

**Simulation Modelling in the Service and Repair Industry**  
**by**

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## Executive Summary

Benco and Fakkkel Armature Winding is a rewinding company in Middelburg that does rewiring of electrical motors and servicing of motors and industrial fans. The rate at which a service is being delivered is a major concern for the company. Certain department's causes bottlenecks in the system. Simio Simulation modeling software will be used to build a simulation model on data gather from Benco and Fakkkel Armature Winding. The company is considering the addition of two new departments, 1) Sandblasting department and 2) balancing department. The model will represent the current situation in the company and will be analyzed according to these data gathered. The model will be studied and analyzed to identify these problems that prohibit the company from performing to its full potential. For example what will the effect be if the company focused on only certain types of electrical motors to repair or how will they improve the overall performance of the company if they try to eliminate idle time in the different departments.

The company has a lot of potential to introduce new methodologies into their system to improve the overall performance, thus research in this environment will be essential in delivering a solution. It's important to know which process innovation methodologies to implement so that they could be applied to the service industry and delivering a result that is feasible. The focus for the project will mainly be on the Simulation modelling of the process flow from one department to the next. Research will be done on the implementation of two new departments that the company is considering to add to their system and what contradiction will these to departments have on the overall performance. A redesign on the current system and layout will be done, also a further analysis on the effect these changes will have on the new model of the company. Improvement of a system can have advantages and disadvantages depending on the way it was introduced into the system. It's also important to identify core ideas from new technology and the value it can add to your system.

From this onwards the company can make decisions on whether or not to implement these changes and what the effect will be on the system if these changes were implemented. In the final report there will be a in depth calculation cost of implementing these changes and comparison between alternatives the company can consider.



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## Introduction and Background

Benco and Fakkell Armature Winding are two companies situated in Middelburg that recently merged operations. The merged company is owned by two brothers.

Fakkell Armature Winding was the first winding company in Middelburg established by Mr Hennie van der Merwe in 1960 and Benco was established in 1989. Mr Ben Heyns, the currently owner of Benco Armature winding and his brother, Nico Heyns worked for Mr Hennie van der Merwe in the early 1980's, upon qualifying the two brothers decided to start their own winding company namely: Benco. At first they worked from their garage at home. They slowly started to build up their own company while helping their mother to raise their family, consisting of two other brothers and one sister.

One of the other brothers took the company, Fakkell Armature Winding, over from Mr Hennie after he had a stroke and was unable to continue working.

Benco and Fakkell Armature Winding specializes in the rewinding of new and old electrical motors, supplying new and recon motors and motor spares. These motors are motors that are used on mines, farms, factories and companies in the surrounding areas of Middelburg, covering an area with a radius of 180 kilometres. Thus any factory, company, farmer or individual can send in an electrical motor for repair at Benco and Fakkell.

Motors usually repaired by Benco and Fakkell are single-phase and three-phase alternating current (AC) motors ranging from 0.75-200kW.

There are currently four Armature winding companies in Middelburg namely: Collison's Electrical, Delba Electrical, Benco and Fakkell Armature Winding (Benco and Fakkell counts as two companies, although their operations have been combined between the two brothers). When a new job comes, in it is processed by the First-in-First-Out method, depending on the criticalness of the motor. When the repair of a motor is highly critical, Benco and Fakkell has a standby team consisting of a winder, fitter and stripper to repair the motor within 24 hours so that the motor can be delivered to the client on time. If a job is done on this breakdown basis, an additional 25% is added to the total amount quoted for the repair work, to cover the over time of the workers.



## Project Aim

The aim of the project is to develop a replicating model of the current situation that exists in the company and to analyze the system to determine how efficient the service process of the company is. Then to do a redesign of the entire system with the addition of the two new departments to replicate the new system and again to do analysis of what the company will gain from implementing the new system model. After the system modelling is done we can implement facilities planning onto the process layout to take into account the two new departments the company want to add to their system. Also to calculate how much these changes will cost the company to implement.

Project simulations can be used proactively to define common areas of great potential risk and incorporate appropriate checks and balances into the project management plan to mitigate those risks. Simulations are used in project management when it is generally not feasible to rely on concrete data to generate a result. After the final layout has been designed for the new departments in the system, another model will be built to represent the impact these new changes will have on the system.

The aim of the project is to find a solution to the current problems in the company that prohibit them to deliver a good and effective service to the public since the competition is continuously growing in Middelburg. Also to determine how efficient and effective their workers/recourses are performing in the company so that workers can be utilized more in the shop. Thus if workers are utilized better the work flow in the shop will be faster and the more electrical motors will be repaired in a shorter time span. The purpose of the model is to build the situation that is currently implemented at Benco and Fakkkel Armature Winding by reflecting it threw Simio to gather information from the simulation from were certain decisions can be made regarding the company. Through doing experiments in Simio and setting up the amount of work needed to be done by each department can tell you how effective these changes will be on you system. Thus running scenarios in which you can give each department the amount of work needed to be done it will become clearer how much will be accomplished at the end of simulation. Through assignment of more work to workers in the shop the idle time on each worker will be reduced while the actual time their busy will increase and so will production as well. The model will help identify areas where resources aren't used properly. The model in my report will only focus on a 22KW electrical motor that comes in for repair and this model will be the basis from where I will build the final model. Data were collected over the past 5years to determine the 20 most favourable motors that came in for repair.(See Appendix for Data Table)

This won't be an exact solution to the problem but will give management an insight to improve problems that exist in their system. Systems in real life aren't predictable, because on a day-to-day basis the system may experience some delays due to natural causes for example raids, sickness among workers, delays in materials, maintenance on machinery etc.





## Project Scope

The first step of the whole project will be to get familiar with the process. In the sense of using methodologies learned and to implement them to the system. Once you know the entire process flow of the company and what contribution each department makes to delivering a service, you can compile the literature review. The literature review will narrow the entire scope and identify the problems that exist and these problems will then be focused on.

Data will be gathered from the past records that have been sending in for repair by Benco and Fakkell. From these data there will be 20 most popular electrical motor selected. This selection of electrical motors will be brought into the simulation model for modelling. Threw only specializing in certain types of popular electrical motors the company will also cut cost in purchasing excess of copper wire used in electrical motors. Certain types of motors use the same thickness of wire.

In the entire process system there is certain departments that can't be changed/moved like the testing department needs to be close to the main supply of electricity and when a motor is placed into the oven it needs to be baked for at least 5 hour. One major concern is the amount of stators that is continuously building up that needs to be rewound and threw the methodologies and technologies available improve this problem. Threw the study of the entire process it will become clear which other problem exist in the system.

The addition of the two new departments will also play a role in the completion of repair work done. Thus through research and allocation the right placement of these two departments, it will become clearer whether or not it will be possible to bring these two departments into the system. Factors that need some attention will be the impact that these departments will have on the work environment, worker health and safety.



## Literature Review

When building a simulation model replicating the current system being implemented at Benco and Fakkell Armature Winding, it's necessary to know which software is available to use. There are vast amounts of simulation software available but are limited in the sense of user friendliness, ease of constructing a working model, purchasing cost, training, system requirements etc. From research I will determine which software to use and will be capable to run on my computer for building my model. The next step will be to do research on the two departments that the company wants to implement and the pros and cons it will have on the company's performance and cost. These departments as stated earlier are 1) A Balancing department and 2) A Sandblasting department, which the company will use to balance rotors, shafts and industrial fans. The sandblasting will not only clean the motor but will help with further cleaning in the Wash Bay Department and in the Painting Department all the old paint will be removed thru this process. Before jumping to a conclusion, it's better to understand were each and every department fits into to whole repair process. Below is a brief description of each department/area in the company (See Appendix for a basic floor plan of the company and were this departments/area fits in the company):

### Winding Department

The Winding Department receives the stator from the Wash Bay Department (where all the copper wire was removed from the stator so that the new copper wire can be wound into the stator). Without the copper wire in the stator the stator cannot induce a magnetic field by utilizing the current supply to the electric motor. This magnetic field makes the rotor turn in the motor to create an output of work at the driver end of the motor. At the non-drive end there is a fan that consistently cools the motor down when running.

In this department, insulation is used to put into the slots of the stator to prevent the copper wire from coming into contact with the stator casing. Should this happen, it will cause the stator to blow or shoot due to neutral and live wires that come into contact with one another. The wound-up copper form coils that is inserted into the stator. Different size motors have different speeds, pitch sizes, wire thickness, connection types and voltage supplies. All the data of the specific motor is noted down onto the job card and the worker at the Winding Department possesses the necessary information to finish the work.

### Testing Department

The Testing Bay consists of a High Voltage Container where electrical motors can be tested. When a motor comes in for repair it is first tested to see what is wrong with the specific motor. Using a pressure tester and a megger one can determine if the motor has blow, acquired water damage, whether the phases are mixed or that it is "down to earth". The Test Bay is also used for testing the motors that has been winded to make sure that before going to the varnish bath and curing oven that the motor is running and that the phases are balanced. The motors, after being assembled, are also sent to the Testing Bay for testing before being sent to the Painting Department.



This is done to ensure that the completed motor is running 100%. After the last test on the motor has been done, the operator at the Testing Bay prints a test report to be attached to the invoice.

### Varnish/Oven Department

This Department consists of a varnish tank and a curing oven. The curing oven is used to bake the electrical motors in after they have been varnished. After a motor as been winded and tested the stator is dipped into the varnish tank. The varnish ensures that all the winding stays in place and puts a protective layer over the copper wire. Then the stator is placed into the curing oven for 5 hours at 180°C to harden the varnish. After the 5 hours an operator then takes the stator out and starts to remove all the excess varnish so that when the stator is being fitted all the parts come together smoothly and a tight seal is ensured. This department should also be on its own, because the working environment is very warm and to work next to the oven the whole day will affect the workers.



Figure 1: Workshop Photo

### Painting Department

In the Painting Department the electrical motors are sprayed after the final test at the Testing Bay has been performed. The motors are sprayed to improve the appearance of the motor and look attractive when the client comes to collect the motor. The spraying is done in a spray booth to ensure that the workers in the facility do not come into contact with the over spray or dangerous mist from spraying. This department should also be on its own, because the over spray can influence: the workers, the varnish in the tank, the isolation used in the motors etc. Over spray is the mist from the spray that cools faster when blown out of the spray gun during spraying. Extractor fans are used in the booth to extract the over spray out of the booth to the outside of the building.



### Wash Bay Department

The Wash Bay Department is where all the cleaning of stators, rotors and spares takes place. Here the copper wire is also extracted from the stator: the stator is warmed up to a certain temperature and the worker then pulls the wire out of the stator. The stator is then cleaned and cooled.

The entire stator then receives a red oxide coating to protect the stator from rust. The stator is afterwards sent to the Winding Department for winding. A high water pressure machine is used to clean all the excess of insulation and to wash spares etc.

### Stripping Department

In this department the motor is totally stripped. The motor is taken apart and divided into current salvage parts, rotor and stator parts. The stator can only be stripped if the stripping department gets the “go ahead” from the office. The salvage parts are placed into bins and sent, together with the other parts, to the Wash Bay for cleaning. Stripping is also a messy department because sometimes when a motor comes in for repair from the mine it’s very dirty or full of water. This is where the Sandblasting Department will come in handy. The dope of the stator is gathered after the stator is stripped from the motor. The dope contains all the information of the connection type in the stator, the amount of turns per coil and the thickness of the wire. All this information is noted down onto the job card so that the worker who is going to wind the stator possesses all the necessary information concerning the heart of the stator. If this data is incorrect the motor will not be wound correctly and at the end the motor will not be working correctly; all the phases in the stator will not be synchronised and the current in the motor will not balance.

