of the mechanical engineering degree at the University of Zaragoza, Spain. Besides, he is enrolled in some courses about manufacturing and management at university of Southern Denmark to expand his knowledge. He did an internship of 6 months in the logistics department of a steel distribution company. He came to study at the University of Southern Denmark because he needed to improve his English, he wanted to experience the life in a different country and to participate in a project group to learn things about team work. The main motivation for choosing the project in engineering management is because he is more interested in logistics and management than in mechanical engineering, so he needed the experience and knowledge he can't get in his own degree.

2.4. Belbin Roles In Our Project Team

2.4.1. Alessandro

Alessandro achieved his highest scores in the Belbin test as a specialist with around 95 % and as a team worker with about 75 % meaning that he has a very professional way of working and making projects and that he is auxiliary and interested in his team colleagues. Furthermore, his strengths are his pleasant and cooperative attitude and his eagerness to get along with his fellows. Like a mentor, Alessandro can train the team in learning new and complex skills and help the team members to develop their selves. He supports the team in achieving its goal by contributing his knowledge as a technical expert. You can describe him as a well-outfitted team player who has the acquirement to provide well-informed aid and advice. Alessandro is less suitable for the role as a team leader, because the pressure and competition might get him down over time. He also does not have the characteristics of a hard-driving manager compassing results by power and force[3]

2.4.2. Angel

Angel achieved his highest scores in the Belbin test as a team worker with around 80% and as an implementer about 75 % meaning that he does the things that need to be done, whether in terms of the work to be performed or in providing general assistance. Furthermore, his strengths are: he prefers to support others rather than lead, he has a pleasant and accommodating attitude. He is also above the average in terms of self organization and control. He may be uncomfortable when having to deal with pressure. Angel's profile suggests to be placed him in a job that has been well thought out and can be clearly presented. A training course or a period of careful supervision would be useful precursors to leaving Angel in the job unattended. [4]

2.4.3. Ignacio

Ignacio achieved his highest scores in the Belbin test as a specialist with around 97% and as a team worker with about 95 %, meaning that he has pride in professionalism and an interest in people emerges. Is keen on getting on well with colleagues, fits well into teams and is able to dedicate him to a particular line of work. Furthermore, his strengths are he is keen on getting on well with colleagues, fits well into teams and is able to dedicate himself to a particular line of work. Like a mentor, Ignacio can train the team in learning new and complex skills and help the team members to develop their selves. He supports the team in achieving its goal by contributing his knowledge as a technical expert. You can describe him as a well-outfitted team player who has the acquirement to provide well-informed aid and advice. Ignacio is less suitable for the role as a team leader, because the pressure and competition might

[3] cf. (Potential, Belbin Test, 2011)
[4] cf. (Potential, Belbin Test, 2011)

get him down over time. He does not have the characteristics of a hard-driving manager compassing results by power and force[5].

2.4.4. Conclusion Of Belbin Test

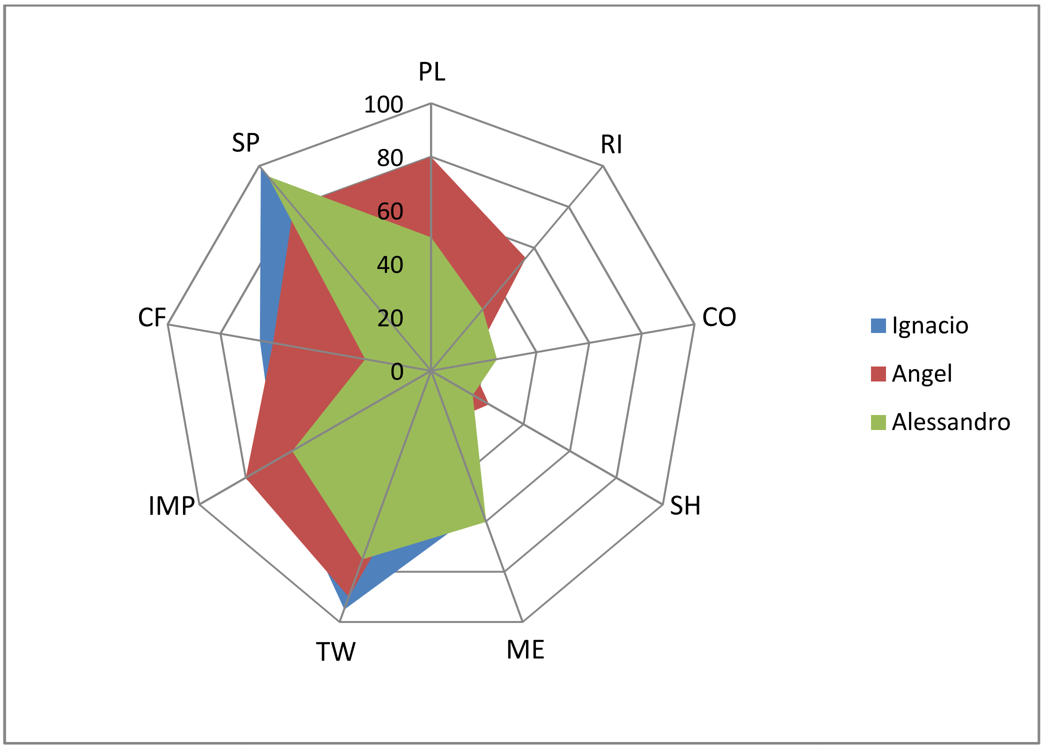


Figure 3 Result of Belbin Test for the team

PL=Plant
RI=Resource Investigator
CO=Co-ordinator
SH=Shaper
ME=Monitor Evaluator
TW=Team worker
IMP=Implementer
CF=Completer Finisher
SP=Specialist

The overall conclusion regarding this team, from the Belbin test, is that no one fits for a shaper and Co-ordinator. This roles are divided between the team regarding

[5] cf. (Potential, Belbin Test, 2011)

each task, which it is assigned individually .All have good qualities in Teamwork, Implementer as well as Specialist. In the other positions there is always one person who has good qualities at that position as well. The team works well together. The strengths of the team are that all its members have a pleasant and accommodating attitude, can adjust to each other's needs or wants. The only cons are the Co-ordinator's and shaper's role rotate in between the team so no stable leadership is established.

2.5. The Gantt Chart

A Gantt chart is a tool of the project management to illustrate the chronological progression of activities in terms of bars on a timeline graphically. It was named after its developer Henry Laurence Gantt (1861-1919) who was a management consultant. The Gantt chart is very helpful for monitoring projects, planning, and scheduling.[6]

2.5.1. Composition and structure

In a Gantt chart the activities of a project are inscribed in the first column of a table. The first row of the table presents the time axis subdivided in days, weeks or months. Then, the single activities are visualized in the particular rows through a horizontal bar. The longer the bar, the longer an activity takes. Coinciding activities are represented by overlapping bars. The illustration of critical paths is also possible. Arrows are often used to clarify dependencies between different activities. So, if you have a huge amount of activities the diagram will easily get confusing.[7]

2.5.2. Variants

The Gantt chart consists of several variants, like, for example, milestones, resources, status, and dependencies. Milestones are subordinate targets of a project. These goals are linked to the completion of an important project result. In the resource column all team members are registered being responsible for the particular task. The status is the project process, whereby the diagram is updated by filling in the work finished

[6] cf. (Authorless, Gantt Charts)
[7] cf. (Authorless, Gantt Charts)

until now. You can see by looking at the dependencies which activity needs to be finished first until another activity can be started.[8]

2.5.3. Advantages and disadvantages

Advantages of the Gantt chart are e.g. that the durations of the activities are visually reflected by the length of the bars. Furthermore, end-start-relations can also be attached during the progress of an activity in the Gantt chart.

2.6. Team rules

How well the team works together is determined by the rules whereupon the team members should act. Out of the multitude of rules, those should be documented in written form having the greatest importance to the cooperation between the team members. These are usually seven to fifteen rules or standards that must not be violated. By the obedience of them the team will ensure that the project runs smoothly and conflicts are identified early. The benefits of formal rules are that each team member knows them in advance and has the same goal to pursue. In this regard they are the team constitution. These rules should be hanged out in the project room so that everyone of the team can see and read them and be signed by each team member

2.7. Evaluating Alternative

When there are different solutions, the problem is to decide which one of the alternatives is the best that fulfils the company needs. There are several ways for doing this. The one chosen in this project is the “Factor analysis method”.

The factor analysis method follows the engineering concept of breaking down the problem into its elements and analyzing each one. This makes it more objective. Essentially, the procedure involves the following:

[8] cf. (Authorless, Gantt Charts)

1. List all of the factors which are considered important or significant in deciding which solution to select:

These are the things that are important to achieve. They also are termed criteria or objectives. They point is, they should be established, preferably by one person (in our case Nicholas) listing them and defining them briefly.

2. Weigh the relative importance of each of these factors to each other:

Established the weight values for each factor is usually a joint decision often involving fairly important members of management. Perhaps the most effective way of actually setting values is to pick out that factor which is considered the most important, give this most-important factor a value of 5; and relate the weight of each of the other factors to 5. Get agreement on these values before going ahead.

3. Rate the alternative solutions against one factor at a time:

Always rate across the form, considering each of the plans for one factor at a time. This allows maintaining a constant interpretation of each factor for the various solutions. And regardless of how honestly objective we try to be, there is always the tendency to have a preference for one plan or another. By rating across and by using letters rather than numbers during the rating process, we help ourselves and others avoid this temptation.

RATING CODE AND VALUES		
Vowel Coding	DESCRIPTION OF RATE	Numerical value
A	Almost Perfect--(Excellent)	4
E	Especially Good--(Very Good)	3
I	Important Results Obtained--(Good)	2
O	OK, Ordinary Results--(Fair)	1
U	Unimportant results--(Poor)	0
X	Impossible	

Table 1 Rating codes and values

The simple vowel-letter coding used throughout is used as above for assigning values to ratings.

4. After the rating has been done for all factors for all solutions, we convert the letter rating to a numerical value. This is done my multiplying the weight factor by the numerical value of the letter rating. After extending the numbers, the total numerical value is added up for each plan[9].

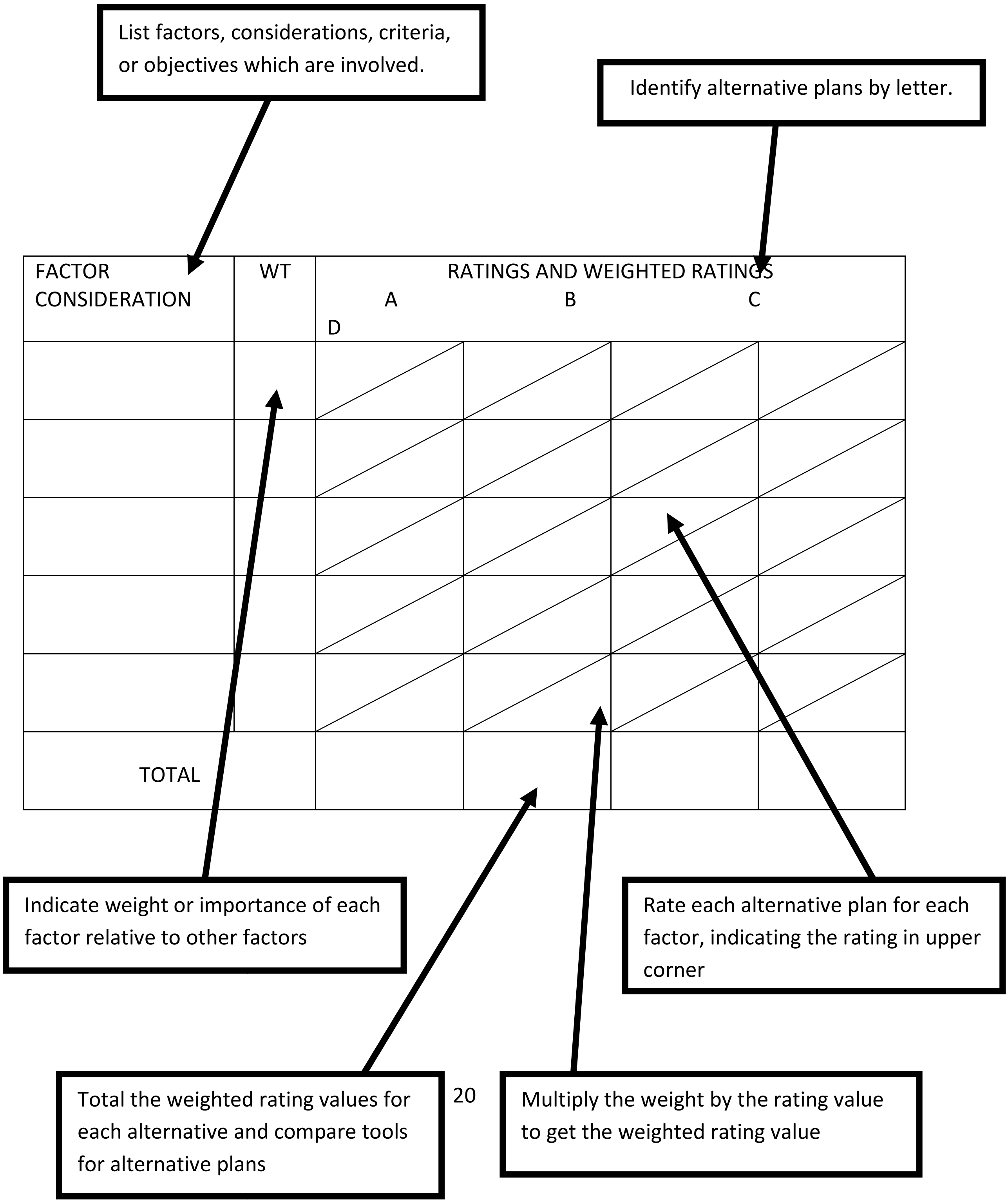
At this, what will usually happen is one or more of several things:

- One solution will be clearly the best.
- Two solutions will actually come out very closely. In this case, revaluation of those alternatives, involving more factors, is a good way.
- During the rating process we discover that a combination of two or more of the solutions can be worked out. This means that we must make a replica of

[9] cf (Systematic Layout PLanning)

that solution, and by addicting another column to the form, we rate the new combination on the same basis as the others.

This method of evaluating is highly flexible yet it is precise even though its accuracy is based on a series of judgments or estimates of probability. To understand better below there is an example of the final table that is created to make the evaluation with the factor analysis method:



3.0 Measurement of the Extruder

3.1 Introduction to Brake linings

3.1.1 Industrial utilization

The purpose of friction brakes is to decelerate a vehicle by transforming the kinetic energy of the vehicle to heat, via friction, and dissipating that heat to the surroundings. As a part of a commercial truck or automobile, brake materials have additional requirements, like resistance to corrosion, light weight, long life, low noise, stable friction, low wear rate, and acceptable cost versus performance.

The design of the brakes affects heat flow, reliability, noise characteristics, and ease of maintenance. History records the use of many kinds of materials for brakes (‘friction materials’). For example, wagon brakes used wood and leather. In fact, many current brake materials still contain organic-based materials, like polymers and plant fibers. Emerging railroad technology in the 1800’s required brake materials to perform under high loads and speeds. Friction experiments were conducted with iron brake shoes in the 1870’s.

Material Description	Application(s)	Approximate Year
Cast iron on steel	railroad car brake blocks and tires	prior to 1870’s
Hair or cotton belting (limited by charring at about 300° F)	wagon wheels and early automobiles	ca. 1897
Woven asbestos with brass and other wires for increased strength and performance	automobiles and trucks	ca. 1908
Molded linings with shorter chrysotile fibers, brass particles, and low-ash bituminous coal	" " "	ca. 1926
Dry-mix molded material to replace cast iron brake blocks that produced metallic dust that shorted electric train rails	London underground	ca. 1930
Flexible resin binders developed along with more complex formulations	brake drum linings	1930’s
Resin-bonded metallic brake linings	industrial and aircraft applications	1950’s
Glass fibers, mineral fibers, metal fibers, carbon and synthetic fibers to provide semi-metallics with higher performance than asbestos (beginning of safety issues with asbestos)	automotive and trucks	1960’s
Non-asbestos (fiberglas) materials	brake drums on original equipment cars	1980’s
Suggested use of carbon fibers	automotive brakes	1991

Figure 4 History of brake linings

3.1.2 Main types of materials

Brake linings are composed of a relatively soft but tough and heat-resistant material with a high coefficient of dynamic friction (and ideally an identical coefficient of static friction) typically mounted to a solid metal backing using high-temperature adhesives or rivets. Brake linings for an automotive brake system represent one of the most complicated compositions of materials since they contain numerous ingredients that are diverse in physical and chemical properties. They have many disparate ingredients such as polymers, ceramics and metals. This is because they have been developed to satisfy a number of requirements such as resistance, high temperature friction stability, no noise, and no vibration at wide rages of braking conditions. A great deal of effort has been given to the development of multiphase composites for a brake lining since a single material or a composite with a few ingredients has never been successful to meet the numerous performance related demands[10].

The complete assembly (including lining and backing) is then often called a brake pad or brake shoe. The dynamic friction coefficient "µ" for most standard brake pads is usually in the range of 0.35 to 0.42. This means that a force of 1000 Newtons (or pounds) on the pad will give a resulting brake force close to 400 Newtons (or pounds). There are some racing pads that have a very high µ of 0.55 to 0.62 with excellent high temperature behavior. These pads have high iron content and will usually outperform any other pad used with iron discs. Unfortunately nothing comes for free, and these high µ pads wear fast and also wear down the discs at a rather fast rate. However they are a very cost effective alternative to more exotic/expensive materials

One can group brake materials and additives based on their expected functions as follows:

[10] cf. (The Application of Neutron Activation Analysisto the Measurement of the Wear of a Friction Material)

- Abrasives
- Friction Modifiers
- Fillers and Reinforcements
- Binder Materials

There is a little ambiguity in this categorization. Some of the additives can be placed into more than one category since they fulfill several functions. Consequently, there are some unavoidable overlaps in the tabular listings. In addition to the basic brake materials, some porosity (5-10% or more) is normally present.

To analyze the role of additives in friction and wear control, it is insufficient to simply know their composition, since their form, distribution, and particle size can affect friction and wear behavior. For example, rounded beads of a hard, abrasive material can have a different effect than angular grits on the formation and stability of the friction-induced surface films that control stopping behavior.

- Abrasives - Abrasives help maintain the cleanliness of mating surfaces and control the build-up of friction films. They also increase friction, particularly when initiating a stop (i.e., they increase "bite").
- Friction Producers / Modifiers - These materials lubricate, raise the friction, or react with oxygen to help control interfacial films[11].
- Fillers, Reinforcements, and Miscellaneous - Fillers are used to maintain the overall composition of the friction material, and some have other functions as well. They can be metals, alloys, ceramics, or organic materials. Cashew-containing friction dust is said to have the ability to absorb the heat created by friction while retaining braking efficiency. It is a major export product of India and the Asian subcontinent. The supposed advantage of cashew resin, compared with plain phenolic resin, is that it produces a softer material which is more efficient for wear when the brakes are relatively cold, as in

[11] cf.(Friction Additives," Product literature, Arnoldstein, Germany)

temperatures generated by lower speed automobiles. Cashew friction dust is a granular, free flowing polymerised resin derived from Cashew Nut Shell Liquid (CNSL). The main component in processed cashew nutshell liquid (CNSL) is cardanol, a naturally occurring, meta-substituted alkenyl phenol similar to nonylphenol. Cardanol is hydrophobic in nature and remains flexible and liquid at very low temperatures[12].

- Binder (Matrix) Materials- Typical binder materials are phenolic resins

Asbestos has had a historical role as a brake additive, but now it is not used because is hazards. It is hydrated magnesium silicate $Mg_3Si_2O_5$ $(OH)_4$. When it is used, the content of asbestos in vehicle brakes varies between about 30-70%. According to Nicholson (1995), the positive characteristics of asbestos are: (1) asbestos is thermally stable to 500°C above which it produces silicates, (2) asbestos helps regenerate the friction surface during use, (3) silicates produced by asbestos are harder and more abrasive that asbestos, (4) asbestos insulates thermally, (5) it processes well, (6) it wears well, (7) it is strong yet flexible, and (8) asbestos is available at reasonable cost. The fibrous character remains intact until about 14OO'C. According to Spurr (1972), asbestos becomes dehydroxylated at high temperatures. It tends to transform to forsterite and silica above 810' C. The wear debris contains forsterite or amorphous material. The kinetic friction coefficient of asbestos against clean iron is - 0.80. The type of asbestos used is important because of differences in cost, properties, and processing. Chrysotile is normally used but other asbestos minerals, amosite and crocodolite, may be used.

Chrysotile makes up approximately 90%-95% of all asbestos contained in buildings in the United States[13]. Three other types (Anthophyllite, Tremolite, and Actinolite) are rarer and found mainly as minor contaminants along with other minerals.

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[12] cf. (Fillers in Friction Materials)
[13] cf. (http://www.dehs.umn.edu/asbestos/)

3.2 Description of the project

The main goal of the project is to find which parameter affects the production of waste material and find a way to reduce the fins by 50%.

The first step was to determine the critical parameters that have an effect on the brake linings. Those are Pressure and Temperature. It is not possible to change the first, only the second one.

The next step was to find a way to measure the temperature. It was done by using a thermocouple cable, a thermocouple head and an electronic thermometer. By doing this we observed if the temperature does indeed have an effect on the waste material that is produced. We concluded that it did.

Afterwards the analysis was focused on which temperature was the most preferred one (higher or lower) and find some way to reduce the size of the "fins". A mechanical solution was proposed with a second "tooth", as well as a chemical one: changing the compound proportions or the ingredients in it to make the material properties change (softness or fragile) without affecting the friction coefficient.

3.2.1 Analysis of the process

The process starts by producing a mix of ingredients, in a facility next to the machine. The size of each batch is 200 kg, after that the mix is moved to a lift which is situated on the back side of the extruder. The container is lifted with a speed around 2m/s and poured in a mixer/tube. After that the material goes down in a tube and enters in a pipe with a screw, inside of which the material is divided into small portions and is pushed to the end. There the material falls between the two wheels, which have different diameters as well as weight. The lower wheel, on which the bottom part of the lining is situated, is bigger than the upper one. The wheels are not stabilized nor are they balanced because of this reason there is slight recoil from the "ideal" line: that is one of the causes for which the "fins" are produced.

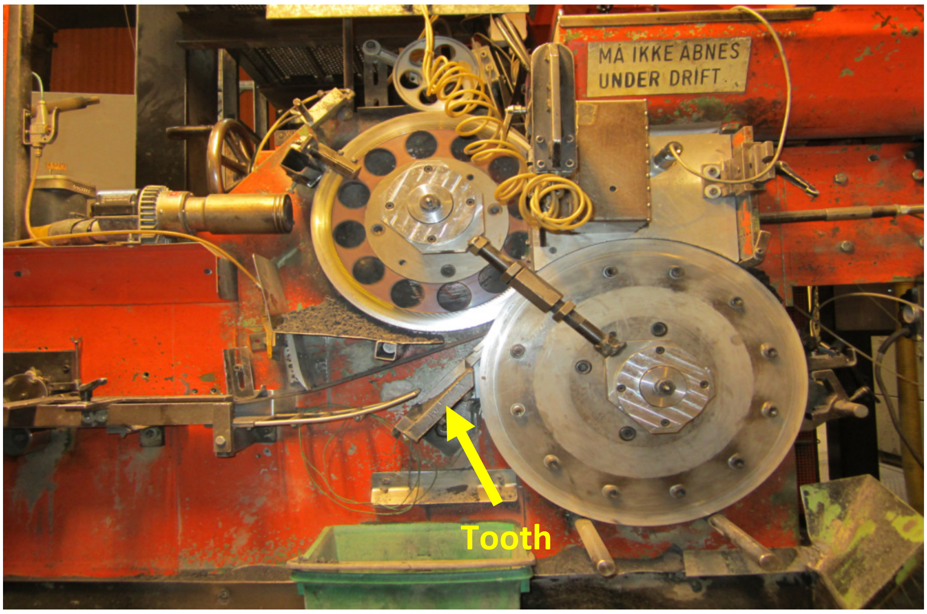


Figure 5 Placement of the tooth

After that a sharp edge piece of metal called “tooth” (Fig.4) separates the produced lining from the lower wheel, and guides it through a short track until it enters the cage. After that in the cage the lining is rolled on a wheel and is cut when the current wheel is full.

3.2.2 Critical Parameters

The critical parameters (pressure and temperature) of the brake linings are lower than those of the machine, so they are taken into consideration, e.g. if the maximum temperature that the machine can withstand is 600 C° and the temperature that the lining can handle is 300 C°. Have to comply with the lower one. The thermal conditions are affected by 3 critical parameters - volume, pressure and temperature. In our case 2 of them are constant - volume and pressure. Volume is the same for the specific type of lining, and it changes once we change the type that we produce. Pressure is a constant as well; so no pressure is implied on the lining during the whole process. The only parameter that can change is the temperature, so its limitations have to be observed and set.

3.2.3 Analysis of the measurements

Four measurements were taken; each of them took one hour. The measurements were taken at different dates as well as times, two of them are on the same type of wheel and two are on different ones. The pause between each measurement was 3 minutes, as well as no measurements were taken during the time the machine wasn't working, or during its "brake down". In these measurements we have analyzed two different types of temperature:

- T1 is the measurement between the wheels (fig 7)
- T2 is the measurement above the track (fig 6)

To measure T1 and T2 a cable was used; on one end of which there is a thermocouple head and in the other ends of the cable it is connected to a similar thermometer device, which measures the temperature in decimal. The end of the cable is a plug and that is how it enters the thermometer’s socket. The thermometer's dimensions are (D)x(H)x(W): 4x17x8 cm. the temperature reach is between -50°C up to 1000°C and it uses a K-type of cable for the socket.

The device that was used is a thermocouple cable- Type K25, Thermocouple head- KDW and a digital thermometer RS 206-3738. (Fig 5)

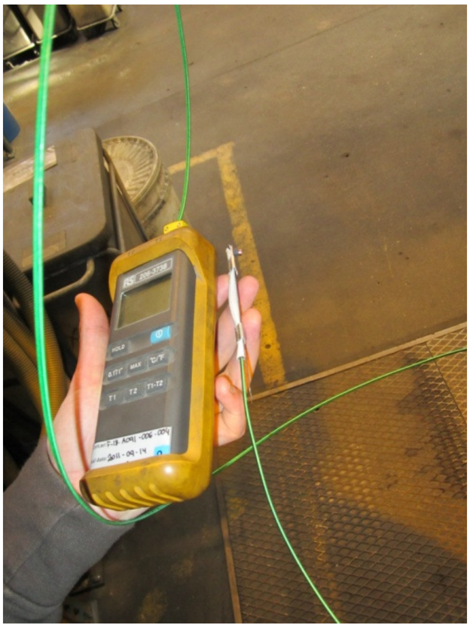
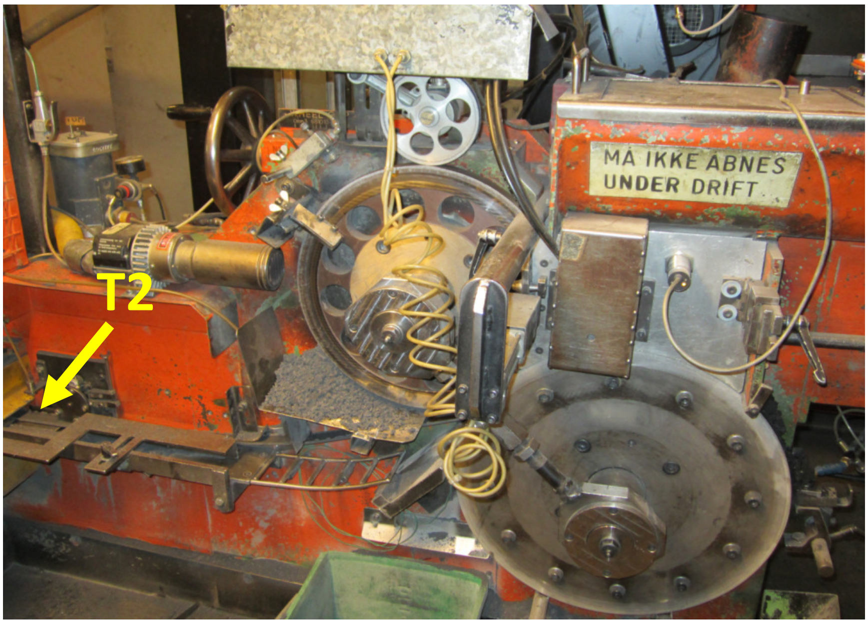


Figure 6 Measuring device

There is a heater on the extruder, which is turned on before the machine starts production. So the temperature of the wheel rises to the required minimum so the material doesn't get stuck to it. The heater is used only when the wheels cool off below 40°C. The speed at which the lining is moving through the track is constant around 15-17m/s. The wide of the lining depends on the wheels that they have installed at the moment, e.g. 30-50mm. It can be observed that - the more narrow the lining is, the higher amount of waste is produced, as well as the friction rises the temperature of the lining much more rapidly.



In Fig.6 is show the exact location of the thermocouple head that measured the temperature above the track just before it enters the cage. This device was place beforehand and it is connected to the display of the machine, as it allows works to keep constant track if the temperature is in it is limits

Figure 7 Measurement above the track

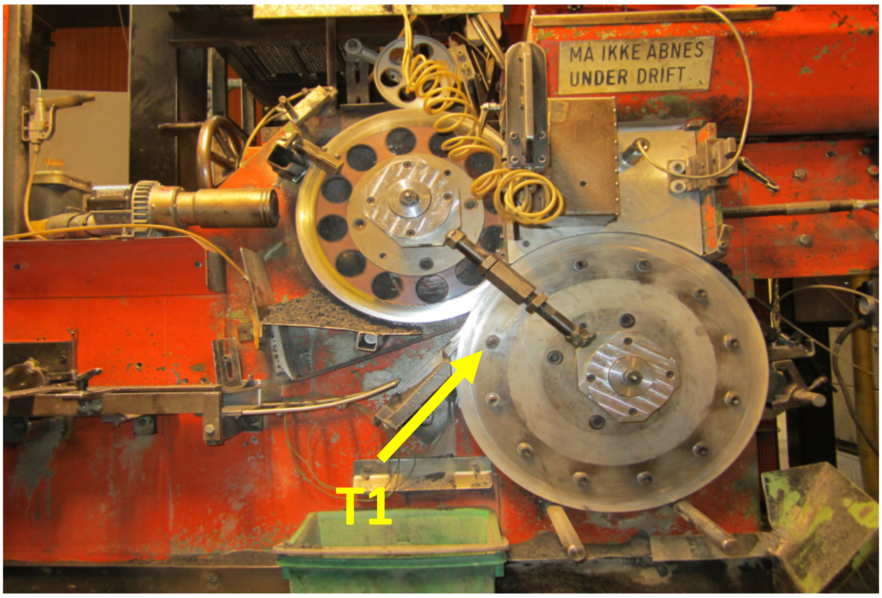


Figure 8 Measurement between the wheels

T1 shows where the proposed measuring device was placed, under the "tooth" in between the wheels. This is the closest place to which the linings were produced. So accurate measurements could be taken. The thermocouple cable is attached to the piece of metal that is above the arrow. The arrow head points to the spot where the thermocouple head is situate, that takes the measurements. The cable goes next to the green box so it does not interfere with the production flow or nor does it create any additional stress to the lining.

To complete the goal, first the critical temperature needs to be found. So measurements must be taken. The amount of which may vary, but usually four or five are enough to make a solid observation which can back up your decision. In each of the sub points is explained the type of wheel that is used, the velocity of the wheels, size of the linings. The size and the temperature are observed closely as well.

3.2.3.1 First measurement

This measurement was taken from the narrowest linings. The upper wheel was No28, the wide of which is 28mm. The speed varies from 15.3-15.7 m/s., increasing that speed has a negative impact on the product.

This measurement has the highest range temperature as well as middle range fins, which vary from 6mm to 12mm. In the beginning the fins were the smallest - 6mm but the temperature rose in proportion with the size of the fins. The highest temperature measured in between the wheels was 69.9℃ -T1, the other one was taken on the track before the cage -T2. The highest temperature is 50℃ this measurement is not as accurate as T1, due to it being measured until the decimal digit. So an error of ± 0.49℃ must be taken into consideration. The difference between the two temperatures or absolute temperature was measured as well - ΔT, the highest temperature was 21.6℃.

During the one hour the measurements took place the machine had 2 stops, both of them with a 5 minute duration, which affected the temperature by 2-3 degrees, the temperature of the upper wheel kept above 40 degrees - because of the heater.

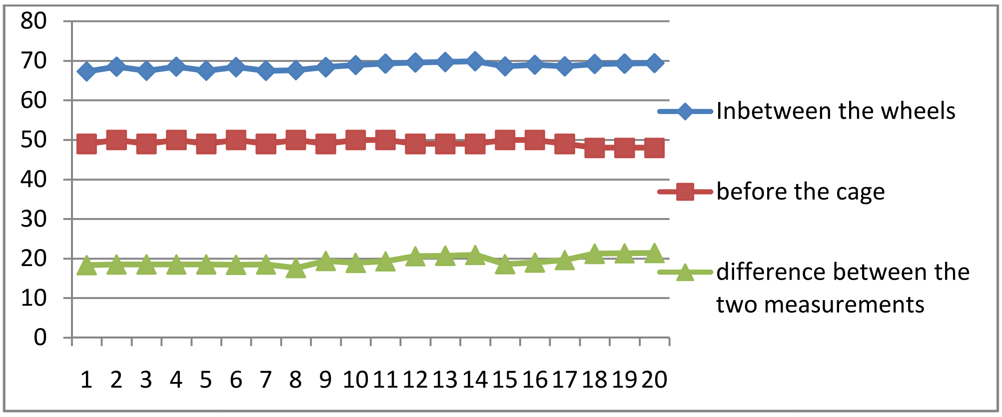


Figure 9 Temperature graph first measurement

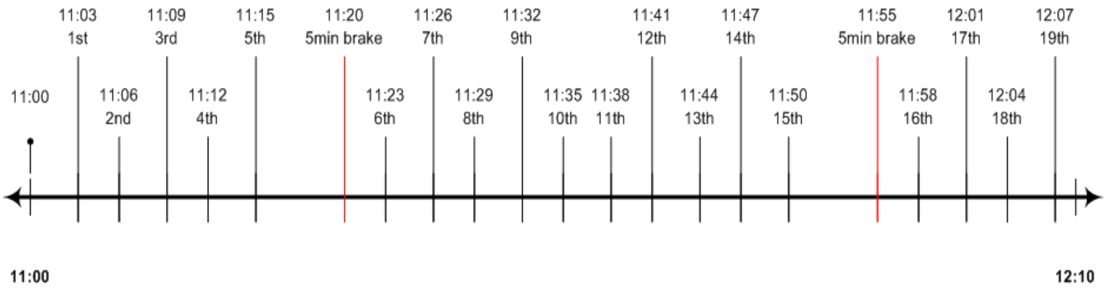


Figure 10 Breakdown/pause graph first measurement

3.2.3.2 Second Measurement

This measurement was taken from the narrowest type of linings. The upper wheel was No30, the wide of which is 30mm.The speed varies from 15.3-15.7m/s above those limitation it has a negative impact on the product.

This measurement has medium range temperature as well as middle range fins, which vary from 5mm to 8. In the beginning the fins were the smallest - 5 mm but the temperature rose in proportion with the size of the fins. The highest temperature measured in between the wheels was 63.4°C - T1, the other one was taken on the track before the cage -T2.The highest temperature of which is 52°C this measurement is not as accurate as T1, due to it being measured until the decimal digit. So an error of $\pm$0.49°C must be taken into consideration. The difference between the two temperatures or absolute temperature was measured as well - ΔT, the highest temperature of which was 13.9°C.

During the one hour the measurements took place the machine had 1 stop for a 5 minute duration, which affected the temperature by 2-3 degrees, the temperature of the upper wheel kept above 40 degrees - because of the heater.

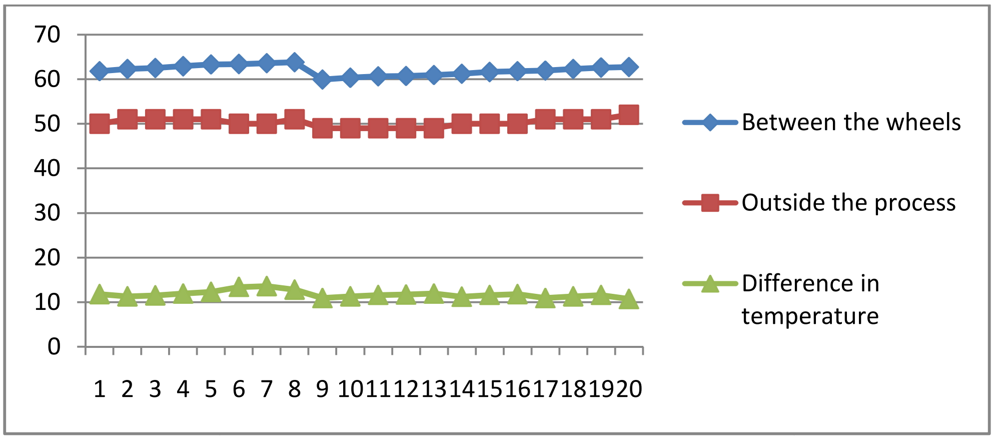


Figure 11 Temperature graph second measurement

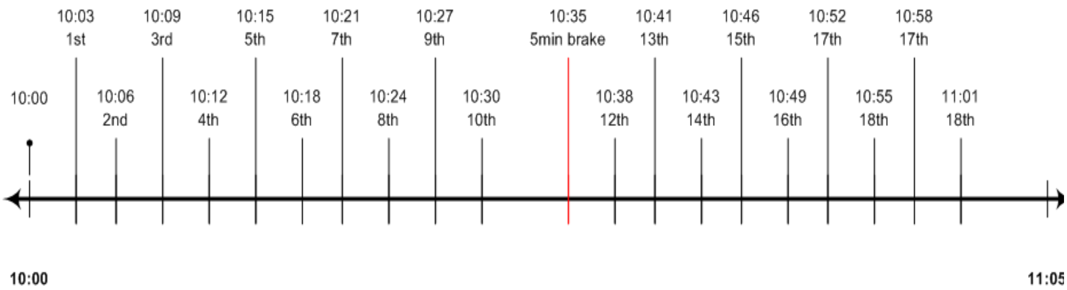


Figure 12 Breakdown/pause graph second measurement

3.2.3.3 Third Measurement

This measurement was taken from the narrow linings. The upper wheel was No30, the wide of which is 30mm.The speed varies from 15.3-15.7m/s above those limitation it has a negative impact on the product.

This measurement has the lowest range temperature as well as smallest fins, which vary from none - 0mm to 5mm. In the beginning the there weren't any fins, or they were the smallest measured- 0-1 mm but the temperature rose in proportion with the size of the fins. The highest temperature measured in between the wheels was 51.4°C - T1, the other one was taken on the track before the cage - T2.The highest temperature of which is 48℃ this measurement is not as accurate as T1, due to it being measured until the decimal digit. So an error of ±0.49℃ must be taken into consideration.The difference between the two temperatures or absolute temperature was measured as well - ΔT, the highest temperature of which was 6.1℃.

During the one hour the measurements took place the machine had 2 stops both of which had 5 minute duration, separated by 25 batches each, which affected the temperature by 2-3 degrees, the temperature of the upper wheel kept above 40 degrees - because of the heater.

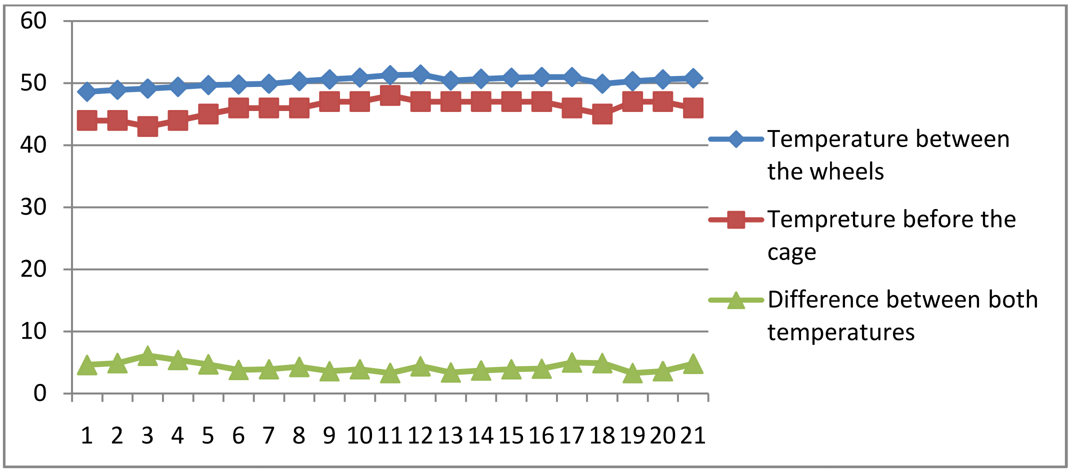


Figure 13 Temperature graph third measurement

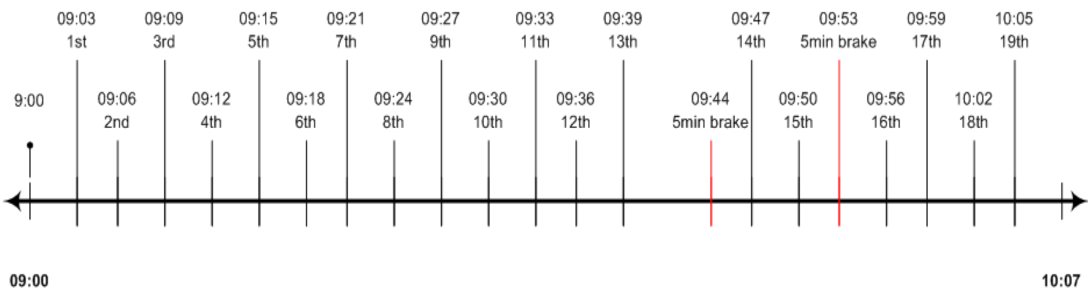


Figure 14 Breakdown/pause graph third measurement

3.2.3.4 Fourth Measurement

This measurement was taken from the narrow linings. The upper wheel was No31, the wide of which is 31mm.The speed varies from 15.3-15.7m/s above those limitation it has a negative impact on the product.

This measurement has medium range temperature as well as middle range, which vary from none 1mm to 6mm. In the beginning the fins were the smallest measured - 1-1,5 mm but the temperature rose in proportion with the size of the fins. The highest temperature measured in between the wheels was 65.4℃ - T1, the other one was taken on the track before the cage - T2.The highest temperature of which is 49℃ this measurement is not as accurate as T1, due to it being measured until the decimal digit. So an error of ± 0.49℃ must be taken into consideration. The difference between the two temperatures or absolute temperature was measured as well - ΔT, the highest temperature of which was 17.4℃.

During the one hour the measurements took place the machine had 2 stops both of which had a 5 minute duration, which affected the temperature by 2-3 degrees, the temperature of the upper wheel kept above 40 degrees - because of the heater.