### Assembly Department

In this department the assembly of the electrical motor is done, after the department has received the stator from the Varnish/Oven Department. However, for the process to be completed, all the necessary parts for assembly, such as the parts from the customer parts area and motor parts storeroom that needs to be fetched. It is essential that fitment is done right, because the drive ends and non-drive ends play a significant role in the setting up of the motor. If this is not done correctly there will be a rubbing on the inside of the motor due to misalignment of the rotor in the stator and this could also lead to motor failure.



Figure 2: Photo of Dispatch



### [Dispatch Area](#)

In the Dispatch Department all the finished, fitted motors are placed for quality control checks and placed onto racks. This department stores all the motors that are ready to be collected or delivered to the client. This department also keeps recon motors, for in case of an emergency. It is necessary for this department to be placed near the door to be easy accessible for collection of the motors, without interfering with the other departments in the facility. No motor will leave this area unless the job has been paid for.

### [Book-in Area](#)

Here all the book-in of the motors is done. All the details of the motor and the client is noted down in the book-in book. The worker here also takes a picture of the motor and stores it under that specific job number assigned to that job. Pictures are taken because it does happen that the client argues and states certain parts where intact in motor, while the worker in the Book-in Department can then refer to that picture whether or not the statement is true or not. Every motor that comes in for repair receives a job number so that during the whole process that motor will be referred to under that assigned number. It is necessary that all the parts of the specific motor are put together in their own ("job-number-assigned") bin.

### [Copper/New Parts Storeroom](#)

Within the New Parts Storeroom all the new parts such as bearings, fans, terminal blocks, grease, soap, o-rings etc. is stored. After delivery of the new parts and material, the parts are stored in this department where the worker keeps record of all parts and material coming in and going out. All of the departments come to this department to fetch parts, paper, paint etc. to do their job in the facility. Copper coils are also turned here and is placed next to the Winding Department and near the office for safety reasons.

### [Customer Parts Area](#)

In this Area all the motor spares, from clients that brought their motors in for repair, are stored. Parts are stored on racks only after it has been washed. This area keeps all the excess spares that is to be fitted at a later stadium, so it can be seen as a temporary storing area for spares of jobs that belongs to a customer. Stores are used to store something while in the facility there are departments that do the fiscal work used for repairing of the electrical motor. Rotors and motor spares are stored on racks.

### [Salvage Parts Area](#)

This Area contains parts of old jobs and spares from motors that have been scrapped from mines and bought by the company. These parts and motors are then used for repair of recon motors and sometimes when suppliers can't provide a specific part one can then go and search to see if there is a part to be found. Lost parts are also sent to the Salvage Parts Area, this is normally when parts go missing in the washing process.



A recon motor is a motor that the company buys from mines to repair and later sell it to a customer that is in urgent need of a motor, even if it is for a short term, while the customer's motor is being repaired, or they are in the process of purchasing a new motor. This is an additional service that the company provide.

### Parts Inspection Area

In this area the worker needs to go through all the parts from bearing sizes, terminal boxes, fans, bolts, nuts, keys, end shields, lids etc. So that parts that are damaged or lost could be ordered for when assembly are done. It's essential that when the motor were booked-in that the worker takes a picture of the complete motor so that when the customer comes to collect their goods, it returns with all necessary belongings. The photo also ensures that the company don't incur further cost in replacing parts that weren't there when the motor came in. The company can also use it as proof to show which belongings were booked-in.



Figure 3: Testing Department

### Stator Inspection Area

Here the worker needs to inspect the stator core and stator slots, because it sometimes happen that from the heat used to strip the copper wire from the stator that the lamination plates move and the stator core goes skew. Another problem that occurs is that the stator has a crack over the entire length of the core and this could have happen from the motor being dropped in the transportation process. If this problem occurs it's better to scrap the motor since it will be difficult to re-align slots. The only option will be to buy a new motor.



The two new departments:

### Sandblasting Department

Before the motor is stripped, it is sandblasted to remove all the dirt and oil of the motor. This eliminates workers being exposed to dangerous chemicals from mines. Sandblasting makes the work for the worker in the Stripping Department easier, as the worker will not struggle to loosen bolts on the motor. It also ensure that all the old paint are removed for when the motor are send to the Painting Department before going out to the client. This is a very loud and messy process depending on the type of machine being bought. This department should be sealed so that the dust and dirt aren't exposed into the company. Also some of these machines are very loud and it would be of essence if this department is placed away from the offices. This department poses also health problem for the work environment and it will be of concern that proper research are done before considering the implementation of the new department.

### Balancing Department

The Balancing Department will consists of the balancing machine that is used for balancing shafts, rotors and fans that is to be fitted to specific motors. Here the operator aligns the shaft in 360 degrees through rotation of the shaft on a average speed of 1500r.p.m. After the shaft and rotor has been balanced the operator prints a balancing report to be attached to the invoice. Balancing is done to ensure that when running, the motor or fan doesn't rub against the casing. The high spinning rate that the balancing machine requires to balance a shaft or a fan causes the need for this department to be separated because harm can come to workers should they get too near the machine while balancing is taking place. When implementing this department it is also of concern, that investing this sum of money in buying and doing the necessary changes in the company that the company will benefit from implementing these changes. Also how often will it be used? is another factor to consider.

Which software to use?

It's important to determine which software to use when building a simulation model. Training in a certain software package is essential to construct a working model and to get good results from running your model. Below is a list of some of the software available on the market:

ACSL, APROS, ARTIFEX, Arena, AutoMod, C++SIM, CSIM, Call\$im, FluidFlow, GPSS, Gepasi, JavSim, MJX, MedModel, Mesquite, Multiverse, NETWORK, OPNET Modeler, POSES++, Simulat8, Powersim, QUEST, REAL, SHIFT, SIMPLE++, SIMSCRIPT, SLAM, SMPL, SimBank, SimPlusPlus, TIERRA, Witness, SIMNON, VISSIM, and javasim.



An ideal simulation package will consist of the properties that the package gives its users such as support, reactivity to bug notification, interface, etc. Since different users have different needs and levels of expertise it's difficult to make a judgement on the specific software to use. Deciding on the type of software to purchase its necessary to know what purpose you will need it for. You must know which features are appropriate for your situation, although, this is not based on a "Yes" or "No" judgment.

On deciding which software to use in my project, my main concern will be time and money. When considering time, we need to take into account the training that will be needed in learning a new software package. I've gained some modelling knowledge in Arena and Simio that will count in my favour of constructing a working model for my project. Money wise it's priceless, since both packages are available at the University computer labs.

Simio represents your model in a 3D view that makes this software very attractive and presentable for clients when presenting the simulation model. Simio is object-based simulation software that uses objects to represent the companies' processes, this form the new generation of modelling software and helps with critical skill development. The objects define both the logic for the model, and the animation used in modelling your model. When comparing Simio to Arena, Simio don't use old architecture or little ongoing development, but makes it easier for the programmer to use.

#### Advantages of Simio:

- Faster modelling of projects that will give faster project benefits.
- Less investment in time and money = lower total cost.
- Lower training cost and resources available to give guidance in using the software.
- Integrated three dimensional technology for an immersive visual experience
- Simio is easy to extend due to true object-oriented design.
- Risks are reduced and operations are improved though the extension of the model lifespan.
- Comprehensive modeling capability.
- Support service to assist user with problems that arise when using the software.
- User interface to simplify learning and using of the software.
- Library objects can be expanded.
- Advanced architecture and modelling approach.

#### Disadvantages of Simio:

- The software is relatively expensive to purchase.
- Not everyone can get the software for free, when saying free there is also a time limit on the available time to use the software.
- Simio uses 3D warehouse on the internet and this might also be considered as a problem then you don't have a internet connection available to download images or ask for on-line help.





Below is a list of 14 pre-built object definitions that makes modelling easier and more understandable for the user to use.

Name	Class	Description
Source	Fixed	Creates entities that arrive to the system.
Sink	Fixed	Destroys entities and records statistics.
Server	Fixed	Models a multi-channel service process with input/output queues.
Resource	Fixed	Models a resource that can be used by other objects.
Combiner	Fixed	Combines entities in batches.
Separator	Fixed	Separates entities from batches.
Workstation	Fixed	Models a 3-phase workstation with setup, processing, and teardown.
Vehicle	Transporter	Carries entities between fixed objects.
BasicNode	Node	A simple intersection of links.
TransferNode	Node	An intersection where entities set destination and wait on transporters.
Connector	Link	A zero-time connection between two nodes.
Path	Link	A pathway between two nodes where entities travel based on speed.
TimePath	Link	A pathway with a specified travel time.
Conveyor	Link	An accumulating/non-accumulating conveyor device.

Table 1:Pre-built objects

An arena model uses process orientation that is through the use of a single modelling paradigm. Blocks are used in the process and elements are defined that hold the state of the system. Thus these blocks are passive and are only activated by the arrival of a single entity. The entity runs through the whole program that causes the state of the model to change over time. Arena uses 2D as a 2-step presentation when you animate your model.

Advantages of Arena:

- Flexible software in the sense that things can be modelled as they are.
- Improved computing and cost ratios in modelling.
- Dedicated models.
- Far easier to use than Graphical user Interface.
- AutoCat can be used to import backgrounds to the model.



#### Disadvantages of Arena:

- Arena doesn't give exact answers but rather estimates and approximations.
- Gives you random output from stochastic simulations.
- Huge difference in price packages.

Simio will be used to give information about the company being investigated that will be represented by the software used. These departments will consist of events which are activated during the run of the simulation model. Each department have different processing times used to process work that entered the specific department. (See Appendix for software comparisons and a data table to be used in building the model)

#### Why a Sandblasting Department?

This process uses compressed air to propel abrasive media towards a surface to be cleaned and later to prepare the surface for painting. If an electrical motor were being sandblasted, the whole motor will be cleaned and will make the job for a worker more pleasant to work on. In the sense that it will be easier to loosen bolts that was stuck in all the dirt from the motor. Sometimes these motors contain dangerous chemicals on them and it will be a health problem if workers came in contact with these chemicals. There are two kinds of sandblasters available and are used for specific reasons.

The Cabinet sandblaster is a simple container that holds the sand inside. The sand is known as Aluminium Oxide. Compressed air is released out of the nozzle where by a vacuum are formed a view centimetres from the nozzle. The vacuum then sucks the sand into the compressed air stream that makes a mixture of air and sand. As the grains of sand hits the surface, the speed of the sand hitting the surface causes the paint to chip away. These cabinets have adequate lighting, dust collector and gloves used inside the blast cabinet. In this type of sandblasting all the dust is trapped inside the cabinet and no respirator are needed to remove dust in the workshop. These sandblasters are also relatively quieter than the pressure sandblaster. This type of blaster is cheaper than the pressure blaster and consists of a lot of control when using this method. Spray can be turned off instantaneously and are easier to maintain than the pressure blaster. This method is limited to space and is not as powerful as the pressure blaster.