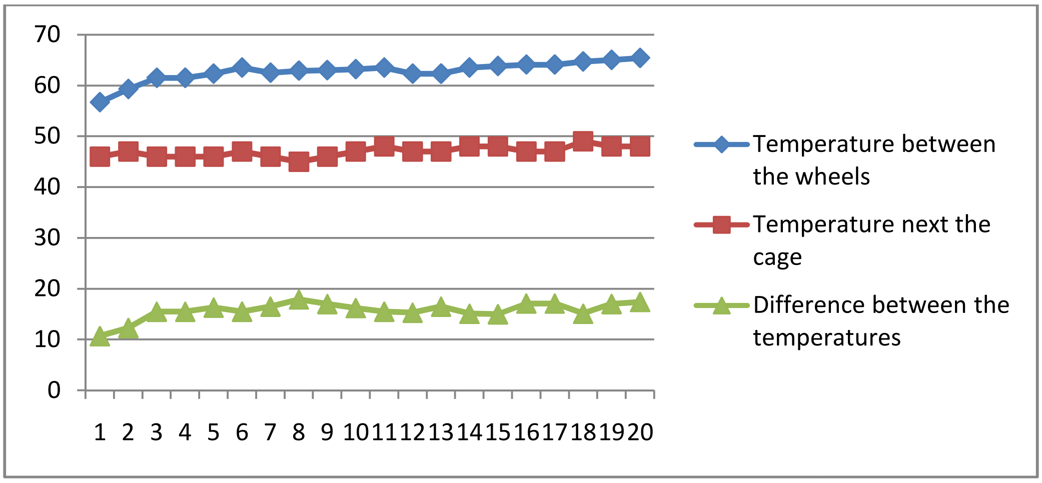


Figure 15 Temperature graph forth measurement

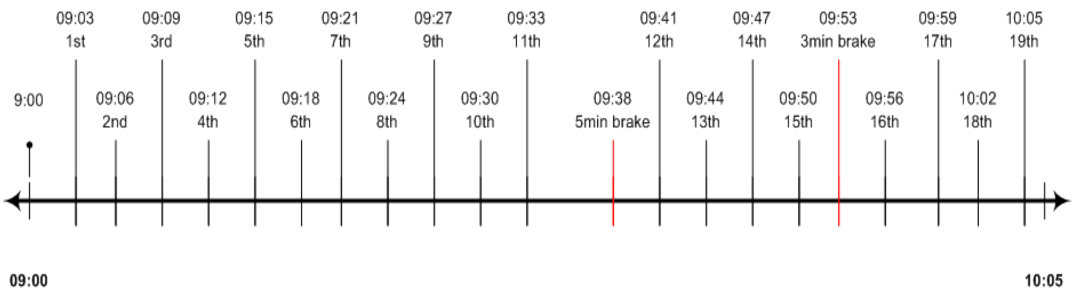


Figure 16 Breakdown/pause graph forth measurement

3.3 Proposal of solution

By observing the process and gathering measurement of one of the 2 critical parameters, which have effect on the lining process, we can make a conclusion that the temperature does indeed affect the "waste material" which is produced in the process.

One way to reduce that waste material is by installing a second "tooth" situated above the lining path.

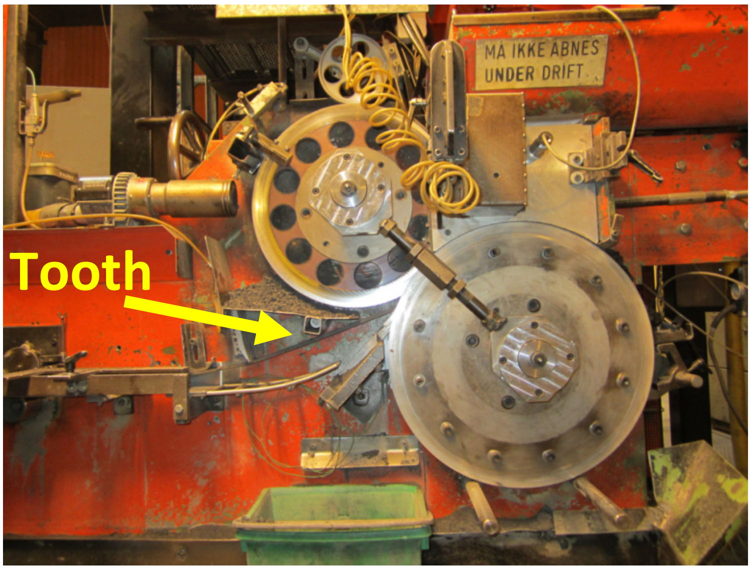


Figure 17 Mechanical solution

It will be attached to the piece of metal that is used to collect the waste material, underneath the upper wheel. Close to the space from where the linings are produced, between the two wheels, so it will have contact almost simultaneously after the lining is produced, in this way the waste material does not harden up and is still soft and easy to remove. The tooth's angle has to be in between the range of 10-15 degrees, so it does not interfere with the process, as well as does not create additional stress on the lining, which might break them. This solution was made by observation. There is a "tooth" which separates the lining from the wheel and it is in the bottom part of the track, after observing the final product it was concluded that indeed this chip of metal removes a large amount of the fins when it makes contact with the wheel on a certain degree (between 10-20, depending on the size of the wheels). That way the goal can accomplished: reduce the fins by 50%.

Unfortunately there is a negative aspect that could influence the production flow of the process. The “drops” - changes its position vertically for a short amount of time and then bounces back to its original state, might produce additional stress which might damage the lining. The produced velocity by this process might cause the lining to be cut down as well or damaged. Another con is the position, if it is interacting with the wheel it might create additional friction which will raised the temperature affect the material capabilities of the final product. This solution is only mechanical and easy to be assembling; as well it is the cheapest possible.

A second option is closely related to the % of each ingredient in the compound, so it may affect the temperature; reduce the size of the "fins”. One option is the change the % of resin in the mix; usually it is around 16%. If we reduce the percent of resin, it will lower the temperature, but the material will become softer and the friction will fall down. If we increase the amount of resin in the mix, the temperature of the material will increases, as well as its friction capabilities. The cons of this are the porosity rises as well as the size of the fins. Another variant is to change the phenolic resin with free flowing polymerised resin derived from Cashew Nut Shell Liquid (CNSL). Cashew-containing friction dust is said to have the ability to absorb the heat created by friction while retaining braking efficiency. It is a major export product of India and the Asian subcontinent. The CNSL only con is that it is a softer material and it is more efficient for wear when the brakes are relatively cold, as in temperatures generated by lower speed automobiles. Other types of modified resins include - a variety of modified resins is available; modifications to alter bonding characteristics and temperature resistance include cresol, epoxy, cashew, PVB, rubber, linseed oil, and boron (Borden (1994)).

3.4 Conclusion

It can be concluded that the pressure does not affect any parameters of the lining, so it can be neglected as a critical parameter, in this case as well as the volume which is a constant. Only the temperature has an effect on the size of the "fins". The higher it is in between the wheels the larger the "fins" are. The amplitude, the difference between the wheels and the end of the track, does not change the size of the "fins", whether it is 10°C or 30°C. The solutions proposed will reduce the amount of waste material. The mechanical one is easier to implement, but in may interfere with the process by adding additional stress upon the lining/which might break it.

The chemical solution is more expensive and it has to be looked into it, because it may not give the properties that are expected from the lining. For instance if the percentage of resin is reduced in the mix, the lining will get softer so less fins will be produced, but the friction coefficient will drop

4.0 Traceability

4.1. The concept of Traceability

Like it is said in the paragraph "Project Task", one of the projects of this object of study is Traceability. At the beginning there is a briefly decription of what it is and its advantages for its implementation in enterprise.

In almost all industries it is important to know where the individual parts and finished products come from, which batch they are part of and when they were produced. Otherwise, continuous process chains in the Supply Chain Management would not be realizable; for these reasons and for many others a lot of companies adopt the approach of the traceability. Traceability refers to the completeness of the information about every step in a process chain. The formal definition of traceability is the ability to chronologically interrelate uniquely identifiable entities in a way that is verifiable. Traceability is the ability to verify the history, location, or application of an item by means of documented recorded identification[14].

Traceability is one of the most important requirements in almost all production processes. The production is the largest investment of a company. Especially today it represents one of the most critical factors of success. In fact, the increasingly competition causes that all the companies have to work in an optical of continuous improvement and become vital activities like the allocation of resources, planning and production control. A traceability system simplifies investigation of causes of product failures and is therefore vital for many industries. Traceability systems are extensively used in manufacturing industries.

One of the characteristics of the traceability is the availability of information that makes possible constant analysis on the efficiency and the development of

[14] cf.(Wikipedia)

production to decide what to produce, in which quantity, with which production unit and when. With these kinds of information it is possible for each organizational level to have all the necessary data to carry out effectively the activities of competence and to support strategic and operational decisions.

The advantages of an approach based on the traceability are mostly related with accurate modeling of the production system, data acquisition, progress of production, the supervision and control of production and generating reports. These characteristics of information systems give some key factors of success such as increased productivity, reduced time (typically the lead time production), reducing costs, reducing of errors in data entry, quality control and a better quality of service[15].

4.2. Analysis of weighing process

It is appropriate to describe the process that requires this implementation. As described before in the previous chapter, in the Pilot Plant usually there is one employee that in the first stage of his work needs to carry out the mixing of two or more raw materials to obtain a component which then will be processed to obtain the pads. The sequence and quantity of each raw material/ingredient is established by a recipe. The recipe is the set of information that uniquely identifies the production requirements for a specific product. It defines how much of each imput material should be added and processed to make a new product.

He has two different weighing stations, one of 20kg of capacity and the other one of 30kg, both of them with an accuracy of 1g. The critical phase for the employee is the mixing; currently he has a weighting scale, but it only provides information about the quantity of material that the operator has to put inside the bowl (as it is possible to see in the pictures below). There is not any control about the process, so mistakes and errors are not registered. Besides, the operator has to check every time if he is

[15] cf.(Authorless, Tracciabilità nei sistemi produttivi)

doing his work in a proper way. This problem can be solved with a kind of software that can guide and save time for the workers, as well as to be able to read and display recipes with different types of mixes, registering every trace of the process. In the following paragraph it is explained all the information the software should provide.

Figure 19 Mixing area

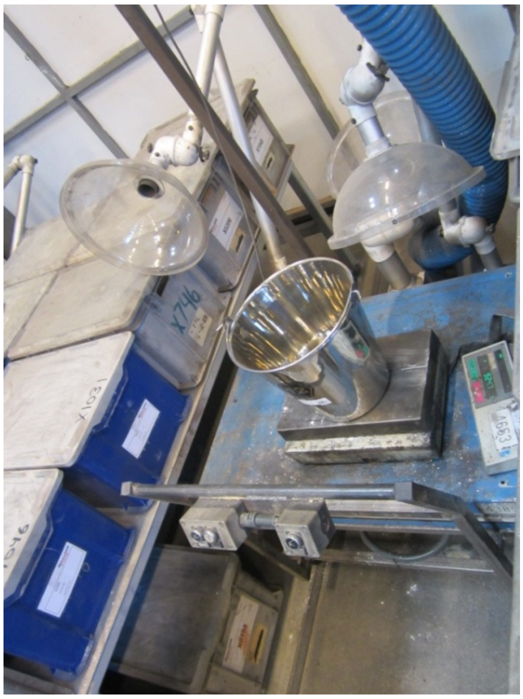


Figure 18 weighing scale

For more deails see appendix to find an example of the two papers that the operator prints when he works in the Pilot Plant.

The first one called " Charge seddel til Pilot Plan" shows :

- job order, that they call "charge number". It is is costituted by a letter followed by three number and another letter. They use the first letter to recognize the year of the order for example this year the first letter is M.
- Date

- Other Information that are indications about how the operator has to do the activities to produce the pads

The other paper “vejeseddel” is related to the recipe. It explains how the mix of the ingredients has to be done and contains information about: recipe number, code of ingredient, quantity of material, tollerance allowed.

4.3. Description of the process

This project, so called traceability, tackles the following problem: claims and production process problems cannot be handled/executed the right way since raw materials, processes and production parameters cannot be traced through the process. The task is to establish a way to make a large and organized system for labeling, through the achievement of more sub-goals:

1) Collect the existing data of raw materials
2) Create a label barcode
3) Find the suppliers and interview
4) Compare of the supplier
5) Find a method to transfer data to new system

Roulunds Braking uses the German software SAP to manage the business operations and customer relations. Thanks to this software it is possible to have all the information related to the materials, each step of a business transaction can be easily monitored and processes are completed from the beginning to the end. SAP Workflow ensures “the right work is brought in the right sequence at the right time to the right people”. Workflow allows process owners to keep an eye on deadlines, provides statistics on the length of time to complete work processes, determine the workload with regard to individual employee and save processing time. The advantages gained by using workflow are not directly financial nature, but the time saved by optimizing processes could easily be translated into money.

Roulunds Braking also uses another software inside the company: RDS (Relational Database Service). With this ERP solution it is possible to have real programs of management, which allows a strategic planning of the IT infrastructure and implementation of solutions. RDS helps to achieve the business goals of the company and a significant return on investment.

Roulunds Braking uses together these types of software especially to collect all information related to the production and inventory. RDS contains all the information related to the mixing process, recipes and ingredients; SAP has some ingredients, batch numbers and stock levels and supplier information. RDS is like a "back office" database for functions inside the company, instead SAP system is also used for all the functions that the company has with its stakeholders.

The company wants to interview the suppliers because it would like to install a Recipe Control Weighing system to provide an indelible ingredient traceability which would enable rapid interrogation of the database about where, when & into which specific batches of recipes any suspect/contaminated batch of ingredient may have been used, as well as increasing the efficiency and quality of the prototype production process. In particular, the batch of raw materials (ingredients) used in a formulation must be recorded.

As explained before the company uses two different kind of ERP software, so the required system must be capable of integrating both softwares to provide a seamless bi-directional flow of data between the three systems. In particularly the system has to be able to convert from RDS the recipe and the mixing process info and from SAP ingredients name, stock level, batch number. Moreover, it needs to update the SAP system with the remaining quantity as appropriate (instantaneously, once a day or once a week) so that new stock can be ordered.

The company has these physical requirements:

- Two weighing scales, with a capacity of 25 kg and 0,001 kg tolerance. Both scales should be connected to each other and allow constant data flow, besides allowing a possible work with the same recipe.
- Barcode reader to identify the material and read the material batch code.
- Label printer.

The software has to work satisfying the technical requirements of the company. The software must:

- Identify the ingredients by 5 different "codes" (I,X,Y,Z,B), which have a specific meaning that is described later in the paragraph 4.3.1.
- Allow the mixing to be done in two or more steps. Many recipes have 2 or more "blocks" or mix steps (with several ingredients in each) and they are added consecutively to the mixer.
- Create the recipes directly or with a conversion file, adding ingredients, and planning the work.
- Read the barcodes and labels on the ingredients
- Produce a label for the weighed out mix/final mix
- Store the information for later retrieval
- Create reports for detailed contents in a completed formula and for each material where it was used

All this information is explained in the paper "Technical Specification".

4.3.1. Collecting the existing data of raw materials

The first part of this project was focused on collecting and analyzing all the data about the raw materials. In the company there is a typical codification to define every different kind of material:

- Letter Y followed by 4 number is related to the Pilot Plant. They use this letter for the new ingredients. This kind of material has to be analyzed in the lab because it has never been previously used in a recipe
- Letter Z followed by 4 number is related to the Pilot Plant. They use this letter for a material that is obtained by the mixing of two or more previous ingredients.
- Letter I followed by 4 number is related to the Pilot Plant. This is a typical code for the ingredients used in India.
- Letter X followed by 4 numbers is related with the production process. They use this code for all the ingredients that are already tested and have been already used in previous recipes.
- Letter B followed by 4 number is related with the production process. They use this letter for a material that is obtained by the mixing of two or more previous ingredients.

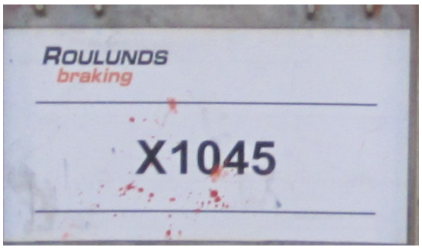


Figure 20 Example code of material

4.3.2. Create a label barcode

Almost every single business today uses barcodes for a lot of different reasons. Whether you are keeping track of computers and other important equipment within the company, own a warehouse that has to keep a constantly current tally of millions of items, or you own a store and need to keep a watchful eye on your prices and your stock, barcode scanners are used to help retrieve and tabulate this data. There are several different types of barcode scanners, so it's important to know which ones will work best for you.

A regular computer cannot read barcodes. A special scanner is needed in order to scan the entire code and then translate the code's formula so that it becomes a readable and traceable piece of data. Essentially, a barcode scanner captures the data from the barcode and transmits the data into a computer system, which then can translate the information, and in most cases store it into a database. Most scanners are easily compatible with most computers and operating systems.

The company needs a label for the raw material and another one for the mix. They must contain the information shown in the figures below.

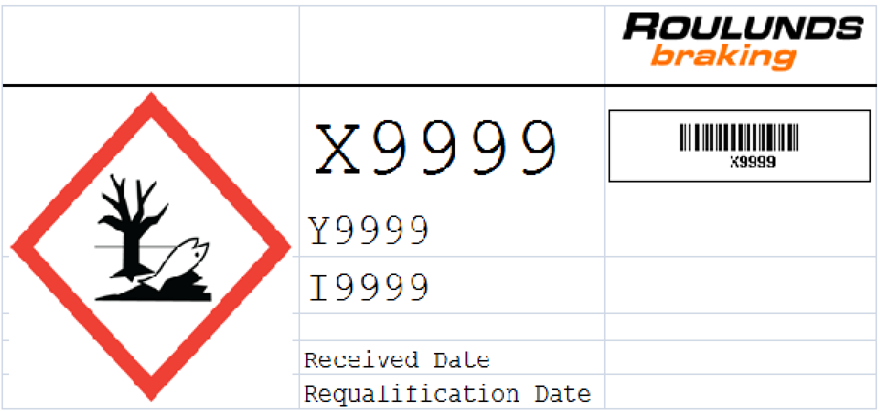


Figure 21 Label of raw material

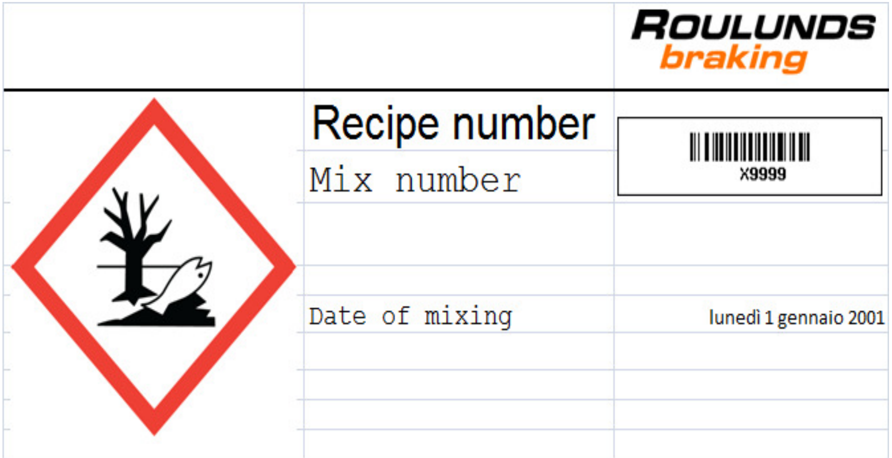


Figure 22 Label for the mix

4.3.3. Find the supplier

One of the most important points of this project, which also required more time, was to find the supplier that could satisfy the requirements of the company. So since February, a careful research was made in order to find the best companies of the market.

Five companies were selected. Each one of these companies has been analyzed more in detail. The attention was focused specially on those aspects that could be useful for the purpose of the project and that could satisfy the company needs. All the information related to these companies was taken from the website. An attempt to organize a meeting with all five companies was made, with the collaboration of the project owner, but unfortunately it was only possible with 2 of them.

Below there is an analysis of each one of the five companies, first with a small introduction and then with a description of the products that they offer and its characteristics. The order is alphabetical, not for degree of importance.

4.3.3.1. Doran

Dorian is a company specialized in the production of the industrial electronic scales manufactured. Their scales were designed to perform with repeatable accuracy in the hostile environments in the food processing industry. Their scales are recognized for speed, durability, and ease of use. One of the ideologies of the company is that every customer is treated as if they were their only customer. That focus accounts for their policy of shipping stock scales the same day they are ordered.

By design, they offer the industry's most varied selection of "off-the-shelf" options. Their wide-range of tower heights, platform sizes, custom indicators, user-programmable options, and software makes it possible to put a Doran scale to work in almost any industrial or commercial application without engineering[16].

Products Offered:

An attempt of a meeting with Doran was made, but it was not possible because they did not replay on time to the request of information from Roulunds Braking.
According to the needs of Roulunds Braking, possible solutions provided by Doran are:

- FC6300 Formula Control System:

The FC6300 records all of the data electronically on a PC. The FC6300 will prompt the ingredient by ingredient insuring that they never miss an ingredient, and it will deliver the data directly to a database.

With this kind of system the correct ingredients are accurately scaled every time. Each ingredient of the formula is weighed within a tolerance that is possible to define. The color-coded on the display ensures ingredients being added are within those tolerances. Each step of the recipe is clearly labeled with batch ID, batch name,

[16] cf. (website Doran)

the step number, ingredient name, target weight and actual weight. Accurate scaling can be achieved with or without experienced production employees.

Figure 23 Doran FC6300 display

Formula Loader is a standard component of the FC6300 Formula Control system. This Windows compatible software is used to configure recipes as well as to provide production reports. Enter the ingredients with tolerances and ID, and then create the formulas by double clicking the ingredient names. Formula Loader will become a database of recipes. In one easy step, create two comprehensive Excel spreadsheets that contain all recipes and ingredients you produce with Formula Loader. The ingredient spreadsheet records the ingredient name, ingredient ID, and the ingredient tolerances. The formula spreadsheet documents the recipe name, recipe ID, ingredient name, and target weights. Standard formula Loader reports can be used to evaluate scale operator efficiency and ingredient usage. Using scale operator ID’s, the FC6300 tracks when a user logs in and out of the scale. Management can easily determine how long the scale operators are taking to prepare each recipe and how accurately it was done.

Scaled formulas are saved as a digital record, far more accurate than the typical handwritten records used on most plant floors today. The digital format makes searching and analyzing production data fast and accurate. With a click of a mouse button, all batch data of a specific lot ID can be retrieved.

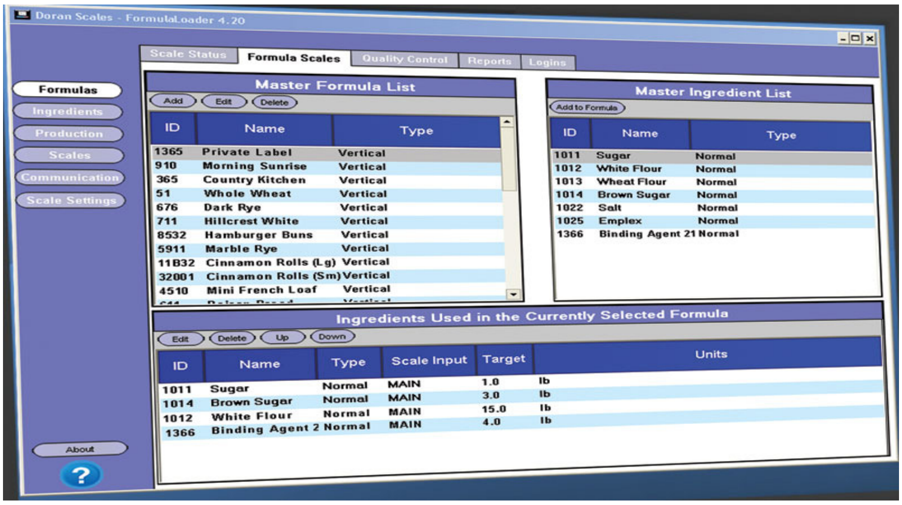


Figure 24 Doran formula control system

- Barcode Label Printer

Doran LR350 scale printer offers outstanding performance, reliability and flexibility to meet the demands of today's fast paced barcode label printing applications. Ideal for all weighing applications such as: packaging, production, warehousing, shipping and receiving printing needs. Direct thermal print technology provides high quality barcode labels time after time. Preloaded Doran label formats provide true plug and play setup for most labeling applications - custom label designs are also available.

Figure 25 Doran Printer

4.3.3.2. Mettler Toledo

It is a global manufacturer and marketer of precision instruments for use in laboratory, industrial and food retailing applications. The company has strong worldwide leadership positions. They have leading positions in each one of their markets, and a significant majority of their instrument sales are in segment in which they are global leader. They focus their attention on the high value-added segments of their market by providing innovative instruments that often integrate various technologies including application-specific solutions for customers. Their products are sold in Europe, Americans and Asia market. Is a growing company that in the last year has registered an increase of 13'3% of the net sales[17].

They are specialized in industrial instruments and software optimize from receiving to shipping with solutions for production, end-of-line inspection and logistics. Their solution provides value to customers with improved product quality, accelerated and automated processes, increased efficiency and regulatory compliance. Many of their solutions are integrated directly into their customers' ERP systems. Their offering to the industrial market includes industrial scales and terminals; software such as statistical quality control, formulation and batching; metal detectors, check weighers, automatic identification, data capture and dimensioning solutions for transportation and logistics; and weighing solutions.

They offer industrial scales in all sizes and formats, terminals and software to control and monitor manufacturing processes. Specialized solutions for formulation and many other applications help to improve productivity and reduce errors.

Products Offered:

Mettler Toledo is one of the companies that were available for a meeting. Mr. Bent Nielsen, product specialist in Mettler Toledo came to the company and made a

[17] cf. (website Mettler Toledo)

presentation of the product that they offer. There are two different kinds of solutions, the first one is called **Formweig.net**: It is Mettler-Toledo's premier manual formulation solution for those applications that require data integrations with a customers' ERP system; the second one is **IND780batch**: It is designed to operate stand alone and does not have the ability to be integrated into a customers' ERP system.

FormWeigh.net:

Usually the typical system layout is formed by a master data workplace (the company can use also their own one), which can also act as a database server, weighing stations (IND780 or ID30) and printers that can be distributed throughout the network and also shared.

Master data is classified as data that forms the basis for work with the FormWeigh.Net system. This data can include: Materials data, recipe data, Equipment data and User data. This data is entered and maintained in the FormWeigh.Net system by authorized users.

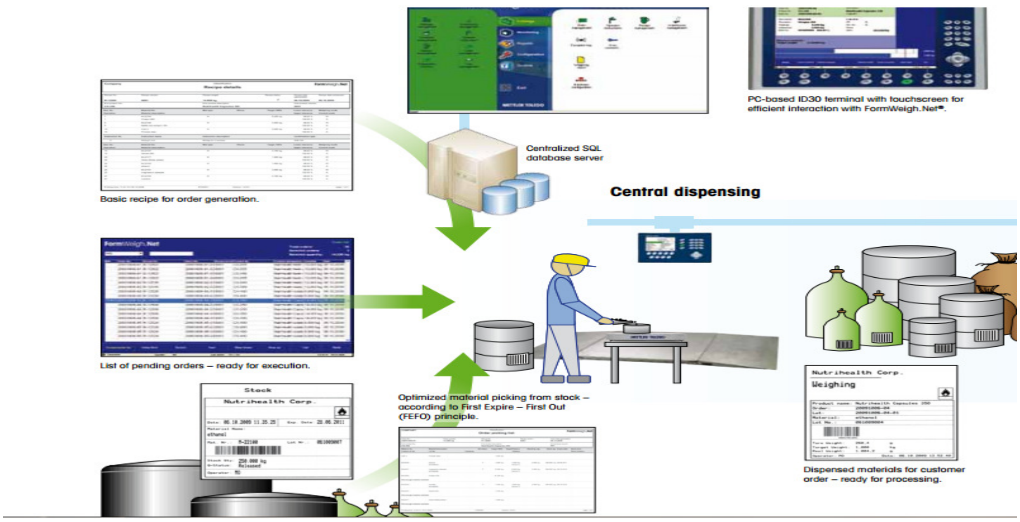


Figure 26 Mettler Toledo System design

The system has the main following characteristics:

- A new material can be saved after entering a material number and material description. The material number must be unique. The status of a material is assigned by the system following definition of a material, when a material is added, it is automatically saved with the status FREE. If this material is no longer needed, its status can be set to BLOCKED. Information on personal protection can be assigned. The assigned protection information is displayed to the operator on the weighing station prior to weighing a material.
- The recipe Management catalog is used to record and maintain the recipes for the manufacture of finished product. The recipe list containing all the recipes that are used to manufacture finished product. The selected recipe can be validated, released for use or blocked using the menu functions
- The reports available in FormWeigh.Net can be printed from the reports section. The preconfigured reports, from the material list all the way up to the manufacturing report, can be preselected as required via the search function in the menu. The following reports are available: weighing report (all the ingredients of a recipe are listed), manufacturing report (all ingredients and instruction of a weighed recipe are listed), exception report (all exceptions that have occurred during processing are listed), order report (the order header data is printed).

The recipes released in the Master Data module can be called up and processed on the IND780 terminal. All materials and instructions to be taken into account in the recipe are displayed on the terminal and must then be executed by the operator to complete a production process or weighing process.

This is the normal process with this kind of terminal:

1) Insert the user name and password, after the operator have access to the functions for recipe weighing and order weighing.

2) In the order list, orders can be selected for processing
3) The list of recipes released for recipe weighing is displayed on the terminal.
4) Once a recipe has been entered for processing, the quantity specifications of each ingredients are displayed
5) The material number can be scanned using a barcode reader or entered manually using the keyboard. The entry is checked against the recipe list. If it does not match, the entry is rejected and an error message is issued. Error messages of this type are logged in the production process and can later be output in an exception report.
6) During weighing, the various sections of the weighing process are displayed differently. The weighing bar is blue when the weight is below the lower tolerance limit. The weighing bar is red when the weight is above the upper tolerance limit. The weighing bar is green when the weight is within tolerances

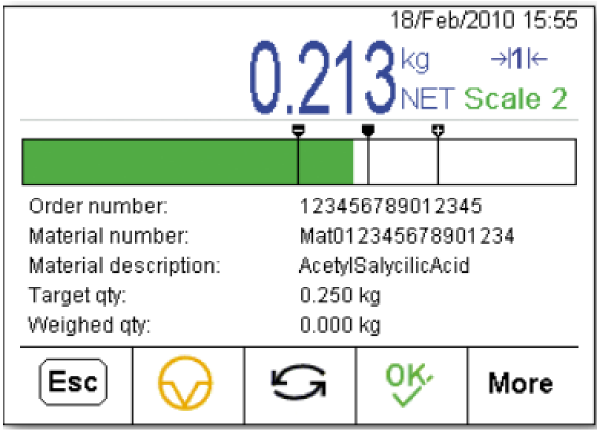


Figure 27 Mettler Toledo weighing bar

7) One all the ingredients of a recipe are complete, a manufacturing report can be automatically printed. Once a recipe is complete a label can also printed on the connected label printer.

IND780 batch batching controller:

The other solution that Mettler Toledo offers is The IND780 batch controller. It combines advanced batching control technology with the features of the IND780.

The system is constituted by: Customer's database (stores process data and system configuration information), IND780batch PC Configuration Tool (configures equipment, creates and manages recipes and orders, generates track and trace data and reports), IND780batch terminals (downloads recipes and orders and controls automatic and manual batching processes).

The picture below shows an example of a manually-controlled batching system including IND780batch, a bench scale with container, and a barcode scanner.

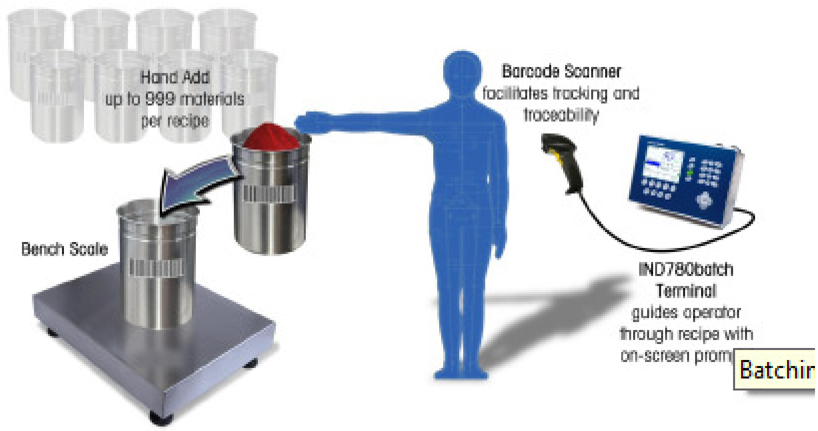


Figure 28Mettler Toledo IND780 Batch

4.3.3.3. Sartorius

Sartorius is one of the world's leading providers of laboratory and process technologies and equipment. The philosophy of the corporate is "turning science into solutions": they use the latest scientific expertise to manufacture innovative products. Their innovative products and high-quality services help customers around the globe implement complex and quality-critical processes. Sartorius operates its own production facilities in Europe, Asia and America, and also has sales offices and local representatives in more than 110 countries. Today, more than 5,000 people work together at Sartorius worldwide[18].

Products Offered:

Unfortunately Sartorious didn't reply on time to the request of information, so all the information was gathered from their website.

Sartorius ProMix for Windows:

The "Sartorius ProMix for Windows" recipe system is a powerful software package for manual weighing and recipe management. The system runs on a Windows PC, preferably an industrial PC (IPC), to which at least one weighing scale or platform is connected. The PC serves both as a weighing station, on which the user first selects the job orders and is then guided through the process, and for the management of raw material, recipe and production data.

At the same time, not only must the raw material batches be systematically traceable but the process steps and operators must also be fully identifiable.

Sartorius ProMix guarantees the exact execution of a recipe due to computer-supported, visually-aided operator management. This means that specified procedures are strictly adhered to and fully reported. In addition, the current status of the production process can be checked at any time. In this way, the consistency and high-quality of a product is assured. Deviations and particular events are specially recorded in the Audit Trail. As a result of these measures, continuous process transparency is achieved.

As it was explained before the The ProMix recipe system runs on a Windows PC, to which scales or weighing platforms are connected via serial interfaces or USB ports. The system is operated on the PC. The operating concepts for the reception of materials and for the weighing station are designed to function with a touch-screen,

[18] cf. (website Sartorius)

which is recommended. The raw material batches can be read in with a scanner, to avoid time-consuming and erroneous data entry via the keyboard. Batch labels are printed on a label printer on receipt of goods and weighing labels are printed after the weighing process, has been completed. Job, reports, recipes, batch inventory and other lists can be output to a report printer.

Below it is possible to see an example of the system design:

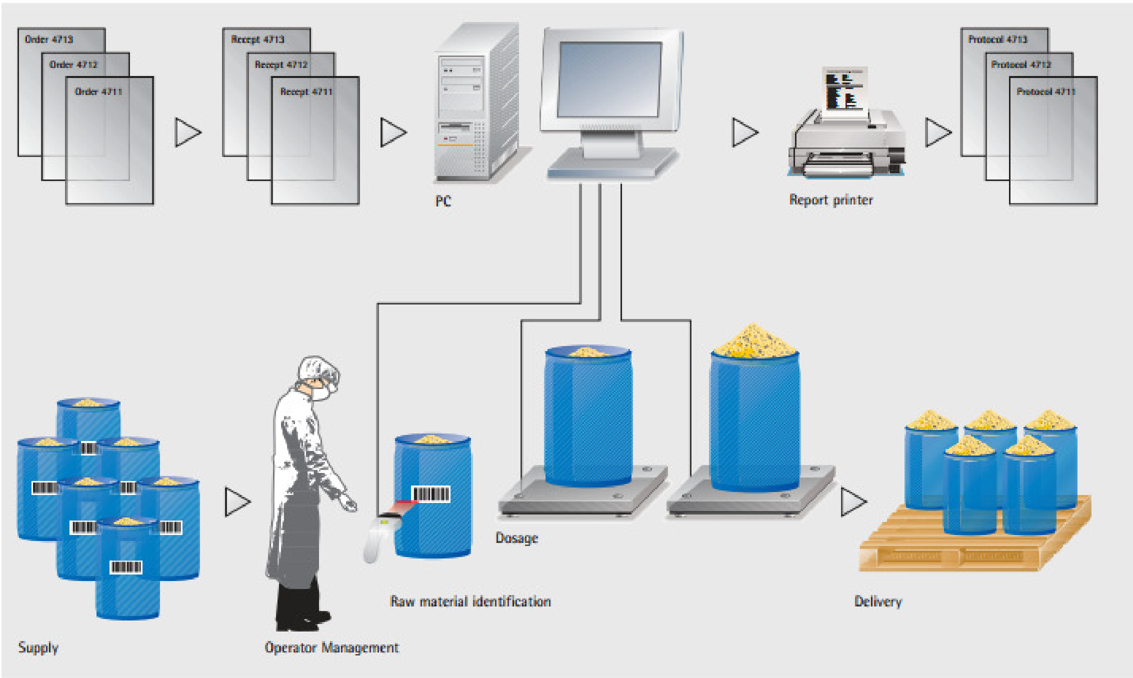


Figure 29 Sartorius system design

The software package consists in two modules:

1. Master data management: this includes, for example, user data, suppliers, materials, recipes, goods received and raw material batches. Jobs are created and authorized here.

2. Weighing module: guides the operator through the specified recipe steps. Weighing jobs can be selected and started. The scale is selected and the raw materials are identified and checked.

Other characteristics of this software are:

- Recipes can be divided and processed over several weighing stations.
- If the quantity of ingredients request in a recipe exceed the tolerance predetermined, to prevent incorrect batches and waste, the system doesn't accept the mix.
- The ingredients batches used are identified, checked and reported.
- The operating language is set automatically according to the user who is logged on.
- Is possible to connect to ERP-systems, such as SAP, via a variety of import and export functions. In this way, raw material data, recipes, jobs and reports can be exchanged automatically.

The manual process weighing can be resumed like this:

Depending on the configuration, batching can be started from an individual material, a recipe or an order. Simply choose from a list and start the production run. Recipes can be weighed as individual quantities into a bowl. The operator is guided by various dialog functions through the procedure. The color bar graph with tolerance limits provides additional visual support. A material ID is used to check if the material used is the correct one.

About the weighing station there are several scales from 0,1 Kg to 35 Kg with an accuracy of 1g and they also can offer several accessories like printers and barcode scanners, etc.

4.3.3.4. Scanvaegt

Scanvaegt is a provider of high-tech solutions to all industries in Scandinavia. They supply their customer with efficient systems, comprising weighing-equipment, packaging solutions, labeling systems, wireless data-capture equipment, inspection & control systems and related IT systems. Their goal is to provide tools for rationalizing the work flows and improve the operating economy of the company. They supply their customers with systems for processing, management and control, all of which contribute to better utilization of resources and optimization of earning powers. They claim that an investment in a Scanvaegt solution is an investment in the constant growth for their customers

They have their own service organization, their own R&D departments and their own training academy, which enables them to adapt their product development and services to the individual requirements to their customers as well as the rapidly changing demands and directives of the authorities. They develop and provide solutions for weighing, labeling, inspection, and data-capture for simple stand-alone jobs as well as complex production plant solutions. They also design IT-systems for e.g. traceability, production management, order control, label design, dispatch and stock management – systems, which optimize the production flow[19].

Products Offered:

Like with Doran and Sartorius, it was not possible to make an interview with them, so all the information regarding Scanvaegt is taken from their website.

The software system for management product data, label design, and exchange of data to administrative systems is Label Flex II, with the following characteristics:

- individual customization of screen display

[19] cf. (website Scavagaet)

- On-line data-collection with individual definition of data, e.g. article numbers, production output etc.
- online printer-updating - the connected label printers are automatically updated
- individual definition of barcodes
- supports Easy LAN for network-connection
- integration to other types of production equipment, e.g. PLC-systems
- language conversion for other countries

It was not possible to have more information about the software.

For weighing any recipe, is possible to choose between range of bench and floor scales and combine them with the comprehensive range of weighing indicators. The bench scales are from capacities of 3Kg to 300 Kg with a tolerance from 0,001Kg to 0,1Kg. There are two typologies of weighing indicator:

ScanWi 8526: is designed to perform a number of weighing tasks using bench scales and floor scales. The characteristic of this tool are described in the figure below:

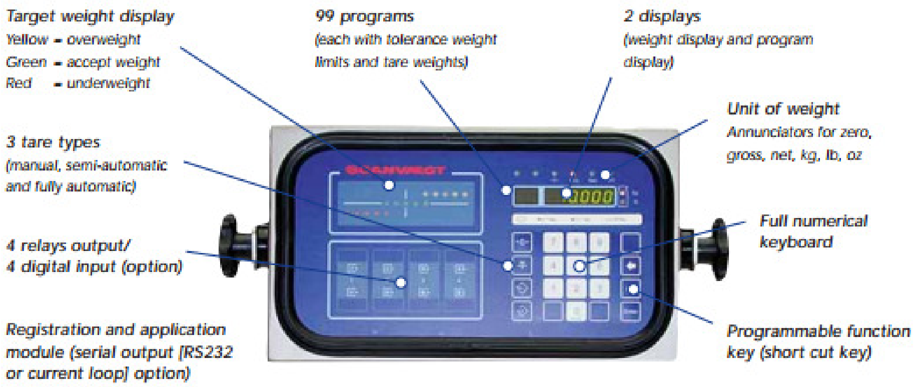


Figure 30 ScanWi 8526

ScanWi 411: Its filter stabilizing software makes the scales very fast and steady, even in the presence of vibrations or other machines that would normally make scales unstable. It is designed to be easy to use. The characteristic of this tool are described in the figure below:

Figure 31 ScanWi 411

4.3.3.5. Stevens Group

For over 170 years, Stevens group has been providing a world class service specializing in IT based weighing systems delivering shop floor traceability and process control to over 1500 companies across the UK, USA, Europe, Australia and Asia. Is one of the most established and respected companies in this sector. Their head office is in Blackburn with support centers around the world. Stevens group offer a complete sales and service packaging providing local support, nationwide, for not only Stevens equipment, but also other manufactures. Their dedicated in-house software development team specializes in turning theoretical requirements from their clients into real world solutions that are not only practical but easy to use at all levels within their clients' business.

For over a hundred years Stevens have been providing flexible, market leading and innovative solutions to their clients.

Working in partnership with forward thinking customers their products are continuously evolving to meet the needs and demands of today legislatively driven market while still delivering realistic returns on investment. WE aim to support all they customers in the best possible way and this flexible approach to solving client needs has enabled them to develop their total business offering, while also gaining some valuable customer relationship[20].

Products Offered

After the interview, Stevens group released a report with all the possible solutions that they can offer. They suggested Roulunds Braking to acquire:

Vantage™' Weighing & Process Control Ingredient Traceability System fully integrated with two Stevens "touch screen workstations, each with platform size 400mm square in stainless steel & weighing capacity of 15kg X 0.002kg.

The Vantage Recipe Formulation System (Stevens RFS) has a good way to ensure recipes are weighed accurately and consistently. The software has the following characteristics:

- The touch screen terminal software focuses on the user experience and is the simplest and most effective formula control scale available today. The Formula Control Scales can be driven by a production plan, setup either on the scale itself or through a PC, or imported through an ERP System.
- To the operators are given only minor choices to make on the terminal and they are forced to enter traceability information before each weighing takes place. Each employee has his user.

[20] cf. (website Stevens Group)

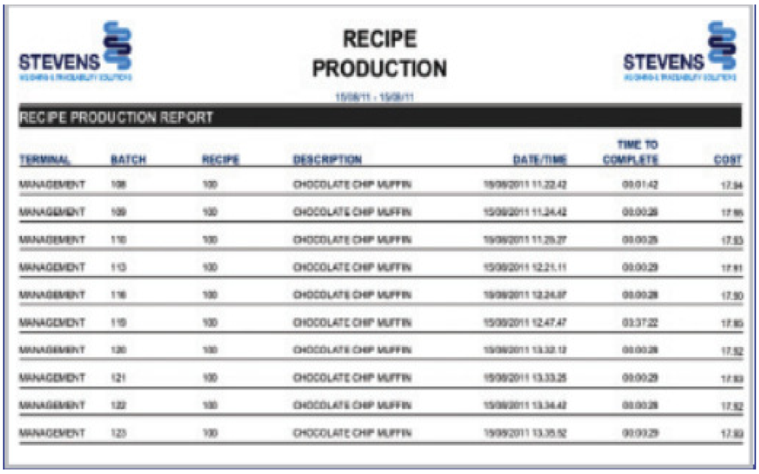
Figure 32 Stevens Vantage interface formulation system (User)

- Each Ingredient must be weighed within tolerance (green zone is configurable by ingredient) and the operator cannot move to the next ingredient until all the ingredients are weighed at the correct target weight. The software drive the operator and give also the possibility to add a new ingredients in the recipe

Figure 33 Stevens Vantage interface formulation system (weighing ingredients)

- The ingredient lot numbers are recorded (or scanned) in during the weighing process to ensure accurate and valid lot numbers are used. As the weighing process takes place, inventory levels are adjusted in real time, providing perpetual inventory.