**Blasting with Silica sand causes Silicosis of the lungs...Do Not Ever Use It!!!**

Pressure sandblasters are ten times faster, more effective than cabinet sandblasters but are more expensive. Here the sand is placed in a container and then pressurized. The mixing process happens a few centimetres below the hopper. The mixture then travels through a hose until the mixture leaves the nozzle. Since this type is more powerful than the cabinet blaster, this blaster can carve deeper into the surface that you want to clean. When this type of blaster is turned on, it's difficult to stop and is subject to clogging.



Figure 4: Cabinet Sandblaster



Figure 5: Pressure Sandblaster

When deciding on the type of sandblaster to purchase it's important to consider a few factors:

- The price of purchasing the specific sandblaster?
- Health related problems?
- Operator training and cost of changes to the system?
- Cost of proper ventilation and building this new department?
- How often will this department be used?
- Are these models available in South Africa?

In the final report I will do a cost analysis on a pressure sandblaster, because this seems to be the most effective sandblaster to use for the big motors that come in for repair.

The cost analysis will be on the buying of the sandblaster, equipment needed, sand, building of a ventilated room where the sandblaster will be used and training needed to operate this device. After the cost analysis this department will be built into the simulation model. ( See Appendix for quotations for buying a sandblaster)



## Why a Balancing Department?

In this department the company wants to determine if it will be more cost effective and time minimizing for balancing parts in the company self than sending it away. Balancing is used to balance scales that aren't in equilibrium, caused from variance in mass distribution known as unbalance. Unbalance are mass times radius. When a rotor, shaft or fan are unbalance they tend to cause noise and vibration during rotation, this leads to bearing failure, housing failure and later motor failure. Bearing failure is caused by restricting the centrifugal force that exists on the rotor. Parts with unbalances tend to have shorter live cycles that balanced parts. With unbalances comes problems in machine operating safety and places the machine as a risk to the surrounding environment. The most important types of unbalances that occur are:

1. Static unbalance – where the mass axis is displaced only parallel to the shaft axis. The unbalance is corrected only in one of the axial plane. Unbalances acts without any rotation to the axis.

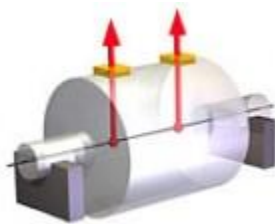


Figure 6: Static Unbalance

This type of unbalance causes the centre of mass to shift away from the geometric centre, that causes the rotor to swing oscillate to the rotational axis when running. In the centre of gravity plane material are removed from the heavy point or added to the opposite side to correct the static unbalance. Vertical balancing machines are used to balance this type of unbalances. Used for disk shape parts.

2. Couple unbalance – where the mass axis intersects the running axis and this type of unbalance is usually corrected in two planes. Here the two unbalances can have the same size, but angular positions of the forces are precisely offset by  $180^\circ$ . Unbalances can't be detected by swinging the rotor, because the rotor doesn't take a unique position at rest and are also known as a couple unbalance through the wobbling movement of the rotor.



Horizontal balancing machines are used to correct this type of unbalances.

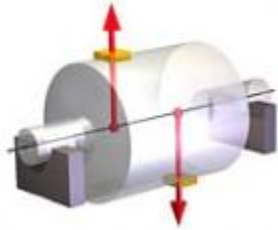


Figure 7: Couple Unbalance

- 3. Dynamic unbalance – where the mass axis is not coincidental with the rotational axis and consists of both static and couple unbalance that is corrected in two planes. Rotors do not only have a single unbalance force acting on it, but an infinite number of arbitrarily forces along the axis.

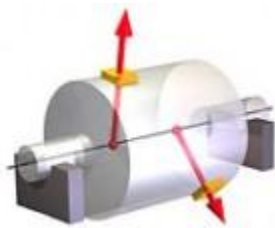


Figure 8: Dynamic Unbalance

Balancing machines can identify any mass axis of 0.001mm of the running axis; this shows how accurate these machines are. Setting up these machines is very simple. Thus for parts to be used over a life span, it's important to ensure that these rotors maintain an acceptable balance. Latest production methods available reduce the need for balancing rotors in low speed applications.



Figure 9: Horizontal Balancing Machine



Horizontal balancing machines can balance rotors from 5g up to 90 tons with the highest balance sensitivity up to 0.05 g.mm/kg. Balance rotors at lower and safer speeds. The machine needs a rigid construction to work from. Make use of special screw-jacks for loading heavy rotors onto the balancing machine.



Figure 10: Horizontal Balancing Machine

	BT-150	BT-300	BT-1000	BT-3000
Maximum weight capacity, kg	150	300	1000	3000
Max. rotor diameter, mm	1050	1130	1600	1600
Distance between the centers of rotor bearing journals, mm	150 - 2200	200 - 2400	200 - 3100	200 - 3100
Shaft journal diameter range, mm	10 - 180	10 - 180	15 - 290	15 - 290
Sensitivity, g·mm/kg	0.1			
Drive motor	AC 1.1 kW	AC 2.2 kW	AC 7.5 kW	AC 15 kW
Drive type	Belt			
	2500	3000	3500	3500

Table 2: Horizontal Balancing Machine specifications



## Data Analysis

Since the company is constantly receiving motors to be repaired and there's a wide spectrum of motors that they repair it will be easier to focus on the most popular motor that comes into the shop. If they do this it will make ordering of parts, bearings and copper wire easier, because they focus on a specific type of motor being repaired in the shop. Also if they focus on certain types of motors there will be fewer bottlenecks in the shop and the excess of carrying all the other parts for motors being repaired will give more shop floor space and better stock keeping of supplies in the shop. Threw the model they want to determine if workers that work in their specific departments are being utilized effectively and adhere to the production of the company. The current model only focuses on one type of motor coming in to the company. This model forms the baseline from where the addition of the other 19 types will follow and the effect it will have on the entire system. (See Appendix for data table that will be used for the implementation of the final model)

## Model Structure

The model was build in Simio and reflects the current state of the company and process flows that needs to take place in the company to do repair work on a stator. The simulation was run for an 8 hour day for 5 days. From using Simio you can have a 3D view of the current state and work flow in the company making presentation more presentable. After the simulation has run it will make it easier to determine were to take away workers and were the company will need to add workers to improve production in the company. If workers are utilized efficiently in the company the overall improvement of repair work done will increase and at the end of the day the company will be able to keep its workers.

## Problem Parameters

Benco and Fakkell currently consist of nine departments in the company were work is done:

- 1) Winding Department (Winding of stators are done here)
- 2) Testing Department (Testing of stators and assembled motors)
- 3) Assembly Department (Assembly of the motor)
- 4) Varnish/Oven Department (Varnishing and Baking of stators winded)
- 5) Painting Department (Painting of motors before send to dispatch)
- 6) Stator Inspection Department (Inspection of stators after washed)
- 7) Parts Inspection Department (Inspection of rotors and parts after washed)
- 8) Stripping Department (Stripping of motor into its ferrous parts)
- 9) Wash Bay Department (Washing of all the parts and stators)

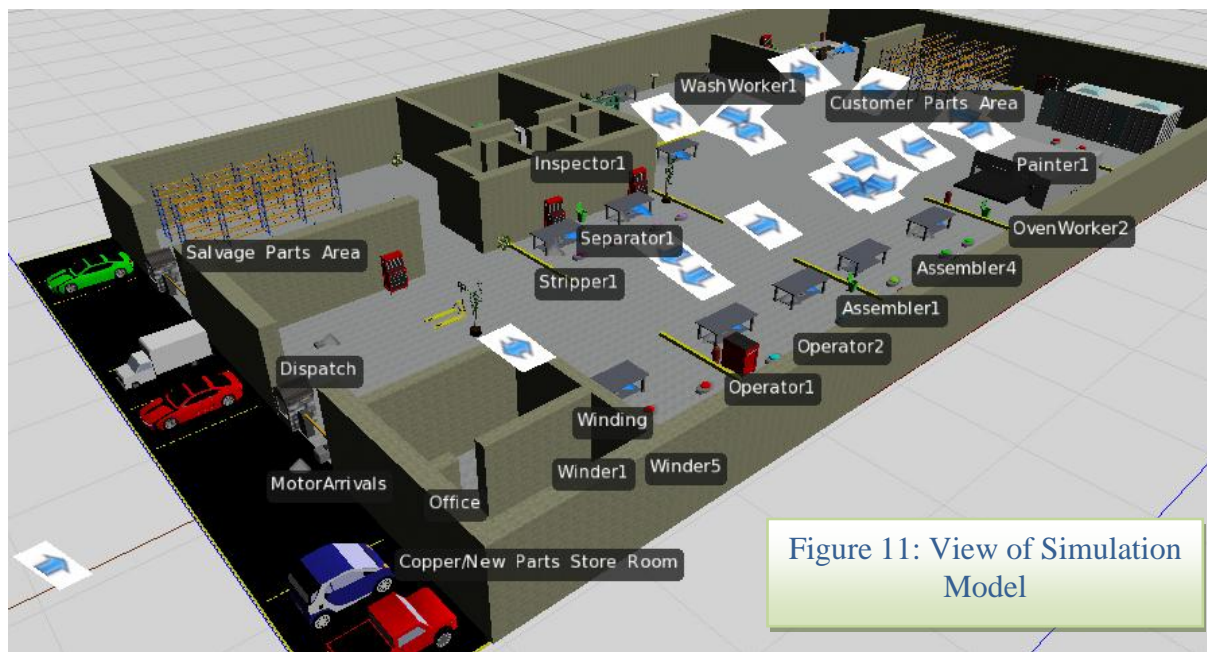
In all these departments there is certain time constraints were tasks are performed on a stator/rotor. For example a stator needs to be baked for a minimum of 5 hours after being varnished.



Assumptions:

- 1) All the motors entering the shop needs repair work and aren't done on a breakdown basis.
- 2) Repair work is only done on 22 KW electrical motors.
- 3) Copper wire and parts are always stocked in the company.
- 4) All the stators that have been wound are correctly and don't need extra work on them.
- 5) All the motors send to testing are properly working and don't need extra work on them.
- 6) There's no delay in parts being ordered.
- 7) Maintenance on Wash Bay cleaning and Parts Inspection Department are not done that often.

When the final model is being build it is important to notice from the data table, that in each department the processing time vary depending on the type of motor being repaired.



## Modelling Approach

Since Fakkal is constantly receiving motors to be repaired and there's a wide spectrum of motors that they repair it will be easier to focus on the most popular motor that comes into the shop. This type of motor is a 22KW electrical motor, 380V. If they do this it will make ordering of parts, bearings and copper wire easier, because they focus on certain types of motors being repaired in the shop.

Also if they focus on certain types of motors there will be fewer bottlenecks in the shop and the excess of carrying all the other parts for motors being repaired will give more shop floor space and better stock keeping of supplies in the shop.





Process of repair:

An Electrical motor (22Kw) will enter the shop every 30min to be repaired. On entering the shop the motor is send to the Stripping Department were a motor will be stripped by four workers with a minimum and maximum time of 25-35 minutes.

After the motor has been stripped there consists two main parts of the motor namely the stator and the rotor. The stator is the part where the winding needs to be done.

The winding process is where the workers put new copper wire into the stator. With the rotor, parts such as bolts, connector blocks, and fan are etc. travels in the shop to keep them together. Parts are then send to the Wash Bay Department were the stator and rotor are being washed and can take anywhere from 25 to 35 minutes, but usually 30 minutes with five workers doing the work. After the parts have been washed the stator is send to the stator inspection department and the rotor to the parts inspection department.