- The software gives also different kind of Networked Traceability Reports (the system releases many other reports; we analyzed in detail only the ones that we believe more functional for the needs of the company, behind each short description there is a image where there is an example of which information gives each report) :
    1. Recipe Production report gives this information: what you have produced over a given time frame, how long it took and the ingredient cost.



TERMINAL	BATCH	RECIPE	DESCRIPTION	DATE/TIME	TIME TO COMPLETE	COST
MANAGEMENT	108	100	CHOCOLATE CHIP MUFFIN	15/09/2011 11.22.42	00.01.42	17.94
MANAGEMENT	109	100	CHOCOLATE CHIP MUFFIN	15/09/2011 11.24.42	00.00.28	17.95
MANAGEMENT	110	100	CHOCOLATE CHIP MUFFIN	15/09/2011 11.25.27	00.00.25	17.93
MANAGEMENT	113	100	CHOCOLATE CHIP MUFFIN	15/09/2011 12.21.11	00.00.29	17.91
MANAGEMENT	116	100	CHOCOLATE CHIP MUFFIN	15/09/2011 12.24.07	00.00.28	17.90
MANAGEMENT	115	100	CHOCOLATE CHIP MUFFIN	15/09/2011 12.47.47	03.37.22	17.85
MANAGEMENT	120	100	CHOCOLATE CHIP MUFFIN	15/09/2011 13.32.12	00.00.28	17.92
MANAGEMENT	121	100	CHOCOLATE CHIP MUFFIN	15/09/2011 13.33.25	00.00.29	17.93
MANAGEMENT	122	100	CHOCOLATE CHIP MUFFIN	15/09/2011 13.34.42	00.00.28	17.92
MANAGEMENT	123	100	CHOCOLATE CHIP MUFFIN	15/09/2011 13.35.52	00.00.29	17.93

Figure 34 Report Stevens recipe production

    2. Ingredient Usage Report: useful to recall list for a contaminated ingredient and see the total amount of ingredient used and all the information about this like for example the different cost achieved between the target and the net.

STEVENS | INGREDIENT LOT NUMBER REPORT | STEVENS

LOT NUMBER	:	050811
INGREDIENT CODE	:	EG
DESCRIPTION	:	LIQUID EGG

BATCH NO.	RECIPE CODE	DESCRIPTION	DATE / TIME	WEIGHT
106	100	CHOCOLATE CHIP MUFFIN	15/08/2011 11.15.10	0.50
107	100	CHOCOLATE CHIP MUFFIN	15/08/2011 11.16.00	0.50
108	100	CHOCOLATE CHIP MUFFIN	15/08/2011 11.22.42	0.50
109	100	CHOCOLATE CHIP MUFFIN	15/08/2011 11.24.42	0.51
110	100	CHOCOLATE CHIP MUFFIN	15/08/2011 11.25.27	0.50
111	100	CHOCOLATE CHIP MUFFIN	15/08/2011 12.11.18	0.50
112	100	CHOCOLATE CHIP MUFFIN	15/08/2011 12.12.29	0.50
113	100	CHOCOLATE CHIP MUFFIN	15/08/2011 12.21.11	0.50
116	100	CHOCOLATE CHIP MUFFIN	15/08/2011 12.24.57	0.49
118	100	CHOCOLATE CHIP MUFFIN	15/08/2011 12.29.32	0.50
119	100	CHOCOLATE CHIP MUFFIN	15/08/2011 12.47.47	0.51
120	100	CHOCOLATE CHIP MUFFIN	15/08/2011 13.32.12	0.50

Figure 35 Report Stevens Ingredient Usage

3. Batch Report: Detailed description of the batch (Date, time to complete the batch, list of all the recipes with all the steps, difference in Kg between net quantity and target...)

STEVENS | RECIPE BATCH | STEVENS

RECIPE BATCH DETAIL

RECIPE CODE	: 100	START DATE/TIME	: 15/08/2011 11.24.56
RECIPE NAME	: CHOCOLATE CHIP	END DATE/TIME	: 15/08/2011 11.25.23
BATCH NUMBER	: 109	TIME TO COMPLETE	: 00.00.26
JOB NUMBER	: 150811-J001	NO. OF PRODUCTS	: 0
SCHEDULED SIZE	: 100 %	PRODUCED MIX	: 100 %
PROD. LOCATION	: ANY		

INGREDIENT CODE	INGREDIENT DESCRIPTION	LOT NUMBER & QUANTITY		NET QUANTITY	TARGET QUANTITY
1	CHOCOLATE POWDER	110811	0.500 kg	0.500 kg	0.500 kg
EG	LIQUID EGG	050811	0.510 kg	0.510 kg	0.500 kg
GRAN	GRANULATED SUGAR	180411	0.500 kg	0.500 kg	0.500 kg
SFLR1	NW SILO FLOUR	180411	10.000 kg	10.000 kg	10.000 kg
W	NW WATER	180411	10.000 kg	10.000 kg	10.000 kg
		TOTAL		21.510 kg	21.500 kg

** - Denotes a Submix
^^ - Denotes Operator Change
NW - Denotes Non Weighed Item

Figure 36 Report stevens Recipe

Thermal Label Printer

The label formats are flexible, however information such as ingredient declaration and GTIN barcodes are available. Each workstation will be supplied with an Industrial Thermal Label Printer enclosed in a stainless steel lockable enclosure to protect the printer from ingress damage to the printer at all times. Typical information includes are: Product Name and code, expiration date, Batch or Lot number, Ingredient Declaration, Produced Date, Weight, Price per Kg and other field that the customer is able to defined.

Integration with both SAP MRP System and another database.

Stevens has a standard interface which allows bi-directional flow of data between all MRP & "back office" systems using XML file transfer methodology. After the interview with Stevens, three different kind of file XML were made in order to give Stevens an example of what information Roulunds Braking needs to be implemented into the software (Recipe import example, Requirement Import Example, Commodities Import Example)

4.4. Comparison of suppliers

The last and the main point of this project is the comparison of all the suppliers and make a rating of them. By doing this, Roulunds Braking can have a guideline for the choice of the supplier that can satisfy better its needs. Unfortunately as it was said in the previous paragraphs, it was not possible to interview all the companies so only for three of them is possible to give a valuable opinion: Mettler Toledo, Sartorius and Stevens Group.

The factor analysis method described in the section.2.7. was chosen to evaluate the different suppliers. The table that resumes the different score of all the companies is shown in the figure below:

FACTOR	WT.	DORAN	METTLER TOLEDO	SARTORIUS	SCANVAGAET	STEVENS GROUP
RESPONSE	3	X	E 9	O 3	X	A 12
FIRST IMPRESSION	4	X	E 12	O 4	X	I 8
PRICE	5	X	E 15	X	X	I 10
COMPARISON WITH TECHNICAL SPECIFICATIONS	5	X	E 15	E 15	X	E 15
TOTAL		0	51	22	0	45

Before going more into details about each company it is better to explain all the factors considered:

- Response: this factor is related to the quality and quickness of the answer of the e-mail that Roulunds Braking sent, for arranging a meeting and to obtain more information.
- First impression. It is the impression that the project owner got regarding each company when he contacted them.
- Price: It is the money that Roulunds Braking has to spend to buy the products that the suppliers are selling to satisfy its needs. Whereas Roulunds Braking didn't give a limit budget, the choice of this value was been made comparing the two offers that METTLER TOLEDO and Stevens Group presented.
- Comparison with Technical specifications: this factor is with the price the most important. It is indicated to evaluate in which proportion the suppliers can satisfy the needs of Roulunds Braking

Some companies never answered or answered late to the request of information of Roulunds Braking, so it was not possible to consider them in the rating. However, information about the software is included in the project in the project owner wants to consider them as an option in the future.

DORAN:

There is not information about the system of Doran (FC6300 Formula Control System) or if it is able to integrate with the SAP system and RDS database that Roulunds Braking is using. The system should able to read produce a label for the weighed out mix/final mix and create reports for detailed contents in a completed formula and for each material where it was used.

In addition, it was not possible to conclude if Doran has the scale that Roulunds Braking needs (25Kg with an accuracy of 0,001 Kg), if not it could be a big limitation.

METTLER TOLEDO:

It is the only company that sent a product specialist to Roulunds Braking and the second one that was interviewed; because of this a score of E in the factor of response has been given to them. The meeting was very good, the product specialist came to the company and gave an overview of the company and the product that they offer (in the valuation for this factor it has been given a score of “A”).

The total price is an estimation, because Mettler Toledo only provided information about the software. The package that they offer (consisting in Basic License, Master data Management, SAP certified interface and Database interface) is around 140000 DKK. For this factor has been chosen a value of “E”.

About the last factor “comparison with the technical specifications” it is possible to say that Mettler Toledo is able to fulfill the system requirements and also the physical requirement from Roulunds Braking.

SARTORIUS:

After two weeks they answered to the request of information and a meeting was organized, but it was not possible to do it because their representative could not attend the meeting. Because of this, they get a score of “O” in the first two factors.

There is not any information about the price of the products that they offer.

Relatively to the technical specifications, they send all the information of their products a few days before the dead-line of this project, but unfortunately there is not any kind of information about the system of Sartorius (Pro-mix for windows) being able to integrate with the SAP system and RDS. Apparently the software fulfils the demands of Roulunds Braking for both system requirements and the physical requirement. The score about this factor (comparison with the technical specification) was “I” but it should be investigated more into details, maybe with a meeting.

SCANVAEGT:

There is not any information about the system of Scanvargt (LabelFlex II) or if it is able to integrate with the SAP system and RDS database that Roulunds Braking is using. The system has an individual customization of screen display, has the function of online printer updating and is possible to customize the definition of barcodes. The system should able to read produce a label for the weighed out mix/final mix and create reports for detailed contents in a completed formula and for each material where it was used. Apparently this company also should able to satisfy the physical requirements of Roulunds Braking. However, it is not possible to tell if they have the scales that Roulunds Braking needs.

STEVENS GROUP:

It was the first company that answered to the request of Roulunds Braking and also the first that was interviewed; for this reason they have been given a score of E in the factor of response. The meeting with Roulunds Braking was on-line and the product specialist made a presentation about the software they can provide (in the valuation has been given a score of “A” for the factor “first impression”).

In relation with the price, Stevens made an estimation. The package that they offer is around 280000 DKK; this price includes the same products that Mettler Toledo included in his offer, but it also includes the delivery of all hardware to Demark, Hotel Accommodation, Installation, plus three day's training for Operators, Stores personnel & Management within Roulunds Braking. For this factor has been chosen a value of "I". But it is recommended to investigate more into detail.

About the last factor "comparison with the technical specifications" it is possible to say that Stevens Group is able to satisfy the System requirements and also the physical requirements of Roulunds Braking.

4.5. Conclusion

As a conclusion for this project, it is possible to say that the supplier that has the best result from the factor analysis method is **Mettler Toledo** with a score of 51, followed by 45 from Stevens Group. This difference is related to the third factor: price. Further investigation is strongly recommended before the final choice, since Mettler Toledo only provided information about the price of the software.

Sartorius is placed at the third place in this evaluation, but there is missing information related to the price and it is not clear if they can fulfill all the needs of Roulunds Braking.

About the other two suppliers, it is not possible to reach a conclusion because they never answered to the request of information. Basing on the information gathered from the website, it is possible to say that they could be adequate suppliers for Roulunds Braking. However, further investigation is recommended again to know if they can be a suitable supplier

5.0 Pilot-Plant Layout

5.1 Definition

Plant layout refers to the arrangement of physical facilities such as machines, equipment, tools, furniture etc. in such a manner so as to have quickest flow of material at the lowest cost and with the least amount of handling in processing the product from the receipt of raw material to the delivery of the final product.

Layout planning is important because it usually represents the largest and most expensive resources of organization. Moreover, the arrangement of production equipment has a direct impact on two of the seven wastes of production identified by Ohno (1997): excessive handling and transportation. Other waste, such as work in process, lead time and delays are also influenced by the physical arrangement of facilities. Therefore, the layout of shop floor has impact in the organization's performance. Performance indicators like flexibility, time, cost, among others, are affected by the concept of physical arrangement adopted by the factory. Designing physical layout in order to obtain an efficient process flow is a big challenge for companies that seek excellence in their production processes.

The objectives of a good plant layout are:

- Proper and efficient utilization of available floor space
- Transportation of work from one point to another point without any delay
- Proper utilization of production capacity
- Reduce material handling costs
- Utilize labor efficiently
- Reduce accidents
- Provide for volume and product flexibility
- Provide ease of supervision and control
- Provide for employee safety and health

- Allow easy maintenance of machines and plant.
- Improve productivity

There are mainly four types of plant layout:

(a) Product or line layout:

In this type of layout the machines and equipments are arranged in one line depending upon the sequence of operations required for the product. It is also called as line layout. The material moves to another machine sequentially without any backtracking or deviation i.e the output of one machine becomes input of the next machine. It requires a very little material handling.

It is used for mass production of standardized products.

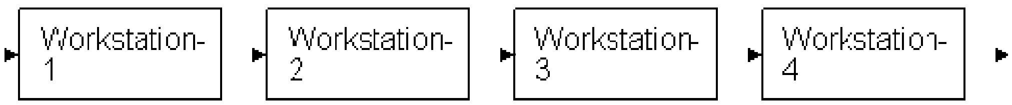


Figure 37 Product or line layout

Advantages of Product layout:

- ·Low cost of material handling, due to straight and short route and absence of backtracking
- ·Smooth and continuous operations
- ·Continuous flow of work
- ·Lesser inventory and work in progress
- ·Optimum use of floor space
- ·Simple and effective inspection of work and simplified production control
- ·Lower manufacturing cost per unit

Disadvantages of Product layout:

·Higher initial capital investment in special purpose machine (SPM)

·High overhead charges

·Breakdown of one machine will disturb the production process.

·Lesser flexibility of physical resources.

(b) Process or functional layout:

In this type of layout the machines of a similar type are arranged together at one place. This type of layout is used for batch production. It is preferred when the product is not standardized and the quantity produced is very small.

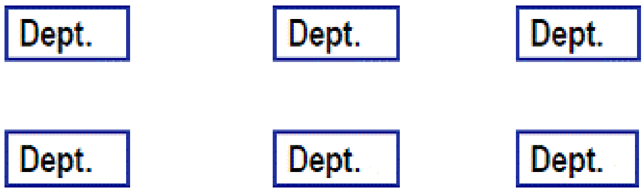


Figure 38 Process or functional layout

Advantages of Process layout:

·Lower initial capital investment is required.

·There is high degree of machine utilization, as a machine is not blocked for a single product

·The overhead costs are relatively low

·Breakdown of one machine does not disturb the production process.

·Supervision can be more effective and specialized.

·Greater flexibility of resources.

Disadvantages of Process layout:

·Material handling costs are high due to backtracking

·More skilled labour is required resulting in higher cost.

·Work in progress inventory is high needing greater storage space

·More frequent inspection is needed which results in costly supervision

(c)Fixed position or location layout

Fixed position layout involves the movement of manpower and machines to the product which remains stationary. The movement of men and machines is advisable as the cost of moving them would be lesser. This type of layout is preferred where the size of the job is bulky and heavy. Example of such type of layout is locomotives, ships, boilers, generators, wagon building, aircraft manufacturing, etc.

Figure 39 Fixed position or location layout

Advantages of Fixed position layout:

- ·The investment on layout is very small.
- ·The layout is flexible as change in job design and operation sequence can be easily incorporated.
- ·Adjustments can be made to meet shortage of materials or absence of workers by changing the sequence of operations.

Disadvantages of Fixed position layout:

- ·As the production period being very long so the capital investment is very high.
- ·Very large space is required for storage of material and equipment near the product.

·As several operations are often carried out simultaneously so there is possibility of confusion and conflicts among different workgroups.

(d) Combined or group layout

A combination of process & product layout is known as combined layout[21].

The Pilot Plant is the part of the factory where the brake pads are produced for testing, with a total area of approximately 470 m^2. Not only brake pads are produced in this area, roll linings are attached to the shoe and given shape before going to the dynamometer for testing.

It basically consists of a storage area of raw materials, weights, mixers, presses, ovens and some additional equipment necessary for the pad manufacturing process.

[21] cf (http://www.websukat.com/)

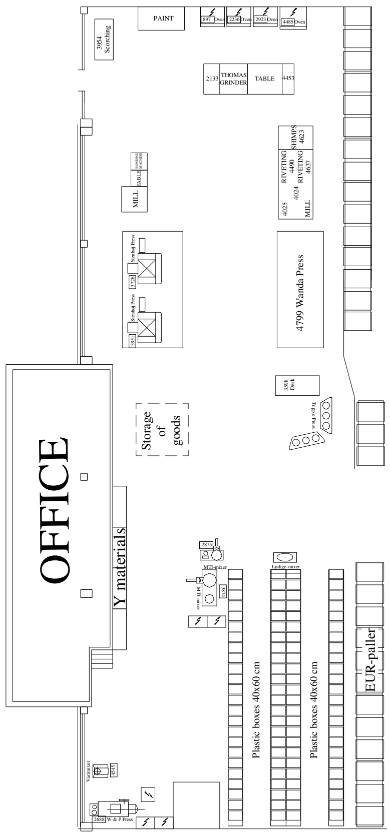


Figure 40 Pilot Plant

It is a small-scale version of the full production process, so that brake pads can be manufactured under the same conditions. Prototypes have to be manufactured before a brake pad reaches the production stage. These prototypes are then tested in the laboratory, dynamometer, car-testing area, test tracks or tested for the customer itself, before finally going into production. Roulunds Braking has five dynamometers for friction testing and, through the sister company Meneta, three noise test rigs. After dynotesting the friction materials are mounted on a vehicle. Testing is carried out in various locations and several test tracks. These tests are based on the high standards and specifications set by the vehicle and the brake system manufacturer. After the rigorous testing program is completed, the friction materials are released and approved by the customer ready for production.

Brake pads are a component of disk brakes used in automotive and other applications, made of steel backing plates with friction material bound to the surface that faces the disk brake rotor. Its function is to convert the kinetic energy of the car to thermal energy by friction. When the brakes are hydraulically applied, the caliper clamps or squeezes the two pads together into the spinning rotor to slow/stop the vehicle. When a brake pad is heated by contact with a rotor, it transfers small amounts of friction material to the disc, turning it dull gray. The brake pad and disc (both now with friction material), then "stick" to each other, providing the friction that stops the vehicle.

Figure 41 Brake pads

Brake pads made by Roulunds Braking are developed in close cooperation with both brake and vehicle manufacturers. Each break system, and the vehicle in which it is fitted, has specific requirements for each break pad.

The pads are attached to a metal backing plate, coated with a special adhesive. The friction material is bonded to the backing plate, and advance in critical technical process considering that a brake pad has to withstand extremely high shear forces.

Afterwards an anti-noise shim is attached to the pad. They prevent the development of noise and squeal when braking. Both backing plates and shims are manufactured by the sister company MENETA.

5.2. Definition of the project

The description of the project is to create a new Pilot Plant layout. The main goal is to achieve a very organized and visual flow for the process in the Pilot Plant. But besides this aim, the project includes as well the integration of all the three departments involved in the production and testing of brake pads: cart testing area, laboratory and the pilot plant itself. The sub-goals are:

- Creating a new laboratory layout
- Making a list of all the equipment in the laboratory that needs to be moved

The first step in the project is a complete dedication of a fully understanding of the process flow in the pilot plant. This requires time for understanding all the stages or operations required in the process. Only after this step, a full analysis of the layout and a proper thinking about the possible improvement can be done.

Understanding the logical movement of people, materials and product traveling between the first stage of production and the packaging area is the primary challenge of developing an efficient plant layout. The ultimate goal is to optimize the workflow of people and product now and into the future.

5.3. Description of the existing layout

As it is shown in the Figure, the Car testing area and the Laboratory are far away from the Pilot Plant. This is a big dysfunction because the Pads have to move from one area to another several times, representing a big waste in time and not contributing to achieve a clear and effective flow of materials.

The pads are produced in the pilot plant and then moved to the laboratory or to the car test area several times for their testing. That is what makes the integration of the

3 areas so important in order to reduce waste of time executing these movements between the areas.

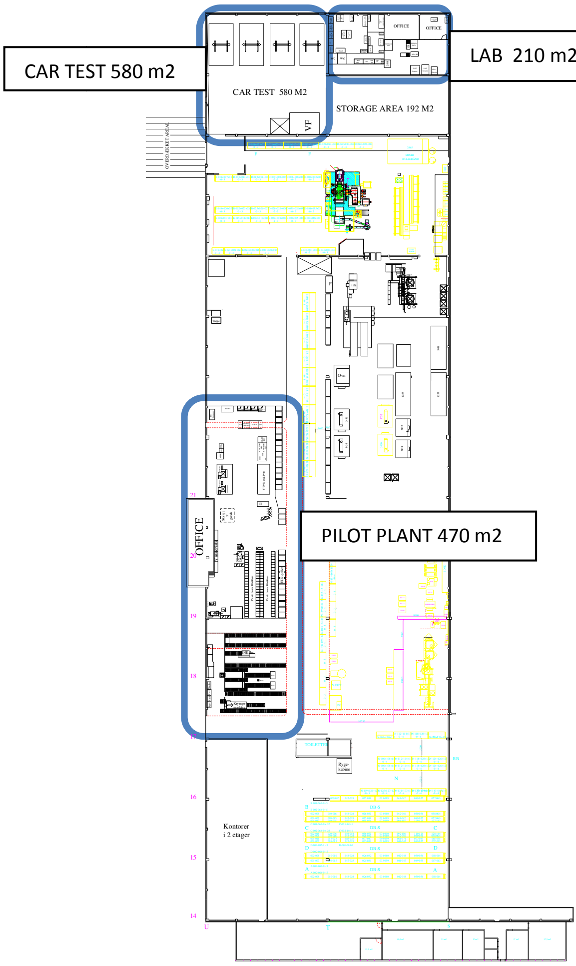


Figure 42 Facility layout

5.3.1. Process flow in the Pilot Plan

The process flow in the Pilot plan has nine stages:

1. Weighing.

Around 200 different raw materials are processed to produce friction materials. The operator receives the order with the recipe and weights the ingredients in any of the 2 weighing scales.

Figure 43 Station weighing

2. Mixing.

This is one of the most delicate processes in the production of a pad. The mix of materials is designed to obtain a material that can maintain a stable coefficient of friction and a constant range of temperatures. The operator mixes the raw materials in one of the mixers. He uses a different type of mixer depending on the amount or type of mix.

Figure 44 Station mixing

3. Pressing.

The prepared backing plates are pressed together with the friction materials. The pressing is carried out by the Wanda press (most often) or the Tripple Press. For the big pads for trucks, the pressing is carried out in the Stenhøj press. This pressing has to be performed in a way that guaranties uniformity in the porosity and density of the material.

Figure 45 Station pressing

4. Curing.

After pressing and sticking the material to the backing plate, the pad moves on to a curing process in several ovens. Between 6 and 10 hours, the pads are subjected to different temperatures, from the ambient temperature to more than 200 °C. This process removes volatile elements which would cause the brakes to fade under aggressive use

Figure 46 Station curing

4.1 Scorching (Optional).

Sometimes this step is required. Scorching is an additional stage in the process in which the uncured bonding agents are eliminated by intense super-heating of the surface, reaching 650°C while being pressed, in order to stop the evaporation of gasses and inefficient materials that cause fading. This process makes the coefficient of friction consistent and predictable.

Figure 47 Scorching

5. Grinding.

The operator grinds the pads in the Thomas grinder to finish the thickness before sending them to the lab.

Figure 48 Grinding

6. Laboratory.

Now the pads go to the lab to be tested. This process is described in the section 5.3.2.“Laboratory“.

7. Painting.

The pads are painted with anti-corrosion paint to prevent the appearance of oxides and impurities in the pad, contributing a fine termination of the product, before the accessories and anti noise shims are fitted.

Figure 49 Painting

8. Finishing.

After being tested in the lab, the pads go to the finishing area. This area includes the equipment necessary for adding the anti noise shims, clips, rivets, etc. There is also a mill where slots can be made to increase heating expansion performance.

Figure 50 Station finishing

9. Testing

When all the process is finished, then the pads are sent to be tested in the dynamometers, in the test tracks or by the customer. Only when all the testing is finished the pad can go into production.

5.3.2. Laboratory

The R&D department in Roulunds Braking has a fully equipped Laboratory in the facilities in Odense. All new raw materials are tested here before incorporating them to the stock of raw materials and the brake pads prototypes and roll linings are subjected to different test as well to verify their properties before they can be launched into production.

These are some of the test and equipment existing in the laboratory:

Shear test: These tests are conducted to determine the strength of the attachment of the friction material to the steel back plates of brake pads and brake shoes.

Gogan hardness: It is a nondestructive (a penetrator causes surface deformation) method of measuring compressibility and is used as a quality control check of the consistency of formulation and processing of a brake lining. Gogan hardness alone shows nothing about a lining's ability to develop friction or to resist fade when used as a friction element in brakes. Gogan hardness varies with formulation, contour, and thickness of the lining. The Gogan hardness and the range of Gogan hardness are peculiar to each formulation, thickness, and contour and, therefore, the acceptable values or range must be established for each formulation and part configuration by the manufacturer.

Rockwell hardness test: It is a method for testing the hardness of metals by determining the depth of penetration of a steel ball or a diamond sphere. The value is read from a dial and is an arbitrary number related to the depth of penetration.

Pycnometer: It is an instrument which measures the absolute density of solid volumes employing some method of gas displacement (usually helium), to determine the porosity of the material. Porosity is a physical characteristic which can affect several performances of friction materials, such as noise damping and fade resistance.

Sieve test: A sieve analysis test is a procedure to assess the particle size distribution (also called *gradation*) of a granular material. Gradation affects many properties of an aggregate, like bulk density, physical stability and permeability. The proportion of different size particles is recorded. This record is the conclusion of the analysis.

Stiction test: Stiction (μ_s) is the static friction that needs to be overcome to enable relative motion of stationary objects in contact. This test measures this friction between the two materials.

Moisture test: Moisture refers to the presence of a liquid, especially water, in a material. Humidity may increase the friction level for the first few applications. They may develop the brakes noise and cause brake-grab for a short time.

Melting point test: The melting point of a substance is the temperature at which the material changes from a solid to a liquid state. Determining the MP is a simple and fast method used in many diverse areas of chemistry to obtain a first impression of the purity of a substance.

pH test: All chemical processes have an ideal pH where they function optimally. That makes the determination of the pH of any material an important issue for testing.

Compressibility test: If the friction material of a brake pad or brake shoe is too compressive the application of the brake will not feel positive and firm. It is therefore important to verify that the material does not compress excessively when a pressure is applied to it. Cold and hot compressibility tests are therefore conducted on brake pads and brake linings in order to establish their compressibility.

Hot swell: In this testing method, the pads are heated to check the swelling they suffer in response of the heating.

Acetone: This test measures the amount of oil present in raw materials or brake pads.

The first thing required by the project owner regarding the laboratory is a list with all the equipment that needed to be moved into the new area and classifying this equipment in categories (Noisy, chemical, sensitive, hot).

Machine	Nº	HEAVY NOISY	Compressibility noisy/hot	OVEN (HOT)	CHEMICAL	SENSITIVE	Extraction needed?	Additional equipment
Sieve test	-	X						Desk
Stamp volumeter (bulk)	3669	X						
Air sieve	3859	X					X	
Weight	3531							
Oven	4606			X			X	
Ash oven	0014			X			X	
Oven	301			X			X	
Flow oven	3536			X			X	
Hot swell	3488			X			X	
Hexamine	4726				X		X	
Moisture	4769				X		X	
Heating plate	4730				X		X	With chemicals
Extraction equip. (acetone)	-				X		X	Cabinet, cooling
Hot plate cure HPC	-				X			With chemicals
Stiction	4641							
PH	4311				X			
Weight	3836					X	X	Cabinet
Melting point test	-				X		X	

Weight	3535					X		
Pycnometer	3793				X			Gas
AAS	-						X	Computer, printer, microwave
Comp.	4507		X				X	Cooling
DST/TGA	-					X		Water, air, computer
Gogan	661						X	
Shear	2971						X	
Drill	4429							
Grinder	3127						X	
Grinder	2215						X	
Grinder	4299						X	
Rockwell	3526		X					
Calibrating equip.	47014							
Oven	823			X				

Table 2 List laboratory equipment

The previous layout of the Laboratory it is shown in the next figure:

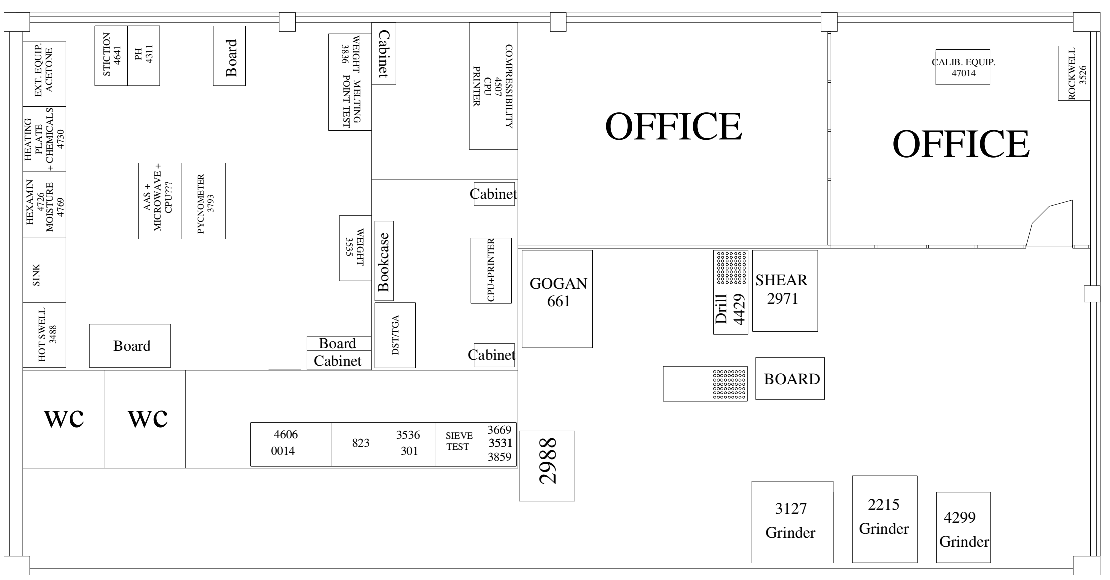


Figure 51 Previous lab layout

Since the Laboratory was going to be placed somewhere else, next to the pilot plant, it was a perfect time to make an analysis of the equipment distribution and consider possible changes in the layout.

The first decision was to move some equipment into the pilot plant area, placing it closer to the pads and roll linings. This equipment is the Shear test machine, the Gogan Hardness test machine, the drill and all the grinders located in the laboratory.

For displaying the layout, the first step was creating the conceptual layout of the laboratory, which means organizing the equipment in "families" or categories, as it was classified in the list: hot/noisy, chemical or sensitive.

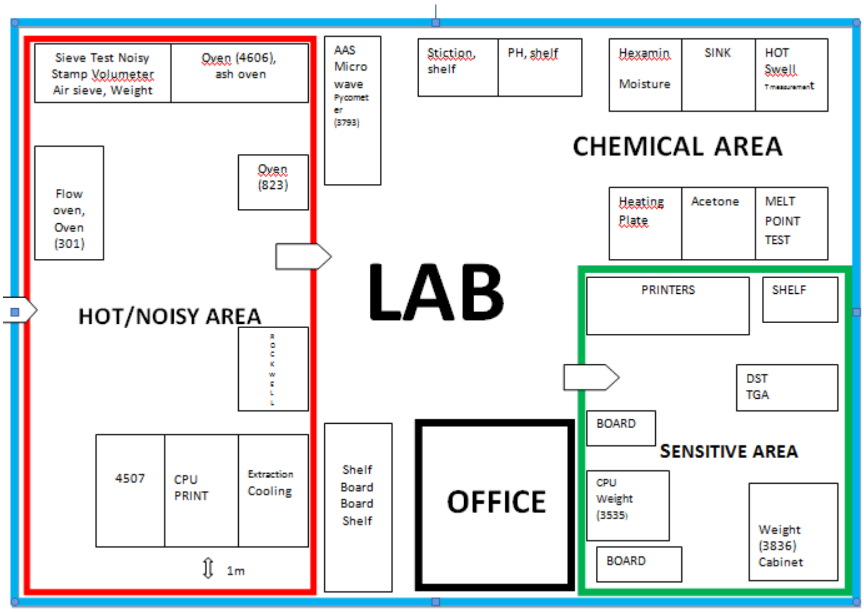


Figure 52 Concept lab layout

This conceptual layout shows an attempt of grouping the equipment with similar characteristics in the same room or area, but finally it was not possible because of the lack of space available. In the new area there were 104 m^2 available, much less space than in the previous area. But with an optimization of the space needed and the reduction of the equipment necessary, the conclusion was that it was possible to fit the new Laboratory in the area available.

For the final layout display, some requests the workers in the laboratory had were taken into consideration. Some of these requests were that the hot swell (3488) was placed in one corner, the DST/TGA was placed in another corner, the chemical equipment was located in some area where people don't walk around, etc.

After considering all these facts and trying to keep the organization of the conceptual layout, this final layout was accepted in accordance with the R & D department and the laboratory workers:

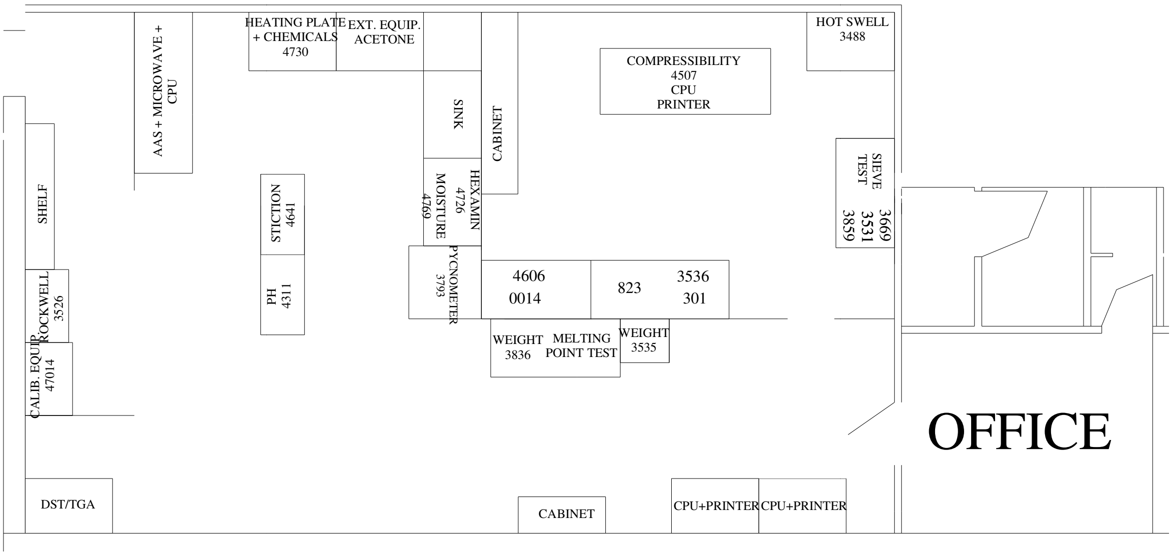
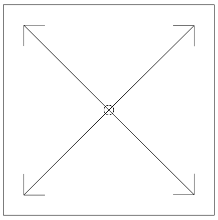


Figure 53 Final lab layout

5.4. Analysis of the concept layout

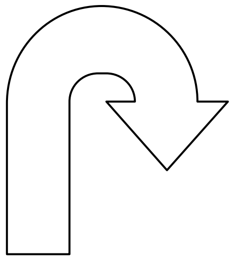
Before thinking about a detailed layout, the first thing to do was a conceptual layout or a general overall layout. This establishes the general arrangements of the area to be laid out.

Since there is only floor worker currently operating in the pilot plant, he is required to do a lot of displacements all over the area for doing all kind of tasks. Due to this fact the decision was to organize the layout following a square concept, which means that the equipment was displaced in a squared shape, with the square representing the minimum distance between one place to another:



It was made a distinguishing between three concepts or separate areas: dusty, hot and clean. The dusty area was the one where a considerable amount of dust was generated, so an extraction system was needed. This area includes the weighing area and the raw materials storage, the mixing area and all the grinders. The hot area is where the machinery operates at high temperatures. In this area the ovens and presses are located. The clean area is that one that needs a total absence of dust and the product to be clean for processing it. This is important in the finishing area, where the anti-noise shims and the rivets are attached to the pad.

Besides this concepts, the decision was to make a "U shaped" layout instead of a linear one. This allows us to organize the equipment in a linear disposition but fitting in the "square" concept explained before.



Regarding all this and after several proposals that can be found in the appendix, this conceptual layout was made in agreement with the R & D department:

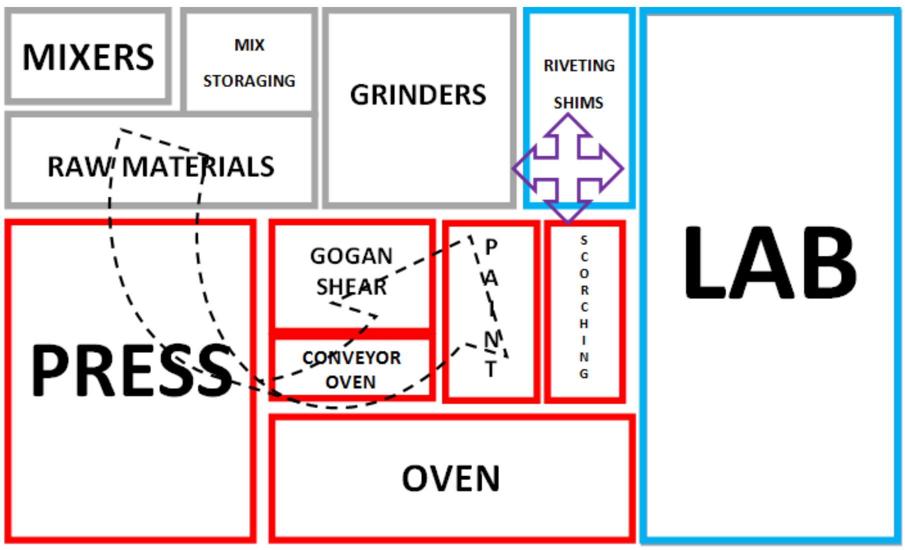


Figure 54 Concept pilot plant layout

5.5. Analysis of the new layout

After the general overall layout is developed, the next phase is to make the detailed layout. This involves the detailed planning of each piece of machinery, equipment and storage area, for each of the activities, departments or areas which have been blocked out in the general overall layout.

As it was explained before, the idea is not only to create a new layout but to move the pilot plant to another location, as well as the laboratory and the car testing area. The first option was to place everything in the storage area next to the offices, as it is shown in the figure:

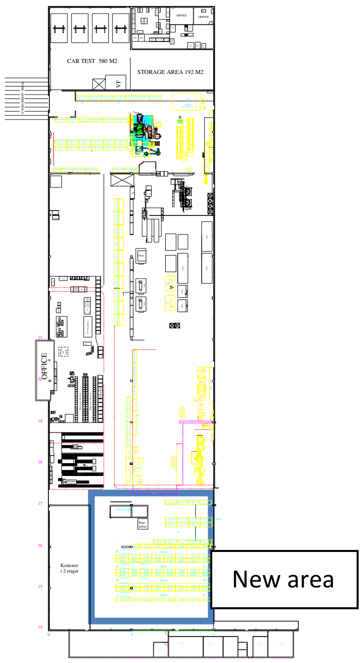


Figure 55 First possible location oft he Pilot Plant

A proposal of layout was made based on this possibility, but this option was dismissed soon because the space available was not enough to place all the pilot plant, laboratory and car testing area, and because the company started to think about the possibility of building a new facility for the pilot plant, situated next to another building rent by the company and currently used as a garage:

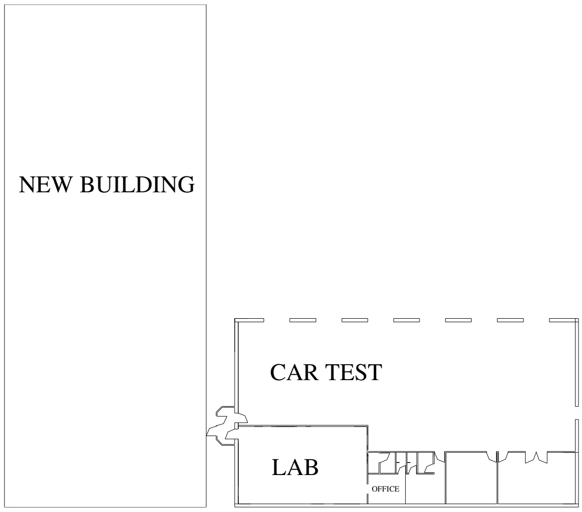


Figure 56 New Pilot Plant location

The new building will have approximately 863 m^2 and the annex building 553 m^2. It will be built by the owner of the land, the Lillebaelt group, and rented by Roulunds Braking.

Working with this new possibility and following the conceptual layout previously described, the two proposals of new layouts are now presented. Those layouts are represented by principal drawings, which means that they are not accurate. These drawings need a further analysis before the final implementation of any layout. Both proposals include the acquisition of a new conveyor oven and a possible new press, and both layouts have a “U” shaped disposition of machinery as mentioned before.

However, during the whole project, several layouts or proposals were considered and afterwards dismissed. Some of these proposals can be found in the appendix.

Layout A

The first proposal is a cellular layout. The mixers and raw materials are located in a closed area to make the extraction easier. The main characteristic is the grouping of equipment in cells.

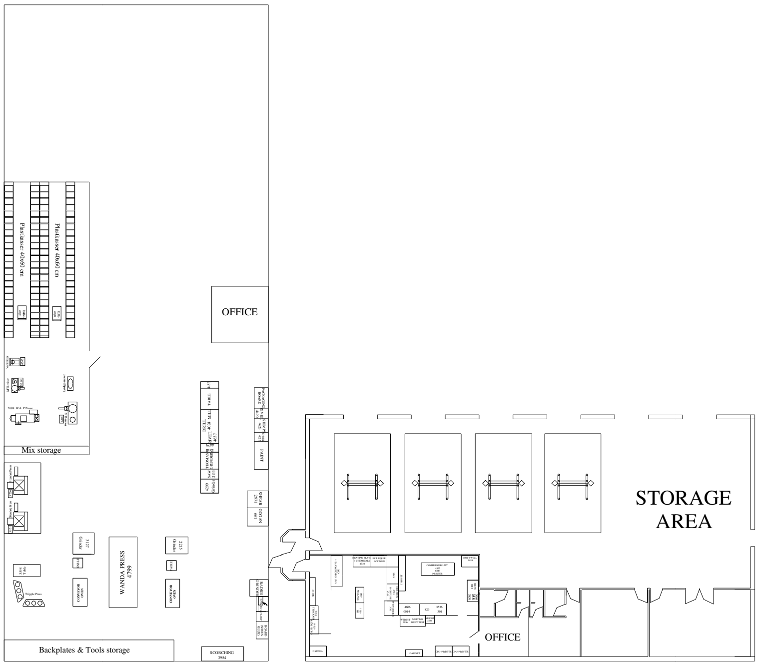
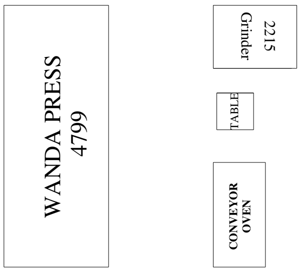
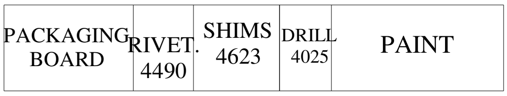


Figure 57 Layout A

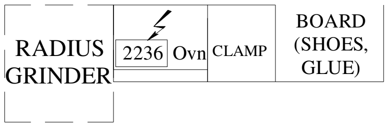
The press, grinder and oven are grouped in one cell, making the process more fluent, with a total of two cells. One of them with Wanda press and the other cell with the Tripple press. This can change with the possible acquisition of a new press, replacing the Tripple press. The pads go straight from the press to the oven and then are grinded before going to the laboratory.