In the stator inspection department the stator is inspected to ensure that the core of the stator haven't moved and that all the slots are cleaned for winding, this usually takes between 30 minutes to an hour. In the parts inspection department all the necessary parts that are damaged, are then ordered and inspection of the rotor and end shields take place. Here they determine if there's engineering work needed on the parts, this whole process of ordering and engineering takes between 6-8 hours.

After the stator has been inspected the stator is send to the Winding Department were the winding of the stator can take anywhere from 3 to 5 hours with six workers working in this department. After the completion of the stator being wound, the stator is then send to the Testing Department were two workers tests the stators send from the Winding and Assembly Departments. To test a stator send from Winding Department can take anywhere from 12 to 20 minutes but usually requires 15 minutes. Where the testing of an electrical motor send from Assembly Department can take anywhere from 15 to 25 minutes but usually 20 minutes.

The stator is then send to the Varnish/Oven Department were the stator is then dipped and placed in an oven to bake the stator, this whole process takes four hours with three workers in this department. From here the stator is then send for assembly were five workers perform this task. Here the stator and rotor are put together that usually takes 2 to 2.5 hours. After assembly the motor is send for testing. Here they insure the proper functioning of the motor before sending it to the Painting Department. In this department the motor receives its necessary colours before sending it to the specific customer. Painting usually takes between 15 to 20 minutes. The model was run for an 8 hour, 5 day simulation length. The model will be refined in the final project, were the final model will represent 20 most favourable motors entering the company and whether or not to implement the two new departments.



## Baseline Results



Asembler1: Scheduled Utilization: 41.74%  
Idle Time: 174.77 min  
Units Allocated: 8  
Busy Time: 125.22 min

Asembler2: Scheduled Utilization: 39.56%  
Idle Time: 181.31 min  
Units Allocated: 8  
Busy Time: 118.68 min

Asembler3: Idle Time: 2400 min

Asembler4: Idle Time: 2400 min

Operator1: Scheduled Utilization: 27.69%  
Idle Time: 59.83 min  
Units Allocated: 43  
Busy Time: 23.73 min

Operator2: Idle Time: 2400min

OvenWorker1: Scheduled Utilization: 81.8%  
Idle Time: 436.57min  
Units Allocated: 9  
Busy Time: 1963.42 min

OvenWorker2: Scheduled Utilization: 81.13%  
Idle Time: 452.73 min  
Units Allocated: 9  
Busy Time: 1947.27 min

OvenWorker3: Idle Time: 2400 min

Stripper1: Scheduled Utilization: 99.75%  
Idle Time: 5.86 min  
Units Allocated: 37  
Busy Time: 2394.13 min

Stripper2: Scheduled Utilization: 98.5%  
Idle Time: 35.86 min  
Units Allocated: 36  
Busy Time: 2394.13 min



Stripper3: Idle Time: 2400 min

Stripper4: Idle Time: 2400min

WashWorker1: Scheduled Utilization: 57.57%  
Idle Time: 28.28 min  
Units Allocated: 36  
Busy Time: 38.58 min

WashWorker2: Scheduled Utilization: 48.73%  
Idle Time: 34.17 min  
Units Allocated: 36  
Busy Time: 32.49 min

WashWorker3: Scheduled Utilization: 56.61%  
Idle Time: 28.99 min  
Units Allocated: 36  
Busy Time: 37.67 min

WashWorker4: Scheduled Utilization: 56.61%  
Idle Time: 28.99 min  
Units Allocated: 34  
Busy Time: 32.24 min

WashWorker5: Idle Time: 2400 min

Winder1: Scheduled Utilization: 93.35%  
Idle Time: 159.46 min  
Units Allocated: 10  
Busy Time: 2240.5 min

Winder2: Scheduled Utilization: 91.79%  
Idle Time: 196.92 min  
Units Allocated: 9  
Busy Time: 2203.07 min

Winder3: Scheduled Utilization: 90.5%  
Idle Time: 227.83 min  
Units Allocated: 10  
Busy Time: 2172.16 min

Winder4: Scheduled Utilization: 88.9%  
Idle Time: 265.19 min  
Units Allocated: 10  
Busy Time: 2134.8 min



Winder5: Scheduled Utilization: 87.3%  
Idle Time: 152.39 min  
Units Allocated: 9  
Busy Time: 1047.61 min

Winder6: Idle Time: 2400 min



Figure 12: View of Simulation Model

Painter1: Scheduled Utilization: 3.89%  
Idle Time: 384.43 min  
Units Allocated: 5  
Busy Time: 18.677 min

Painter2: Idle Time: 2400 min

Forklift1: Idle Time: 25.77 min  
Units Allocated: 80

Forklift2: Idle Time: 33.10 min  
Units Allocated: 69

Forklift3: Idle Time: 33.39 min  
Units Allocated: 69



## Linking Simulation modelling with Facilities Planning

### Current and Future Trends in Facilities Planning

The International Facility Management Association (IFMA) sponsored a fascinating forecasting workshop (International Facility Management Association, 2007) regarding emerging trends in Facilities Planning and Management and also the concerns and issues that might have a significant impact on Facilities Planning and Management as a profession. The study focuses mainly on trends as a concept as opposed to implementing specific technology or software that might be popular or might be the trend at the moment or in the future.

Specialists from various fields were chosen to attend the workshop, so as to get a wide, but relevant trend pattern that transcends disciplines.

The workshop attendees recorded 8 forecasts and trends:

1. Linking facilities management to strategy

To be aware what are the organization's core strategy and that planning and managing should be done according to this, as the facility will have a very large influence on the internal culture of the facility and accordingly also on productivity, employee morale, efficiency, whether the facility inspires innovation and public opinion of the organization.

2. Emergency Preparedness

All possible emergency situations from a terrorist attack to data protection and basic safety and security must be catered for. Scenario planning can be used to identify vulnerability areas and to set up action plans, evacuation plans (in case of, for example a fire). Employees should be aware of these plans and training and practice drills should be carried out. (Legal procedures of fire drills etc. of the country and area should also be taken into account). When employees of the organization are prepared for an emergency, they can be more self-reliant and do not solely have to wait for outside help to arrive; this will reduce the time of the disruption and speed up the recovery operation.

3. Change Management

The rapid pace at which technology and digital equipment is progressing has added a lot of intricacy to Change Management. A facility should be so planned and designed as to be very flexible and not over-customized, although due to budget and training constraints all new technology cannot be implemented as soon as it is released into the market, when there is decided on implementation of new technology or equipment, it must be possible.



Although not always possible, but regulatory changes (e.g. Disability Acts) must be anticipated and planned for, or (yet again) a facility must be flexible so as to respond to these regulatory changes with minimal disruption to the flow of the business. Develop and sustain prearranged strategies for change – outsourcing, contracts, and lease options etc. – PLAN

#### 4. Sustainability

LEED = Leadership in Energy and Environmental Design

This trend includes “environmental responsibility, energy management, investing in high performance systems, indoor air quality issues”.

Sustainability has certainly become a buzzword; and a fundamental requirement, more than a luxury in facilities planning. It can stretch limited resources in contrast to the need to having to develop new technologies. High performance systems (such as LEED and ENERGY STAR) are not requirements to maintain a high performance facility; however, applying these systems is becoming a trend and gains a lot of public recognition.

Sustainability are more important in some countries than others, regulations regarding recycling may exist and planning and implementing programmes to “reduce, reuse and recycle” (a phrase that is becoming more and more familiar) will adhere to regulations and suit the culture and attitude of the facility.

#### 5. Emerging Technology

Building operation systems are becoming more automated. An increasing amount of buildings are being designed using BIM (Building Information Modelling) software – drafting models of the facility is linked to a database of project information. The virtual information can be passed from design team to contractor to building owner. The idea is communication and effective facilities management.

Integrated Workplace Management System (IWMS) is also used for facilities management, as it is a portal where various sources can provide inputs.

#### 6. Globalization

This is a general trend of the economy and various disciplines. The world has become a lot smaller. There is infrastructure available, transportation to other countries and opportunities for companies to open branches in more than one country. A facilities planner is not restricted to only one area or environment and the possible positive technique of decentralization might be employed.



This trend includes many challenges as a consequence, such as: cultural differences, different regulations in different countries, language barriers, different expectations from employees and clients.

#### 7. Broadening Diversity of Workforce

There is a reduction in the fixed age of retirement, thus different generations have to work together, which could cause some conflict as different work styles are used by different generations and different cultures. Different cultures working together could be caused by the globalization trend. Differing work preferences should be taken into account when working with various people. Support activities are becoming standards.

#### 8. Aging Buildings – Replacing or Maintaining

Return on Investment should be considered when considering the main issue of replacing or maintaining. Hazardous materials that have become known since the construction of the building might pose an intricate problem to the facilities planner. The entire situation could be a sensitive and emotional issue if the building had some sort of role in the history in the community.

A classification system of the process of current trends (Singh & Sharma, 2006) in Facility Layout Problems (FLP) is listed as:

- Facility Layout
- Static (or dynamic) layout
  - {the application of models}
- MIP (Mixed Integer Programming), QIP, Graph Theory
- Solution Methodologies

Their research indicated that FLP isn't converging, but rather diverging. Implying that AI (Artificial Intelligence) could be used to aid in solving large sized FLP's; that multiple objective functions can be integrated to have a more applicable layout. Research also indicates towards stochastic facility layouts instead of static layouts. In the abstract a statement is made (Singh & Sharma, 2006): "A trend toward multi-objective approaches, developing facility layout software using meta-heuristics such as simulated annealing (SA), genetic algorithm (GA) and concurrent engineering to facility layout is observed." It is a promising research field in applying these meta-heuristical approaches, particularly as the concluding result is reliant on the initial solution.

A fuzzy set is a category of concepts or objects with no definite, well-defined boundaries between these concepts or objects that belong to the category.

Deb and Bhattachacharyya also expects a move towards stochastic methods, more specifically the use of "everything" fuzzy, such as fuzzy: - multi-criteria decision-making methods; multifactor facility selection routine; decision-making system (FDMS).



During the planning of libraries, the clients (patrons of the library) are the principal segment of persons involved in the facility and mostly the library is designed to accommodate them. The effect of this (Bellemare *et al.*, 2006: 387) has been the large percentage amount of the sampled library personnel questioned (80%) to have experienced symptoms of musculoskeletal disorder (MSD) and associated it with their workplace.

A current trend for ergonomic analysis of activities recommend that a job-shadowing approach ought to be followed, as compromises can then be made, as when a designer has to work with a set of extremely rigid criteria it could inhibit how they factor work activity into the design.

Increasingly more focus is being placed on health and ergonomics. Incorporating ergonomic design into facilities planning can be greatly beneficial to the company – less insurance claims, less complaints, higher employee morale.

Shohet (2006: 345-352) recognizes that maintenance, renovation, restoration and upgrading of existing facilities, rather than building and planning for entire new facilities has become a trend. Mostly due to reasons such as mounting construction expenditure, the identification of space on productivity, the increase in performance requirements and due to new bureaucratic and legislative requisites, it is often difficult to initiate new projects.

According to (Tompkins *et al.*, 2010: 113) there are various advantages and limitations when the Process Layout is employed at a facility:

Process Layout	
Advantages	Limitations
1. Better machine utilization	1. More material handling needs
2. Flexibility with regards to personnel and equipment allotment.	2. Increased work-in-process
3. General-purpose equipment can be utilized.	3. Production control becomes more intricate
4. Variety of tasks can be performed by personnel.	4. Length of production lines increase.
5. Specialized supervision is achievable.	5. Level of operator skills must be increased so as to complete variety of tasks required.