The finishing area is made grouping the machinery needed for the finishing process for both pads and roll linings in two separate groups of machinery. For the pads it includes the painting, one drill, the shims machine, one riveting machine and a board for doing the packaging.



The equipment necessary for the roll linings is the following: A board for attaching the lining to the shoe and a clamp to give it the shape necessary before sending it to the dynamometer to be tested. It includes as well the possible purchase of a new Radius grinder.



Next to the laboratory the Shear and Gogan test machine are placed, the rest of the equipment is placed in front of the finishing line.

NEW PROCESS FLOW

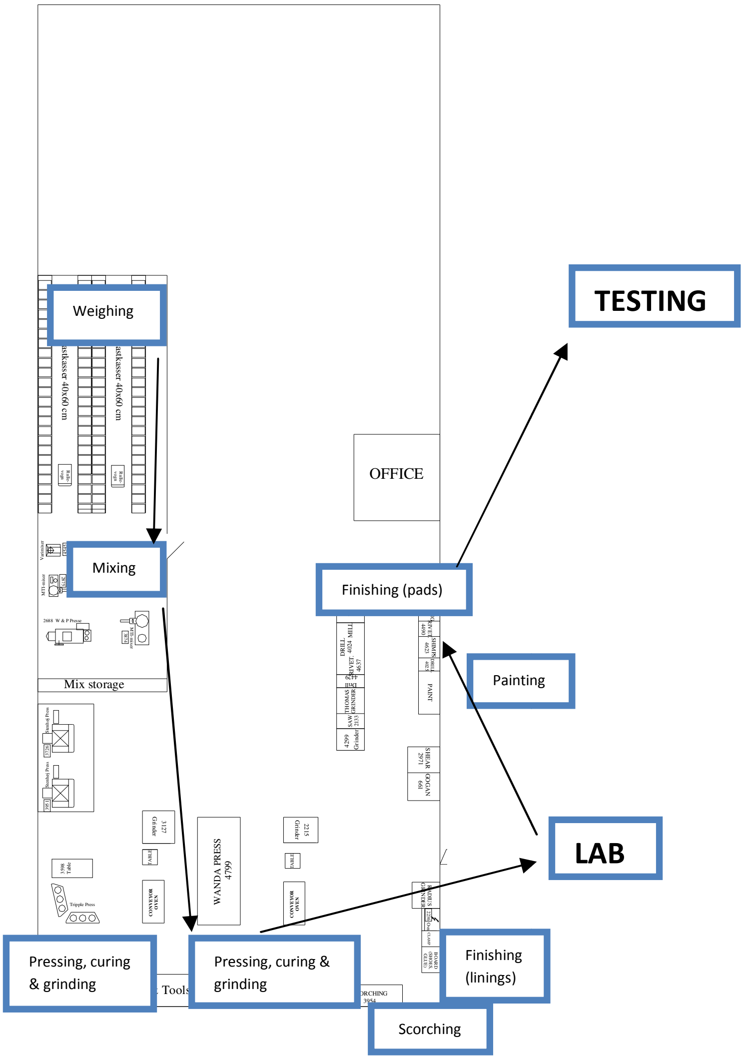


Figure 58 New process flow Layout A

Layout B

The second proposal of layout is a combined layout, combination of process and product layout. The machinery is displaced in one "U" shaped line according to the process (product layout) but some machinery is grouped by similar characteristics, like the finishing area (process layout).

Figure 59 Layout B

In this layout the machinery is organized according to the stages in the process. First the mixing and weighing area, then the presses, grinders, test, painting and scorching and finally the finishing area. The grinders are all together in one closed space to allow a better extraction.

NEW PROCESS FLOW

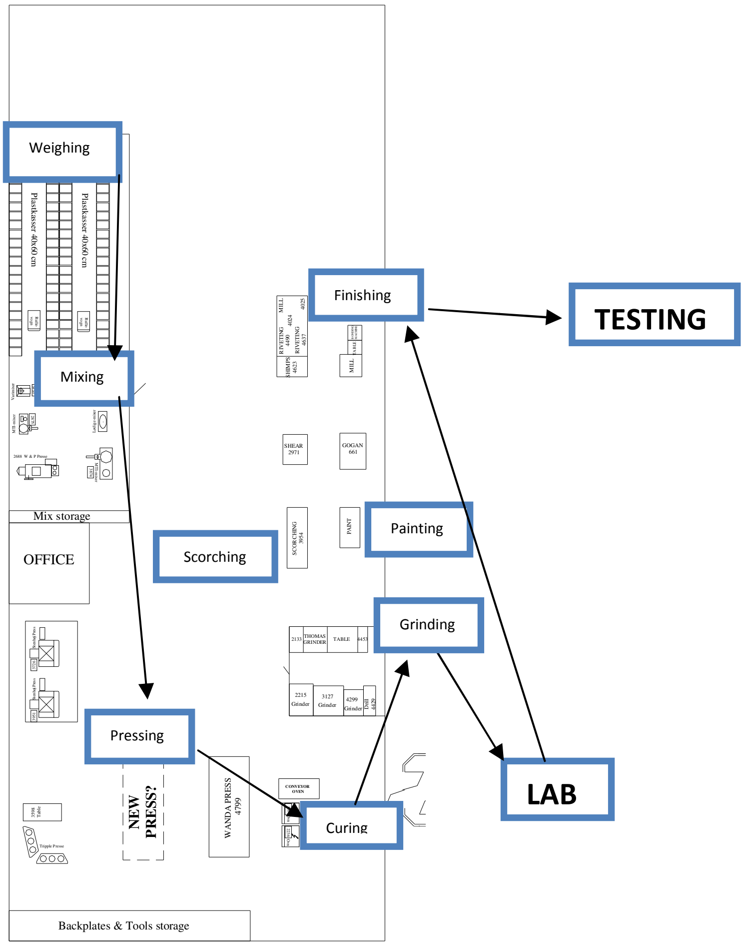


Figure 60 New process flow layout B

LAYOUT RATING

The rating of the two proposed layouts is made according to the method explained in section 2.7:“Evaluation of alternatives“. This method is called factor analysis method.

The factors taken into consideration for the rating and the importance or weight or each factor was agreed with the project owner. The cost is not considered a factor due to the fact that both layouts require the moving and installation of the equipment, which makes the cost almost the same for both of them. So when the economic considerations don’t make a difference in the choice of the layout, the factor analysis method is a very good way of evaluating the alternatives. The factors chosen were the followings:

- Worker flow: It is related to the space needed to be covered by the worker to perform his daily operations
- Process flow: Describes the material movements during the process
- Flow visualization: How visual is the process flow and the sequence of operations
- Possible expansion: Existence of the possibility of expanding the layout
- Interaction with other departments: Proximity or inter-relation of the Pilot Plant with the Laboratory and the Car test area
- Flexibility: A flexible layout is one that maintains low material handling costs despite fluctuations in the product demand levels
- Grouping of equipment: The organization of the equipment in groups with the same characteristics or according to the process needs

FACTOR	WT.	LAYOUT A	LAYOUT B
WORKER FLOW	4	A / 16	E / 12
PROCESS FLOW	5	E / 15	I / 10
FLOW VISUALIZATION	4	I / 8	E / 12
POSSIBLE EXPANSION	3	A / 12	A / 12
INTERACTION WITH OTHER DEPARTMENTS	4	A / 16	A / 16
FLEXIBILITY	4	E / 12	I / 8
GROUPING OF EQUIPMENT	3	E / 9	I / 6
TOTALS		88	76

Figure 61 Evaluation of the different layout

According to the results of the rating, the Layout A gets a total score of 88 and Layout B a score of 76. This analysis will have a significant weight in the final decision of selecting a layout.

5.6. Cost analysis

The costs showed in this section are the ones of moving the pilot plant to the new location. It is an estimation of the cost of taking down the machines, moving and installing them, as well as the purchase of new machinery or equipment and the power supply needed for all the pilot plant.

The same cost is assumed for the two possible layouts, since the location is the same for both of them.

Machine	Num.	Hours	Price per hour (dkk)	Total price (dkk)
Dt press	3598	16	410	6560
Ovens (all)		16	410	6560
Wandapress	4799	10	410	4100
Stenhoj Press	3726/3951	50	410	20500
Mixers (all)		16	410	6560
Grinder	2688	8	410	3280
Gogan	661	4	410	1640
Grinder	4299	2	410	820
Shear	2971	3	410	1230
Grinder	2215	2	410	820
Carrycot		8	410	3280
Extraction		80	410	32800
All small machinery		16	410	6560
Total		**231**		**94710**

Figure 62 Cost of taking the machines down

Machine	Num.	Hours	Prices per hour (dkk)	Total price (dkk)
Dt press	3598	37	410	15170
Ovens (all)		37	410	15170
Wandapress	4799	23	410	9430
Stenhoj Press	3726/3951	100	410	41000
Mixers (all)		37	410	15170
Grinder	2688	18	410	7380
Gogan	661	9	410	3690
Grinder	4299	5	410	2050
Shear	2971	7	410	2870
Grinder	2215	5	410	2050
carrycot		18	410	7380
Extraction		184	410	75440
All small machinery		37	410	15170
Total		**517**		**211970**

Figure 63 Cost of installing the machines

Concept	Price (dkk)
Vacuum cleaner	100000
Power cable in the building	200000
Air for machines	240000
Power supply for the machines	300000
Moving machines to the new building	100000
Cooling water	400000
Transform	350000
Conveyor oven	100000
Power board for all machines	200000
Total prices	**1990000**

Figure 64 Cost of new equipment and others

TOTAL COST: 2296680 DKK

5.7. Conclusion

The objective of this project was to create a new layout and to achieve a very visual process flow, so any of the proposed layouts fulfill these conditions. But after analyzing both proposals and rating them, the project leaves the conclusion that the best possible layout is **Layout A**.

According to the factor analysis method used to rate the proposals, the layout A is the best choice for Roulunds Braking ApS, since the factors and their relative weight were chosen by the project owner.

With this new layout the goal of obtaining a very visual flow is achieved. All the equipment is displayed in a logic way and it is very easy to see the sequence of operations. But besides this main goal, the objective of the integration of all three departments (pilot plant, car testing area and laboratory) is clearly achieved as well, due to the proximity of the three areas in the new location.

The laboratory gets and improvement with the new layout since there was a lack of a study about the laboratory processes and the organization of the equipment.

Although recommending the Layout A, the project conclusion cannot be the implementation of the new layout. The drawings are principal drawings, which means that for the full implementation of the layout, a further analysis is required and accurate drawings needed, as well as a checking of the cost analysis. This was not done in this project because it was not the objective of the project owner.

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Authorless. from Sartorius : http://www.sartorius.com/

Authorless. from Scanvaegt: http://www.scanvaegt.com/

Authorless. from Stevens Group: http://www.stevensgroupltd.com/

Authorless from Sukat http://www.websukat.com/

Statutory Declaration

We assure that this report is a result of our personal work and that no other than the indicated aids have been used for its completion. Furthermore, we assure that all quotations and statements that have been inferred literally or in a general manner from published or unpublished writings are marked as such. Beyond this, we assure that the work has not been used, neither completely nor in parts, to pass any previous examination.

Location, Date	Signatures of authors

Appendix

PROJECT ODER

MEASUREMENT OF THE EXTRUDER TO REDUCE FINS (KKP)

a) Description of the problem:

Excessive amount of fin in the process of extrusion in ALTEC roll former and missing measurement for the temperature between the wheels.

b) Description of the project:

Identify the critical part of the process where the "fins" are produced with the purpose of eliminate them

c) Description of the goal:

Elimination of surplus material or at least reduce the amount of 'fins' by 50%.

Sub goals:

Find a way to measure the temperature at the wheels.
Find how the temperature effects on the wheels
Find a way to reduce the negative effects of the temperature on the linings
Find a way to control/remove the distortion in the wheels
Find how the distance between the wheels effects the product
Find a solution to reduce the numbers of the fins

INPUT	PROCESS	OUTPUT
Mix temperature/Time limit	Temperature	Lining (with fins)
Wheel Speed and ratio	(result of process)	Make quality measure
Wheel thickness		
Different Production formulations	Distortion of Wheels	
Mix Hardness/"extrudability"		
Effect of formulation		
Dimension of wheels		
Existing temperature		

PILOT PLANT LAYOUT

a) Description of the problem:

Working in the Pilot Plant area involves a lot of unnecessary handling and movements of raw materials, tools and finished goods due to lack of flexibility process wise and flow wise

b) Description of the project:

Create the new Pilot Plan Layout.

c) Description of the goal:

Create a very visual flow of the process

Sub goals:

Analyze the Current Pilot Plant layout.
Find the best way to create a continuous flow with respect of the purpose – reduce unnecessary handling and movements.

d) Limitations of the project:

Only use the existing area and machinery

TRACEABILITY

a) Description of the problem:

Claims and production process problems cannot be handled/executed the right way since raw materials, processes and production parameters cannot be traced through the process

b) Description of the project:

Establish a way to make a large and organized system for labeling

c) Goal description:

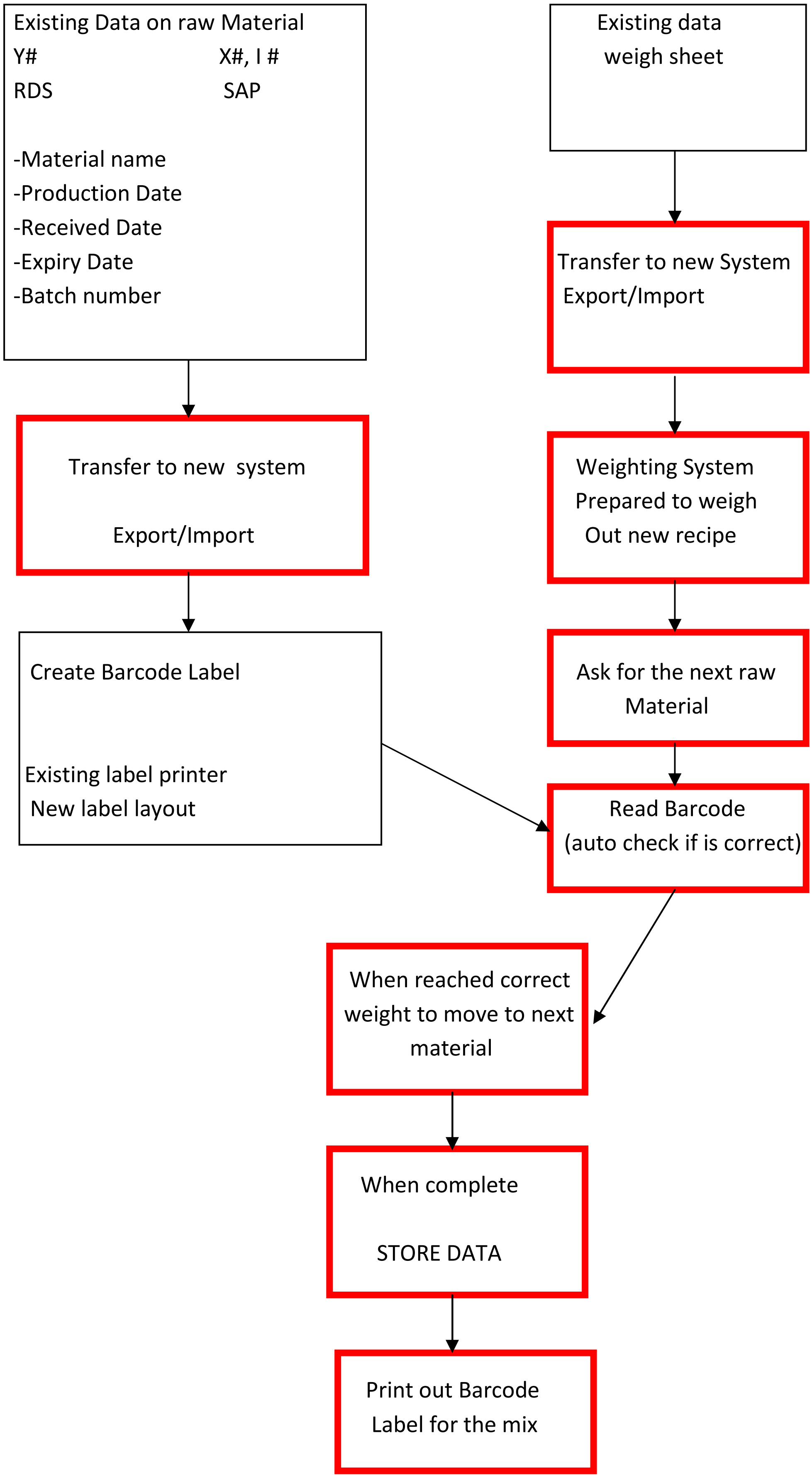
Document Traceability (Labeling/Weighting)

Sub Goals:

Collect the Existing Data
Find a way to transfer the Data to a system
Find a way to transfer the existing Data weight sheet (export/import) also the weighting system is prepared to weight out new recipe and ask for the next raw materials.
Create Label Barcode.
Search for Suppliers (Barcode/Labeling and weighting system).

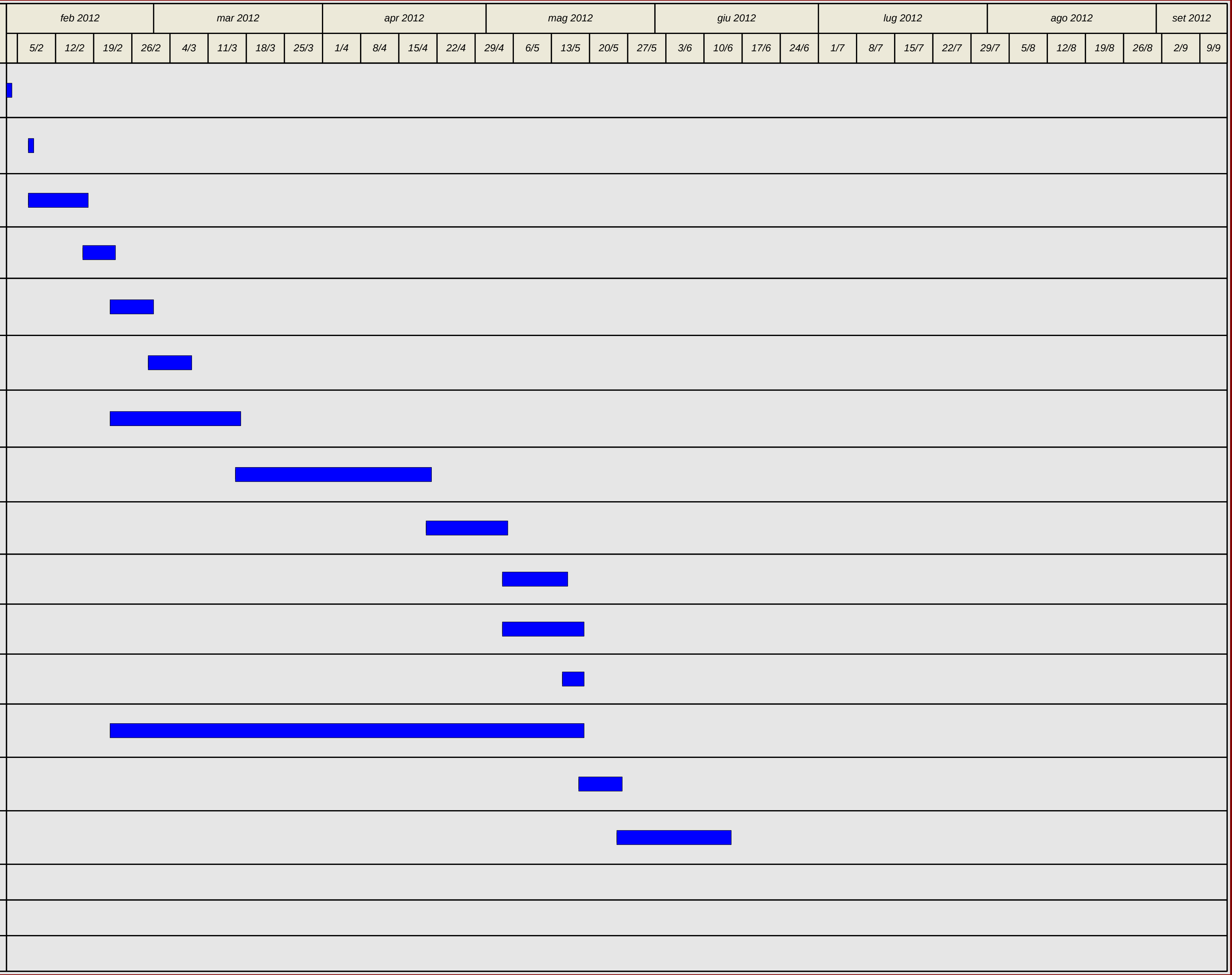
d) Limitations of the project:

Lowest cost/investment as possible.