Table 3: Advantages and Limitations of Process Layout

At Benco and Fakkell Armature Winding, employees have fixed tasks/jobs – as this determines the individual’s salary. The type of work that, (for example) the winders do, one needs to be qualified as a winder. As a result, tasks cannot be rotated on a regular and fixed basis. However, should there be a problem with unavailability of personnel in a specific department and a higher qualified employee is able to do the job, then he/she can be assigned to the particular department.





## Product Positioning Strategy

A description for defining (Ostaseviciute & Sliburyte, 2008) product positioning is: “Product positioning is about visibility and recognition and what product represents for a buyer.”

Benco and Fakkel’s Product Positioning Strategy is Quality. Quality of products used and quality of service.

Their strategy of quality is revealed in various activities, functions and benefits given to their clients, such as:

- Benco and Fakkel has been SABS approved.
- High quality bearing selection – SKF or FAG or any other bearing that the client specified; application where the motor is to be used is also considered especially when considering the carbon content of the bearing. Low quality bearings won’t even be considered. If a higher quality bearing (or the specified bearing) is out of stock and needs to be ordered, the client will be informed and the client will be at liberty to make the choices regarding using a different bearing or waiting for the ordered bearing.
- Life duration of a motor decreases if a low quality grease is used – thus Benco and Fakkel uses a high quality grease to improve the possible life duration of the motor.
- Isolation is done with the greatest care – should anyone slip up, the motor can short between the winding and the stator and the process from Stripping onwards needs to be repeated (and this time at the cost of the company). This factor has the client in mind, because should the insulation be insufficient, it could also lead to motor failure, however, it is also attempting to keep company expenses as low as possible.
- Motors are sealed – locktight is put onto bolts and nuts so that they don’t loosen (this could cause a safety issue should it loosen); fans are also tighten, as it could also be a safety hazard should they become disassembled.
- The motors are sealed to become watertight to lessen the chance of the motor receiving water damage (however, clients who want to make a claim due to the warranty on their repaired motors, need to have at least a roof over their motors and a proof of invoice with job numbers of specific job).
- Motors are not returned “dirty” to their owners – the motors are sandblasted before being stripped and spray painted before going to the Dispatch Department).



- At Dispatch a final quality test is performed to ensure that no fans on the motor is making excessive noise, to ensure that terminal blocks and lids are fixed and receives a quality control sticker. An information plate is fixed onto the motor indicating who serviced the motor, the job number, motor specification.
- Testing reports are generated at the relevant departments and are included when the motor is dispatched to the client.
- After repairs, all motors have a 6 months quality guarantee after the motor has been collected and installed.

Should a motor fail before the 6 months, an electrician is sent out to the client to identify if the motor failure was caused by voltage drop and shorting or water damage.

### Process Positioning Strategy

The main areas that are critical inside the facility, is the testing bay, wash bay, curing oven and spray bin. The testing bay is located near the main voltage supply, so there isn't a voltage drop and the motors are able to be tested. The curing oven has to be close to any wall and where there is enough space for movement of hot motors. An exhaust is installed as an outlet through the wall, for the releasing of gasses. The same goes for the spray bin. But instead, an extractor fan is installed, to prevent overspray, so the painted surface of the motor is smooth. The wash bay has to be close to stripping (which needs an extractor fan through the ceiling), but also at a draining system and water supply. The storage departments are located to the other small stations like fitting and stripping. The reception/office has to be close to the entrance, so the motor doesn't have to travel far to be booked in, this way time is saved.

### Production Planning and Scheduling Approach

Planning and scheduling in advance for work on a specific day is dependent on the quantity of breakdowns of motors during that period. Most motors operate throughout the year and may breakdown at any time. Seasons do influence the frequency of breakdowns. The company observed through years of experience an increase in breakdowns during the rainy season in summer. This is due to motors acquiring water during rain and flooding. Another factor is the increase in irrigation on farms during summer, for which electrical pumps are employed. Planning and scheduling in advance is thus difficult. Benco and Fakkell plan on a day-to-day basis regarding production, employing a first-in first-out production sequence for most work tasks.

On request, Benco and Fakkell may collect motors for repair from clients located up to 180 km radius from the workshop. Prior arrangements are made if this service is to be granted.



Three different repair types are identified:

<b>Precedence</b>	<b>Repair type</b>	<b>Work duration</b>
First	Breakdown service repair	Within 24 hours
Second	Warranty claim repair	Up to 2 days
Third	Regular bring-in repair	Up to 4 days

Table 4: Repair type and Precedence

The breakdown service repair is a service provided for the immediate repair of a motor within 24 hours. This breakdown service receives priority over all other repairs. A 40% surplus charge is added to the total amount quoted on the quotation. Second priority is given to warranty claim repairs. Regular bring-in repairs may take up to 4 days to repair and are attended to after the above two breakdown types. The Simulation model was build on assuming that motors will be repaired on a Regular bring-in repair. First-in First-out production is employed for these kinds of repairs.

Factors determining the duration of a repair include time of labour and part sourcing. Some frequently used parts are stored in the inventory. These parts are re-ordered in advance once inventory levels become low. Due to the large variety of motors for repair, most required parts are ordered using the make-to-order principle once haven been assessed. The delivery time on average usually occurs within 5 hours of the order having been placed; however certain specialised components may take a couple of days to source. The just in time storage method is implemented to use up less inventory space without sacrificing the availability of parts.

The production scheduling is planned such that multiple repair tasks requiring the work of a single workstation do not clash at the same time. Employing this technique eliminates unnecessary idling time of workstations.

Some clients make use of a credit account to pay their invoices. The municipality account is payable every 6 months while most mines' due payment is on a monthly basis. All other customers pay on receiving their repaired motor. Financial planning insures that there is sufficient inflow of income to cover the daily bills and expenses of the company in between the account payment date periods.

## Space Requirements

In the current space requirement layout of the company it is very difficult to specify a certain space to the specific machine, workstation, because of numerous uncertainties that exist in the work environment. The total floor area in the shop is 858 m<sup>2</sup>. From the current system it can be seen that the workstation among each department varies depending on the size of the motor that has to be repaired. Thus the tables in the workstation will be moved around to accommodate the motor area. There are also a lot of spares misplaced around the shop, this leads to missing parts and personnel falling over spares.



The main path running from the entry of the building straight through to the end of the Painting Department is 37m in length while the width is 3.3m. This is sufficient space for the fork lift to travel.

Workstations should also be designed to effectively and efficiently utilize material, machinery and space in the department. In the current space requirement there is a lot of floor space that is going to waste because of insufficient facility planning.

There are a lot of spares in the Salvage Parts Area that is broken and discarded that occupy unnecessary space in the department. Space should be better optimized so that the overall layout of the company can be more sufficient. When considering aisle space one should consider the flow in the specific direction to reduce damage to parts and injury to personnel.

Facility space requirements needed for parking and delivering is also a main concern in the design of the facility. Currently there are 34 employed workers in the facility were by 11 of the personnel use their own transport while the other personnel use public transport.

From observation and research outside the facility there are 10 parking spaces in front of the company and at times of no delivering or receiving there are 3 company vehicles that accommodates parking in front of the facility. Thus some of the personnel have to park their vehicles in the near surroundings of the company.

If one increases the area of parking space it will decrease the amount of time spent to park and de-park the customer and personnel vehicles. Since there is only one entrance and exit at the same place there is at times a build up of traffic in front of the company. When it comes to storage of employee belongings the office personnel store their belongings in one of their desks drawers or nearby the desk. While the employee's in the different departments store their belongings in their standing toolbox assigned to them. Lockers will be used to store personnel belonging for the employees working inside the shop.

Restrooms in the facility should be situated within 200 feet of each department to ensure convenience to the working personnel.

In the current layout of restrooms in the facility there are no handicapped restrooms available to handicapped employees, but in this facility currently there is no handicapped employees working for the company. The required lavatories needed in the facility should be four since the amount of workers in the facility sums up to 34 employees' and at the same time have a sum of three water closets. Food services are of the premises but in a surrounding of 2 km there is 6 food services were personnel can buy food. Since food services are located outside the premises employees get an outside view during break and some of the food services nearby allow delivering of food. Shift starts at 7:30 in the morning, lunch break is from 12:00 till 13:00 and shift ends at 17:00 depending on whether you're on standby for the week.



## Material Handling

There are several materials handling equipment found in Benco and Fakkel. For containers, Pallets are used as a surface for the objects to be lifted, to rest on. Pallets are lifted via an industrial lift truck and then placed on a pallet stacking frame. However, there is not enough pallet stacking frames in the plant, because some of the pallets are placed on the floor, which reduces the space for movement.



Figure 13: Pallet Jack

Benco and Fakkel uses wooden pallets which has a base weight of between 55lb and 112lb. It has an average durability and is easy to repair. The wood makes the pallet biodegradable and easy to recycle. They have a wide general use for hardware and durable goods. In this case they are used to store the motors, the lifting of the sandblasting sand bags etc.



Figure 14: Jib Crane



Figure 15: Gantry Crane



Other material equipment used for the lifting of the motors are the monorails, hoists and cranes. Two different cranes are found at Benco and Fakkel, namely the Jib crane and the Gantry crane. The Gantry crane has a safe working load (S.W.L.) of 3 ton. Using cranes, the flow is more intermittent and flexible than using conveyors. But they have limited mobility, unlike the industrial lift trucks.

Hand carts are also used for the transportation of gas bottles that are too heavy and large to be carried alone by the worker. Two hand carts are located on two random places in the plant. A two-wheeled hand cart, like the ones in the plant, is usually allowed to carry a maximum weight of 114kg within a maximum distance of 16m.



Figure 16: Hand Cart

Then there are two counterbalanced forklifts in the company. They are mostly used for the transporting of the motors. For the saving of time and space, pallets aren't used here. Instead a strap is placed over the two forks with a hook at the point where the strap's two ends meet. The hook is then used to lift the motor by the ring on the top. The forklift then carries the motor with an angle, to be sure that the motor doesn't make contact with the floor when in transit. Speed also has to be kept, so the motor doesn't swing and cause injuries when an emergency brake has to be performed.

After a motor has been varnished, it needs to be taken to the curing oven. The motor is loaded onto a metal trolley which is moved via the forklift. The two forks of the fork lift are inserted by the gaps as shown. The trolley moves on a rail, but because the varnish forms a thick liquid when melted in the oven, this causes the trolley to move more difficult. Thus due to safety regulations, the trolley will be too hot and heavy to be pulled out by a worker alone.



Figure 17: Hoisting of Motor

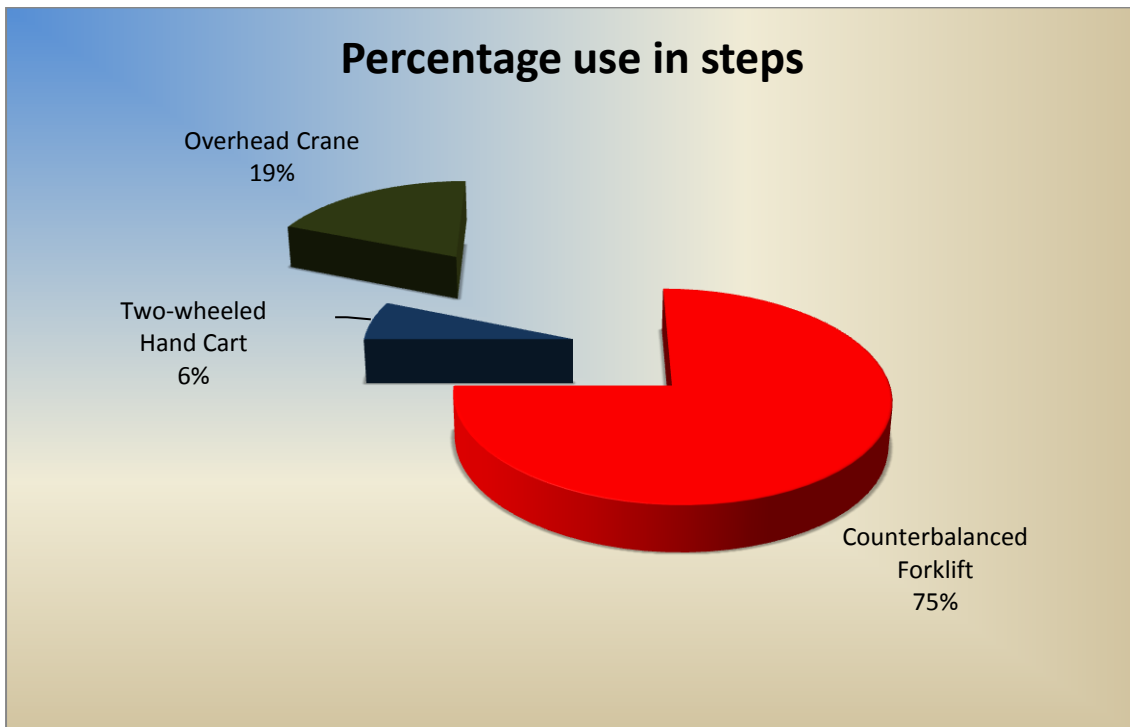


Figure 18: Material Handling

## Problems in the Design of a Materials Handling System

The main problem currently being experienced is that there aren't separate inlets and outlets of the flow. All the flow that is happening in the plant, has an input and output at the same point. This causes unnecessary costs that have to be reduced. The forklifts use a lot of fuel, thus the paths that are driven repeatedly which can be avoided, are a waste. To have a fluent flow for the material handling, an input point must be on one side of the plant and then an output point at another area. By doing this, the forklift will reduce its distances. Another way to reduce the costing of the forklift is to use more of the other materials handling equipment. The forklift is currently being used 75% of the time.

## Safety Considerations

Safety should be one of the first subjects to look at when designing a material handling solution or a part of a facility. By engineering and integrating safety into a design, reliance on process controls or personal protective equipment can be avoided. Many material handling equipment suppliers are reputable and provide OSHA-compliant equipment. The importance to a safe facility is focussing on the interface between the workforce and the equipment. Inside the plant there are multiple uses of pallet racks and 2 industrial lift trucks. Due to poor layout, the lift trucks only use the main aisle, where the other aisles branch on, for movement.



The main aisle doesn't have sufficient space for pedestrians and lift trucks, which is a safety hazard, when observations aren't thoroughly executed. No matter how well trained or safety conscious the workforce may be, aisles that are too narrow will cause damaged uprights, damaged vehicles, and injured workers. Hand carts are recommended to be used in aisles with a width of 1m.

For a Four-wheel counterbalance industrial lift truck, the recommended aisle widths are 2.6 to 3.3m for pick aisles and 3.3m for cross aisles. To minimize the injuries to it's very lowest, the office areas or employee common areas, should be kept along the perimeter of the building and away of process and storage areas. Entrances into travel aisles should be kept in open areas, away from equipment or building structures that can create "blind spots" for both pedestrians and vehicle operators. Place stanchions or barriers at entrances, so that pedestrians must frequently stop, look, and go around them.



Figure 19: Forklifts Working

Workstations should also be designed to minimize eye strain, hazards and fatigue in every department. In the company, material handling varies depending on the size of the motor, if it's above 15Kw one should rather use a fork lift to carry the motor around the work place.

If it's between 5-15Kw you can use a trolley and any size below 5Kw can be manually handled

In the facility there is no tearoom where employees can go and sit during their break so this could also be established into the work environment so that on cold rainy days personnel can go and sit in the tea room and not in each department.





## Types of Plant Layouts to consider when adding Sandblasting to the repair process

When selecting the type of layout that the company wants to implement, there are certain points to consider:

- Will the implementation affect the process flow in a positive way?
- How many departments need to be moved to apply the new changes?
- How much will it cost the company to do these changes?
- Will the workforce adapt to these changes?
- How long will it take to apply these new changes?
- Will the company benefit from these new changes?
- Is there enough surface area available to accommodate these new changes?

Below are four different types of layouts the company could implement:

- Layout A: The building of the new Sandblasting Department.
- Layout B: The use of a container to accommodate the Sandblasting Department.
- Layout C: The use of modern technology through using a Vacuum Blaster from Nederman.
- Layout D: Moving the Tea Room to the current Stripping Department and vice versa (Using the Vacuum Blaster in Layout C).

In all four types of layouts there has been an addition of two new rooms: 1) A bigger store room for new parts and office supplies. 2) A room where the employees can keep their belongings save in lockers. Also the receiving and dispatch are now being operated separately from two entrances.

Parts Management:

- Centralization of the New Parts Storeroom: this ensures that when a worker needs something from the New Parts Storeroom it is more accessible
- Improved ventilation: Extractor fans will be placed in the Wash Bay Department and above the maintenance area to ensure a consistent air flow in the facility. For the tea room there will also be an air con with tables, chairs, microwave and television.



## Layout A

In this layout the company has the option of building a room for the Sandblasting Department where the sandblasting can be done inside a good ventilated room without affecting the worker safety in the company. It also shows that receiving of motors that has to be repaired will now enter the company from another entrance. This will prevent traffic build up when a customer comes and fetch his repaired motor. After the motor has been booked-in it can be sent directly to the sandblasting department if the motor is covered in dirt, this happens approximately 80% of the time, because most of the customers are from mines in the surrounding area. This room will be build by bricks and cement. The company will not have an expense in purchasing extractor fans to remove the dust from the air, because there are a few of fans that they can repair from the Salvage Parts Area. Below is a diagram showing these new changes with the process flow from when entering the company until ready for collection by the customer (Appendix shows a bigger representation of the diagram)

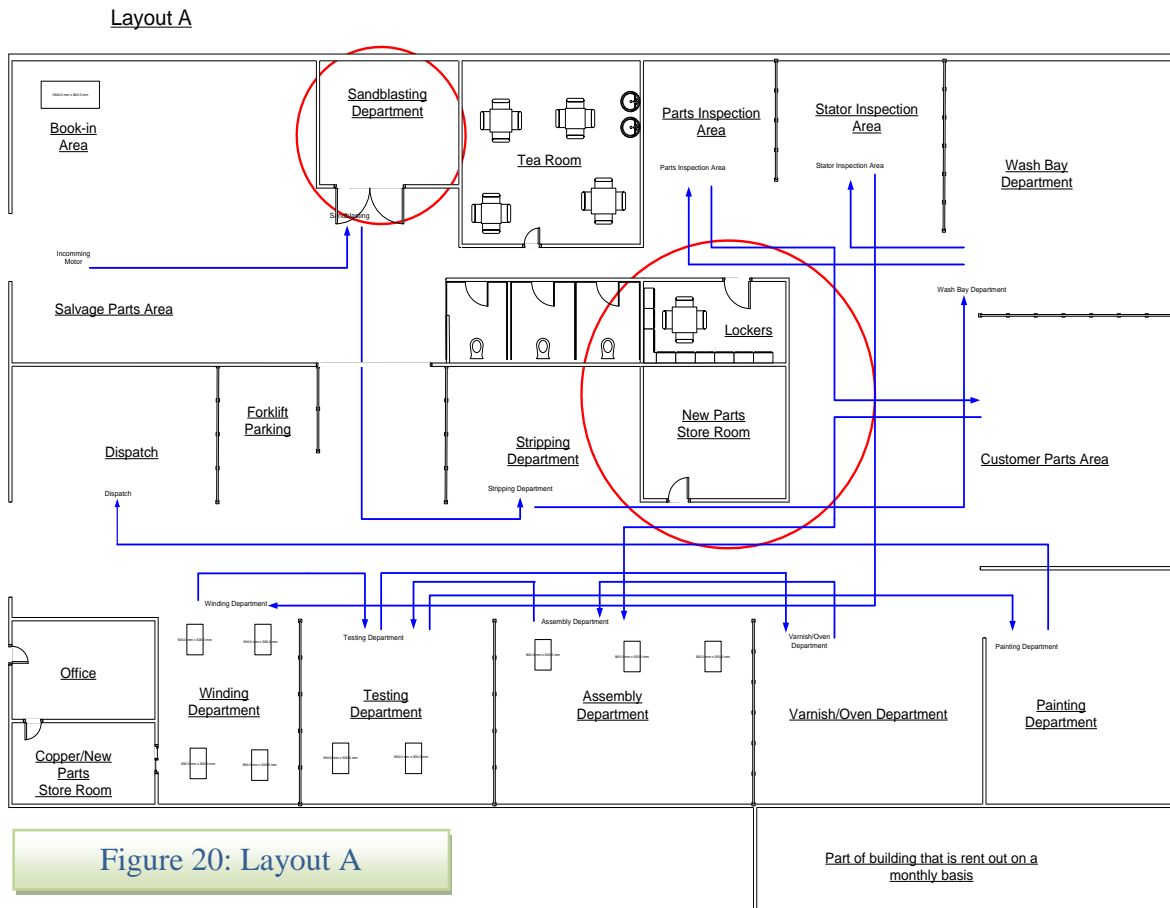


Figure 20: Layout A



**Cost Analysis for Layout A:**

Prices for building materials were gathered from Cash Build in Middelburg and Mi Build. Below is a summary of all the materials that will be needed in building the sandblasting room.



Figure 21: Builder

<b>Building Material Needed for Sandblasting Department (All prices incl.VAT)</b>							
Length of walls:	2.3 m (3m high)	Bricks needed:	379	Sand Needed:	0.28 cubic meter	Cement:	1.24 bags
	4.4m (0.5m high)		123		0.09 cubic meter		0.4 bags
	3.75m (3.5m high)		618		0.45 cubic meter		2.03 bags
			<b>1120</b>		<b>0.82</b>		<b>3.67</b>
<b>Material supplied by Cash Build Middelburg</b>							
Cement:	R67,70 per 50kg						
Building sand washed:	R185,99 per cubic meter			<b>Cost Calculation:</b>			
Bricks( Mamparras):	R1,45 per brick						
Door(Mansonite Hollow core):	R204,98 per unit			Cement:	4 bags	R 270.80	
Door(Aluminium sliding 2100*3000):	R4900 per unit			Sand:	1 cubic meter	R 185.99	
Corrugated Galvanized(610mm*4,2m) :	R228,27 per unit			Bricks:	1200	R 1 740.00	
Structural Pine(38mm*114mm*4,2m):	R62,99 per unit			Door:	1 door	R 4 900.00	
Florecent Light:	R147,80 per unit			Corrugated:	7 lengths	R 1 597.89	
Light Switch:	R72,50 per unit			Pine:	9 lengths	R 566.91	
Extractor Fan:	Priceless			Lights:	3 lights	R 443.40	
Sandblasting Machine (200L Industrial Pot):	R 28 215.00			Light Switch:	1 switch	R 72.50	
				Labour:		R 2 500.00	
					<b>Total:</b>	<b>R 12 277.49</b>	
<b>Total Amount for Sandblasting Department:</b>			<b>R 40 492.49</b>				

Table 5: Cost for Layout A



## Layout B

When considering layout B, the ease of moving the sandblasting department will be relatively easy, because it's a movable unit. To consider this type in conjunction with layout A there's a huge price difference in constructing the new department. Layout B is not time dependant such as layout A and could be in use much faster than Layout A. Again the implementation of an exhaust and extractor fans to remove the dust from within the container will not be of extra cost. Below and in the Appendix is a representation of the layout.