Existing Data on raw Material
Y# X#, I #
RDS SAP
-Material name
-Production Date
-Received Date
-Expiry Date
-Batch number
Existing data
weigh sheet
Transfer to new System
Export/Import
Transfer to new system
Export/Import
Weighting System
Prepared to weigh
Out new recipe
Create Barcode Label
Existing label printer
New label layout
Ask for the next raw
Material
Read Barcode
(auto check if is correct)
When reached correct
weight to move to next
material
When complete
STORE DATA
Print out Barcode
Label for the mix

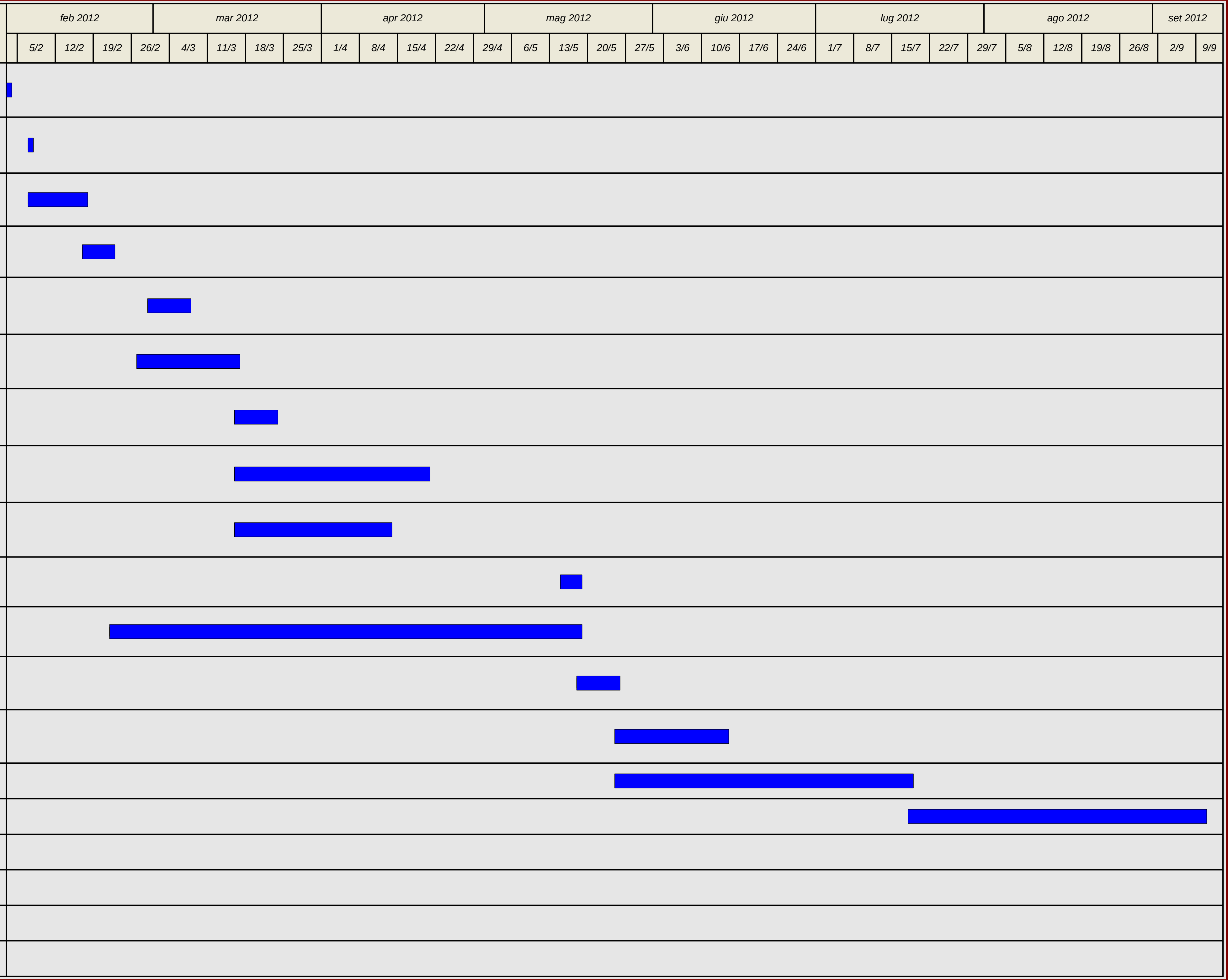
MEASUREMENT OF EXTRUDER

ID	Task Name	Start	Finish	Duration
1	Start Meeting	03/02/2012	03/02/2012	1d
2	Start project Work	07/02/2012	07/02/2012	1d
3	Project Definition	07/02/2012	17/02/2012	1w 4d
4	Timing Plan	17/02/2012	22/02/2012	4d
5	Analysis Of the Machine	22/02/2012	29/02/2012	1w 1d
6	Analysis Of the Critical Parameters	29/02/2012	07/03/2012	1w 1d
7	Measurement For the Machine	22/02/2012	16/03/2012	3w 3d
8	Make Calculation And Solution	16/03/2012	20/04/2012	5w 1d
9	New Measurements	20/04/2012	04/05/2012	2w 1d
10	New Solution	04/05/2012	15/05/2012	1w 3d
11	Analysis result	04/05/2012	18/05/2012	2w 1d
12	Finalize the Project	15/05/2012	18/05/2012	4d
13	Writing The Report	22/02/2012	18/05/2012	12w 3d
14	Editing The Report	18/05/2012	25/05/2012	1w 1d
15	Preparing The Presentation	25/05/2012	14/06/2012	3w
16				
17				
18				



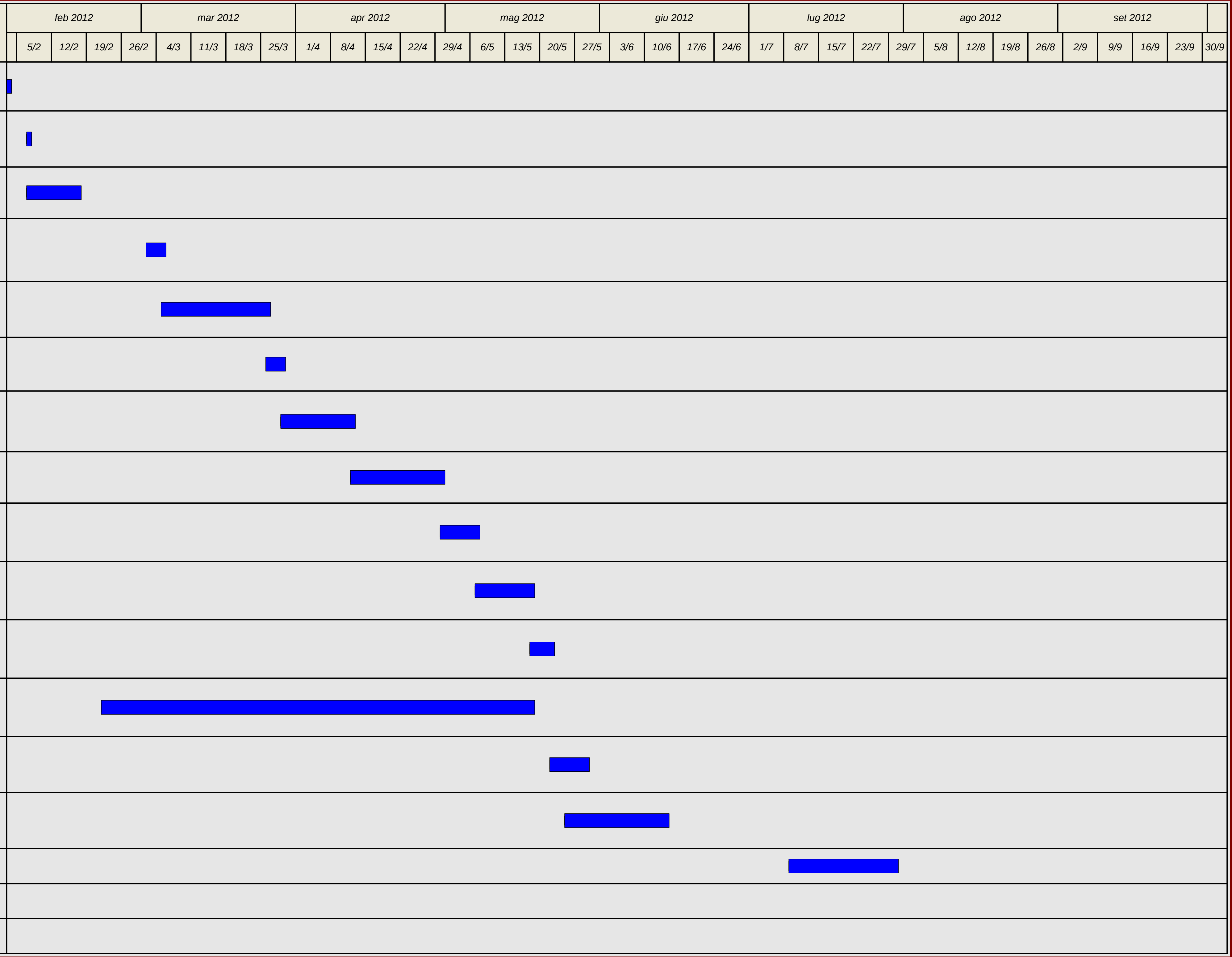
TRACEABILITY

ID	Task Name	Start	Finish	Duration
1	Start Meeting	03/02/2012	03/02/2012	1d
2	Start project Work	07/02/2012	07/02/2012	1d
3	Project Definition	07/02/2012	17/02/2012	1w 4d
4	Timing Plan	17/02/2012	22/02/2012	4d
5	Analysis Of Existing Data of raw materials	29/02/2012	07/03/2012	1w 1d
6	Find a method to transfer to new system	27/02/2012	16/03/2012	3w
7	Trasfer To New System	16/03/2012	23/03/2012	1w 1d
8	Find and Compare Suppliers (Technical)	16/03/2012	20/04/2012	5w 1d
9	Invite Supplier to Demo And Quote	16/03/2012	13/04/2012	4w 1d
10	Finalize The Project	15/05/2012	18/05/2012	4d
11	Writing The Report	22/02/2012	18/05/2012	12w 3d
12	Editing The Report	18/05/2012	25/05/2012	1w 1d
13	Preparing The Presentation	25/05/2012	14/06/2012	3w
14	Purchase	25/05/2012	18/07/2012	7w 4d
15	Install The Barcode	18/07/2012	10/09/2012	7w 4d
16				
17				
18				
19				



PILOT PLANT LAYOUT

ID	Task Name	Start	Finish	Duration
1	Start Meeting	03/02/2012	03/02/2012	1d
2	Start project Work	07/02/2012	07/02/2012	1d
3	Project Definition	07/02/2012	17/02/2012	1w 4d
4	Timing Plan	02/03/2012	05/03/2012	2d
5	Analysis Of the Pilot Plan Flow	05/03/2012	26/03/2012	3w 1d
6	Make a List Of the Equipment in the Lab	26/03/2012	29/03/2012	4d
7	Make measuremee Pilot Plan	29/03/2012	12/04/2012	2w 1d
8	Proposal of Possible Lay-Out	12/04/2012	30/04/2012	2w 3d
9	Make CAD drawings	30/04/2012	07/05/2012	1w 1d
10	Study of Viability of the Chosen Lay-Out	07/05/2012	18/05/2012	2w
11	Finalize the Project	18/05/2012	22/05/2012	3d
12	Writing The Report	22/02/2012	18/05/2012	12w 3d
13	Editing The Report	22/05/2012	29/05/2012	1w 1d
14	Preparing The Presentation	25/05/2012	14/06/2012	3w
15	Implementation of the New Lay-Out	09/07/2012	30/07/2012	3w 1d
16				
17				



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2	48,9	44	4,9		3	
3	49,1	43	6,1		3	
4	49,4	44	5,4		3	
5	49,7	45	4,7		3	
6	49,8	46	3,8		3	
7	49,9	46	3,9		3	
8	50,3	46	4,3		3	
9	50,6	47	3,6		3	
10	50,9	47	3,9		3	
11	51,3	48	3,3		3	
12	51,4	47	4,4		3	
13	50,4	47	3,4		8	Restart of the machine 30 batchs
14	50,7	47	3,7		3	
15	50,9	47	3,9		3	
16	51	47	4		3	
17	51	46	5		3	
18	49,9	45	4,9		8	Restart of the machine 20 batchs
19	50,3	47	3,3		3	
20	50,6	47	3,6		3	
21	50,8	46	4,8		3	
		09:00	10:07		73	

	MEASUREMENT OF EXTRUDER No1-6mm				
	T1	T2	T1-T2		
1	56,7	46	10,7		
2	59,3	47	12,3		
3	61,5	46	15,5		
4	61,5	46	15,5		
5	62,3	46	16,3		
6	63,5	47	15,5		
7	62,5	46	16,5		brake
8	62,9	45	17,9		
9	63	46	17		
10	63,2	47	16,2		
11	63,5	48	15,5		
12	62,3	47	15,3		brake
13	62,3	47	16,5		
14	63,5	48	15,1		
15	63,8	48	15		
16	64,1	47	17,1		
17	64,1	47	17,1		
18	64,7	49	15,1		
19	65	48	17		
20	65,4	48	17,4		

	MEASUREMENT EXTRUDER No 5-8mm							
	T1	T2	T1-T2		The fins are between 5-8 mm			
1	61,8	50	11,8			3		
2	62,3	51	11,3			3		
3	62,5	51	11,5			3		
4	62,9	51	11,9			3		
5	63,3	51	12,3			3		
6	63,4	50	13,4			3		
7	63,6	50	13,6			3		
8	63,8	51	12,8			3		
9	59,9	49	10,9		Restart	8		
10	60,3	49	11,3			3		
11	60,6	49	11,6			3		
12	60,7	49	11,7			3		
13	60,9	49	11,9			3		
14	61,2	50	11,2			3		
15	61,6	50	11,6			3		
16	61,8	50	11,8			3		
17	61,9	51	10,9			3		
18	62,3	51	11,3			3		
19	62,6	51	11,6			3		
20	62,7	52	10,7			3		
		10:00	11:02			65		

	MEASUREMENT EXTRUDER No8-12mm				
	T1	T2	T1-T2		
1	67,3	49	18,3		3
2	68,5	50	18,5		3
3	67,5	49	18,5		3
4	68,5	50	18,5		3
5	67,5	49	18,5	restart	5
6	68,4	50	18,4		3
7	67,5	49	18,5		3
8	67,6	50	17,6		3
9	68,4	49	19,4		3
10	68,9	50	18,9		3
11	69,3	50	19,3		3
12	69,6	49	20,6		3
13	69,7	49	20,7		3
14	69,9	49	20,9		3
15	68,6	50	18,6	restart	5
16	69	50	19		3
17	68,6	49	19,6		3
18	69,2	48	21,2		3
19	69,3	48	21,3		3
20	69,4	48	21,4		3
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<question>Weight into bin 2 and mix the ingredients</question>
<answerA>OK</answerA>
<freeform>false</freeform>
<nonWeighed>7</nonWeighed>
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R o u l u n d s   R e c e p t   S y s t e m ,   F U
Charge seddel til Pilot Plant

Charge K298A Dato 6/07/2010 Godk. RJD

Formål ABC/Cu fri 8201 til VOLVO S-80(F)
Pr¢veordre Termin 3.10.2007 Projekt 120
Bemærkning ABC lav Cu keramiske udvikling

FORFORMNING: Nej Forforme kraft +/-
Bemærkninger +2 uden BP til vgtfld TJEK UL VGT

PRESSE 3598 Produktionsmetode DT Bagplade V318/9

Kvalitet 80TD027 Blanding K0609 Vægt 133
Underlag B3032 Blanding Vægt 20

Antal pressede emner 4+4
Dimension 673481 VOLVO S80-FORHJUL Form Emner/form 1

Pressecyclus 000071P

	LT		HT		LFT		LF		Antal
	[sek]	[bar]	[sek]	[bar]	[sek]	[bar]	[sek]	[mm]	
1.			15	85	15				6
2.									
3.			180	85					1

Total tid 360

Temperatur ¢vre 155 [°C] nedre 145 [°C]
Bemærkninger konst. trykk

HÆRDEcyclus 00055,00P
Bem.

SEARING Tid [sec] temp. [°C] Holdetryk [kp/emne]
Bemærkning

FÆRDIGG¥RELSE
Tyk. 18.00-18.50
Stempelinstruks Kva.+CH

KOMMENTARER
Mærkere K6 værdier på kanterne af belægninger

FORDELING:

Modtager	Dim.	Antal	Kommentar	Ialt 12
4645		4		
FU-lab.		8		

LABORATORIUM

Nr.	Type	Antal	Kommentar
F06	Shear Test		
F07	Hårdhed		
F09	Massef & Vandabs	2	på bel uden BP
F30	Kompr.,kold	8	retur til PP

Briket areal 58,6 [cm²] radius 142 [mm]

Recept 83TD079

Blanding E1010
Oprettet 11.10.04
Mixer MTI Lille
Cyclus 020240D

Råvare	Mrk.		RRANR		Mængde	Tid	Temp.	Hast.
			X1027	.....	116			
			X104	.....	129			
			X197	.....	140			
N	T		X198	.....	159			
			X066	.....	194			
			X1029	.....	223			
			X1033	.....	290			
			X0170	.....	652			
			X1011	.....	16			
			X399	.....	516			
			Ialt 1	....	2435	60		2
			Y1649	.....	387			
			X1036	.....	551			
			X1044	.....	26			
			Y1470	.....	119			
			X489	.....	153			
			X338	.....	155			
			X1028	.....	194			
			X1017	.....	345			
			X397	.....	516			
			X1014	.....	964			
			X153	.....	155			
			Ialt 2	....	3565	180	50	1
			Ialt	....	6000			

Kommentarer til vejeseddel (blanding E1010):

1. Aim

We need to install a Recipe Control weighing system to provide an indelible Ingredient Traceability audit trail, to increase the efficiency and quality of the prototype production process. In particular the batch of raw materials (ingredients) used in a formulation must be recorded.

2. Existing information and equipment

RDS has recipes and ingredients
SAP has some ingredients, batch numbers and stock levels
We are in the process of preparing a standard bar coded label for raw materials (if needed adjustments can be made to suit the chosen system)
2 existing weighing scales 20kg and 30kg with 1g accuracy
Internal standardized bar code reader (info needed from CGH)
Existing label printer

3. System Requirements

The system should take over the function of the "vejseddel" which includes both ingredients and mixing process

The system must be capable of integrating with both "SAP" MRP system and another "back office" database called RDS to provide a seamless bi-directional flow of data between the three systems.
- i.e. recipe and mix process info needs to be converted from RDS to the system - Roulunds
- i.e. ingredients name, stock level, batch number from SAP to the system - Supplier
- need to relate the mix to the charge request (could be job number?) - Roulunds
- need to "backflush" the SAP system with the remaining quantity as appropriate (instantaneous, once a day or once a week?) so that new stock can be ordered - Supplier

Typically we create 200 recipes/year and use 400 different materials/year (of which 50 to 100 are new)

Ingredients can be identified by 5 different "codes" (I, X, Y, Z, B) which have a specific meaning

Many recipes have 2 or more "blocks" or mix steps (with several ingredients in each) and they are added consecutively to the mixer.

The program should be able to read our barcodes and labels on the ingredients
The program should produce a label for the weighed out mix/final mix

Store the information for later retrieval

Create reports for detailed contents in a completed formula and for each material where it was used

We expect that there will be 2 types of user. The first is creating the recipes directly or with a conversion file, adding ingredients, and planning the work. The second is the operator who is making the weighing and mixing and recording details with the bar codes etc.

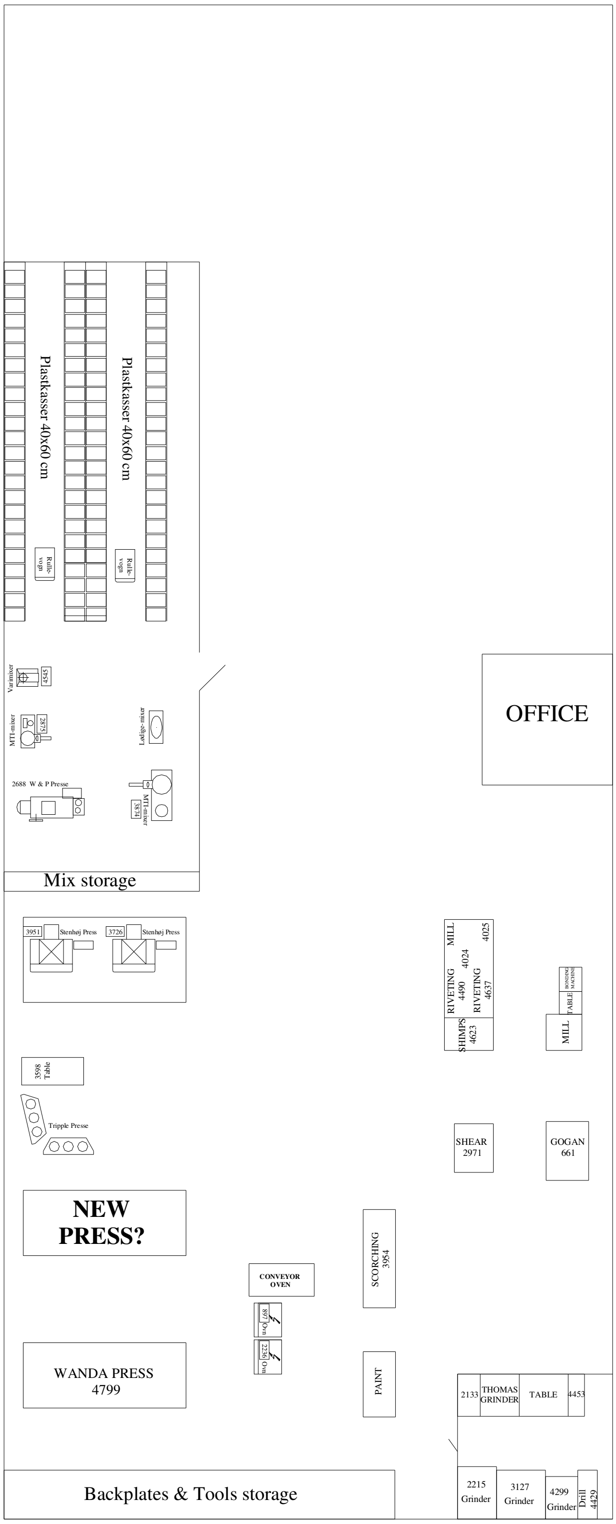
Approval: N Ishii-Dodson	Checked: J Boegedal	Issued by: A Balevski
Date and signature	Date and signature	Date and signature

4. Physical requirements

Two weighing scales the capacity of which is 25kg and 0.001kg tolerance
Both scales should be connected to each other and allow constant data flow , and possible to work with the same recipe.
Bar code reader to read the material and material batch code
Label printer

First proposal of layout

Proposed layout 3



Proposed laboratory layout