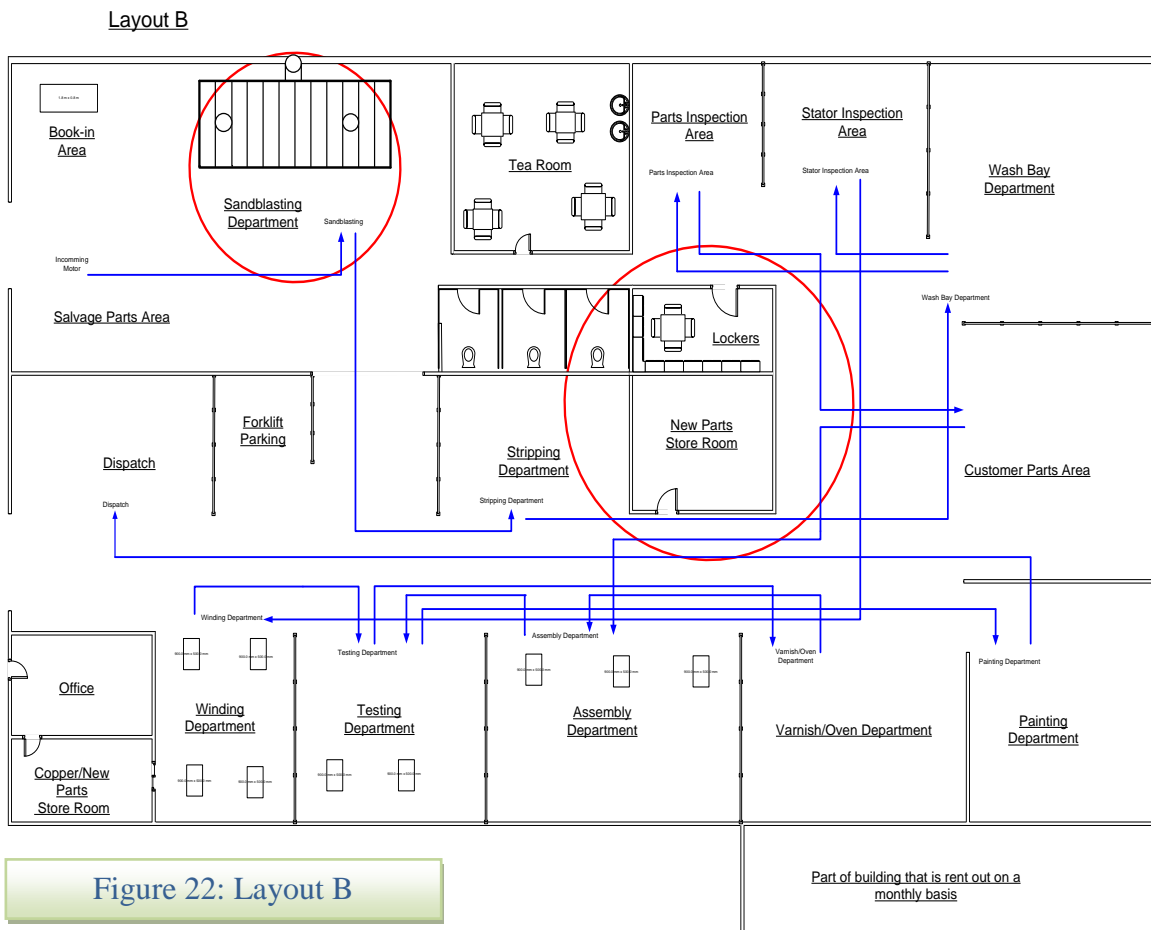


Figure 22: Layout B



**Cost Analysis for Layout B:**

Route 21 will be supplying a container with transport from Pretoria to Middelburg at a cost shown in the table below. The sandblaster that will be used in the department is a 200Liter sandblasting pot that includes safety helmet for the worker, gloves, apron and hoses.



Figure 23: Builder

<b><u>Building Material Needed for Sandblasting(Container)</u></b>							
<b><u>Material supplied by Cash Build Middelburg</u></b>							
Price for Container( 6m*2,4m):	R 26 619.00				<b><u>Cost Calculation:</u></b>		
Sandblasting Machine (200L Industrial Pot):	R 28 215.00				Container:	R 26 619.00	
					Sandblaster:	R 28 215.00	
					<b><u>Total:</u></b>	<b><u>R 54 834.00</u></b>	
<b><u>Total Amount for Sandblasting Department:</u></b>	<b><u>R 54 834.00</u></b>						

Table 6: Cost for Layout B

**Layout C**

This type of layout does not need any type of room for the sandblasting department to function, because the sandblaster that the company can use in this department is a mobile vacuum blaster. This type of blaster can be used anywhere in the company and does not need a specific location within the plant. This type of blaster can be driven by compressed air or electrical. With this type of sandblaster abrasives can be used several times because it collects the abrasives just send out from the hose. It's also more environmentally friendly than the normal industrial sandblasting pot.



This type of blasting can be done indoors as well as outdoors. The only problem with this type of blaster are the price that goes with it, prices ranges from R20 000 to R350 000 depending on your requirements. Below is the layout of the plant but like I've mentioned its movable and does not need to be located at a specific area within the company. The model that will meet the requirements for Benco and Fakkell will cost approximately R50 000.

Layout C

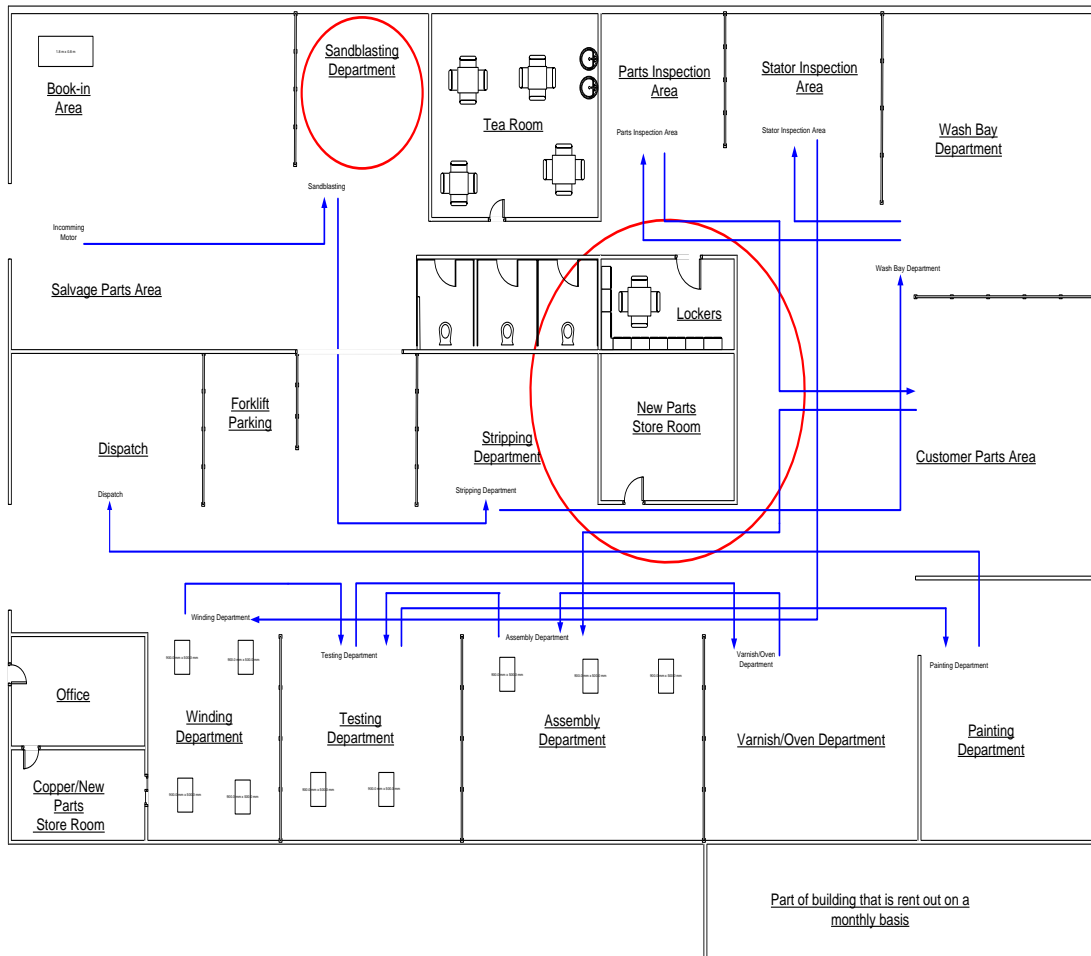
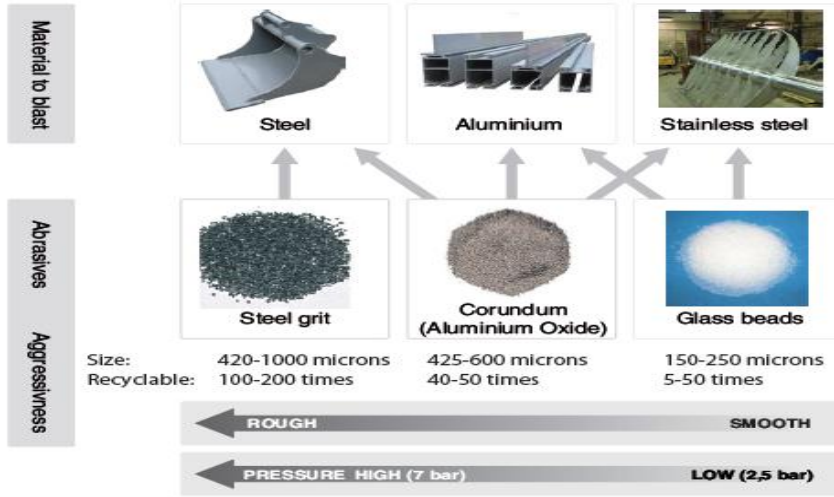


Figure 24: Layout C



## Abrasive recommendations



Outside those recommendations, contact Nederman for technical support

Aluminium Oxide, 25 kg  
Part no: 40376292

Figure 25: Abrasives

Below are the types of hoses that come with the vacuum blaster to sandblast different surfaces:

### Nozzles

	Part No	Description
1	40375404	Brush ring standard
2	40375403	Inner tube kit standard
3	40375410	Clamp for brush holder.
4	40375408	Inner corner brush ring
5	40375406	Inner tube and brush holder inner
6	40375407	Outer corner brush ring
7	40375405	Inner tube and brush holder outer

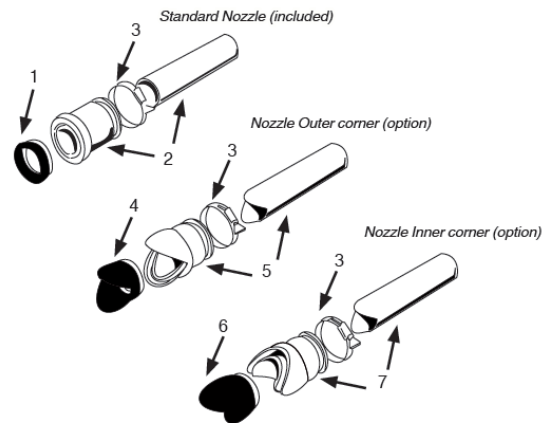
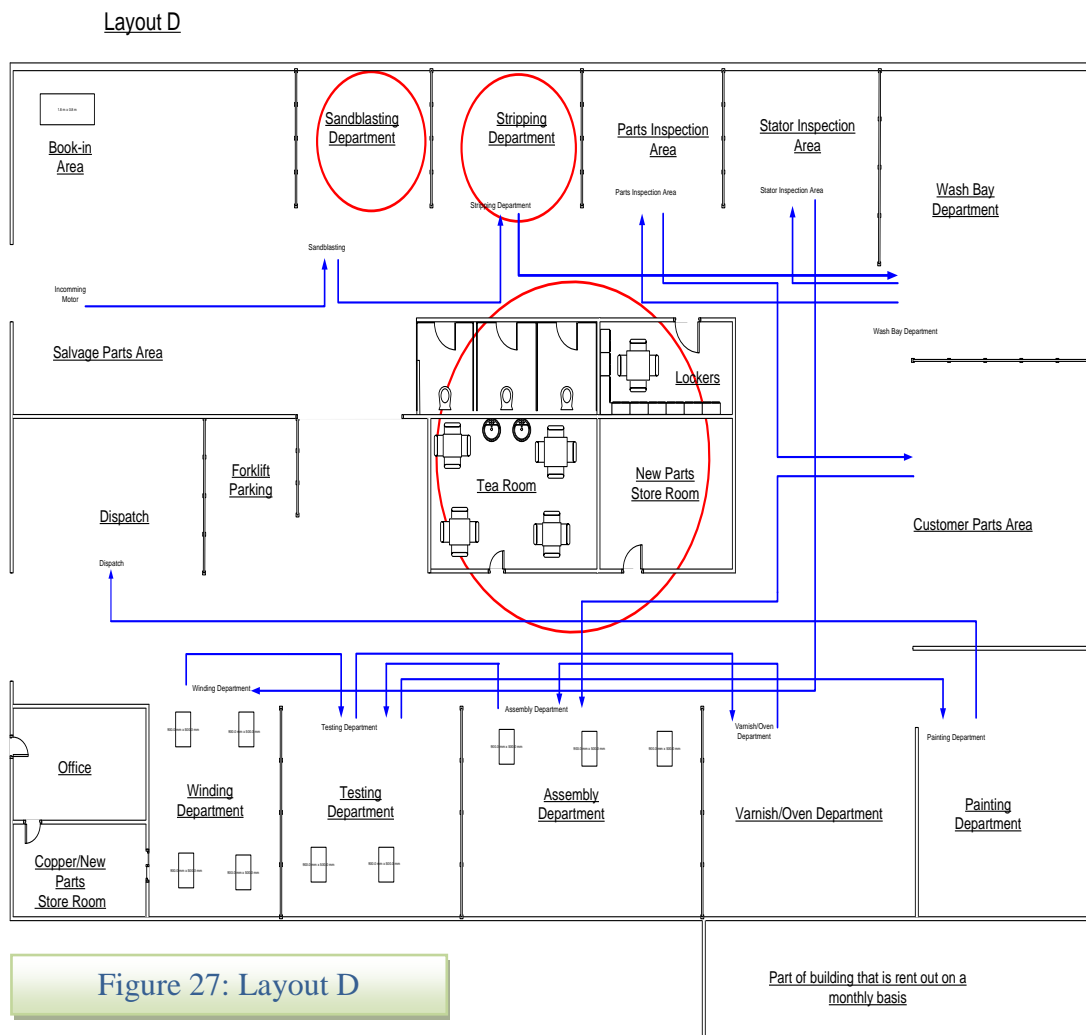


Figure 26: Nozzles



## Layout D

When this layout the stripping department will be moved to the current area where the tea room is located in the company and the tea room will be moved to the current stripping department. With stripping department in its new location we will cut out the crossing of work flow within the company and improve the steps of repair and functioning between departments in the company. To implement these changes it will take time to move and rebuild these two areas. Below and in the Appendix is a representation of the layout:







**Cost Analysis for Layout D:**

Prices for building materials were gathered from Cash Build in Middelburg and Mi Build. Below is a summary of all the materials that will be needed in building the sandblasting room.



Figure 28: Builder

<b>Building Material Needed for moving Tea Room(All prices incl.VAT)</b>							
Length of walls:	4.6 m (2.5m high)	Bricks needed:	633	Sand Needed:	0.46 cubic meter	Cement:	2.07 bags
	3.99m (2.5m high)		549		0.4 cubic meter		1.8 bags
			<b>1182</b>		<b>0.86</b>		<b>3.87</b>
<b>Material supplied by MI Build and Cash Build Middelburg</b>							
Cement:	R67,70 per 50kg						
Building sand washed:	R185,99 per cubic meter			<b>Cost Calculation:</b>			
Bricks( Mamparras):	R1,45 per brick						
Door(Mansonite Hallow core):		R204,98 per unit		Cement:	4 bags	R 270.80	
Door Frame:		R145.99 per unit		Sand:	1 cubic meter	R 185.99	
Corrugated Galvanized(610mm*4,8m) :		R260.88 per unit		Bricks:	1200	R 1 740.00	
Structural Pine(38mm*114mm*6.6m):		R99,99 per unit		Door:		0 R 0.00	
Florecent Light:		R147,80 per unit		Corrugated:		0 R 0.00	
Light Switch:		R72,50 per unit		Pine:		0 R 0.00	
				Lights:		0 R 0.00	
Price for Double Door locker:		R680 per unit		Light Switch:		0 R 0.00	
				Door Frame:		0 R 0.00	
Sandblasting Machine (Vacuum Sandblaster):		R 50 000.00		Lockers:		0 R 0.00	
				Labour:		R 2 000.00	
				<b>Total:</b>		<b>R 4 196.79</b>	
<b>Total Amount for Store Room and Locker Room:</b>			<b>R 54 196.79</b>				

Table 7: Layout D



## Store Room and Locker Room

Benco and Fakkel also wanted to know how much it will cost them to build a new parts store room and a locker room for the employees. The new parts store room will improve:

- Better ordering in quantity of parts.
- Improve stock keeping.
- Improved space requirements to keep stock.
- More centralized to the surrounding departments.
- Keep more inventories for when certain parts are difficult to order.

The locker rooms will protect employee belonging and keep them from leaving their belongings with them in the department that the serve. It will reduce the risk of belongings being stolen or damaged.

Below is a cost estimation of how much it will cost the company to build these two new rooms:

<b><u>Building Material Needed for Store Room and Locker Room (All prices incl.VAT)</u></b>							
Length of walls:	6.5 m (2.5m high)	Bricks needed:	894	Sand Needed:	0.65 cubic meter	Cement:	2.93 bags
	3.55m*2 (2m high)		391		0.28 cubic meter		1.28 bags
	4.45m*2 (0.5m high)		122		0.09 cubic meter		0.4 bags
	4.45m (2.5m high)		612		0.45 cubic meter		2 bags
	3.99m (2.5m high)		549		0.4 cubic meter		1.8 bags
			<b>2568</b>		<b>1.87</b>		<b>8.41</b>
<b><u>Material supplied by MI Build and Cash Build Middelburg</u></b>							
Cement:	R67,70 per 50kg						
Building sand washed:	R185,99 per cubic meter			<b>Cost Calculation:</b>			
Bricks( Mamparras):	R1,45 per brick						
Door(Mansonite Hallow core):		R204,98 per unit		Cement:	9 bags	R 609.30	
Door Frame:		R145.99 per unit		Sand:	2 cubic meter	R 371.98	
Corrugated Galvanized(610mm*4,8m) :		R260.88 per unit		Bricks:	2600	R 3 770.00	
Structural Pine(38mm*114mm*6.6m):		R99,99 per unit		Door:	2 door	R 409.96	
Florecent Light:		R147,80 per unit		Corrugated:	11 lengths	R 2 869.68	
Light Switch:		R72,50 per unit		Pine:	9 lengths	R 899.91	
				Lights:	3 lights	R 443.40	
Price for Double Door locker:		R680 per unit		Light Switch:	2 switch	R 145.00	
				Door Frame:	2 frames	R 291.98	
				Lockers:	12 lockers	R 8 160.00	
				Labour:		R 4 300.00	
					<b>Total:</b>	<b>R 22 271.21</b>	
<b><u>Total Amount for Store Room and Locker Room:</u></b>			<b>R 22 271.21</b>				

Table 8: Cost for New Store Room and Lockers



## Which Layout will be the best?

When considering a final plant layout, observation needs to be made and certain criteria and factors need to be taken into account. This process was done and completed in the evaluation section to ensure that a layout is not chosen based on “popularity” only. The main focus was to implement a material flow process and an improvement of the overall layout of the facility, as well as the material handling of the facility.

The Weighted Factors Comparison Method was used to evaluate the different alternative layouts and Layout D and C scored highest on this method. Accordingly (but also incorporating common sense) Layout A has a time frame in which the building needs to be build before making use of it. Layout B is like a drop and go, where the container will be delivered to the company and where work can be started.

Layout C does not need a enclosure wherein it needs to function sense its more environmental friendly and moveable. Layout D also has a time frame in which these departments needs to be moved and will take a while to complete. These changes will affect the process flow since machinery, tables ect. needs to be moved so that building can be started for the tea room. When considering cost and time, in my opinion I will go for layout C but in the long run Layout D will be more beneficial.

Reasons for selection:

Weighted Factor Comparison										
Layout			A		B		C		D	
Nr	Factor	Weight	Rate	Score	Rate	Score	Rate	Score	Rate	Score
1	Material Flow	30	17	510	17	510	17	510	25	750
2	Space Utilization	10	3	30	3	30	3	30	4	40
3	Initial Cost	20	18	360	7	140	10	200	8	160
4	Throughput	5	2	10	2	10	3	15	4	20
5	Security	10	5	50	5	50	5	50	5	50
6	Personnel Support	5	3	15	4	20	4	20	3	15
7	Environmentally Friendly	10	5	50	5	50	9	90	8	80
8	Personal Employee Comforts	5	2	10	2	10	4	20	3	15
9	Health and Safety	10	4	40	4	40	8	80	7	70
10	Training	5	4	20	4	20	4	20	4	20
11	Ease of expansion	5	2	10	3	15	4	20	3	15
12	Accessibility	15	10	150	9	135	12	180	10	150
13	Working Schedules	10	6	60	6	60	7	70	6	60
14	Distance Travelled between departments	15	7	105	7	105	7	105	9	135
15	Material Handling Ergonomics	10	6	60	6	60	9	90	8	80
16	Delays in process	10	5	50	5	50	6	60	7	70
17	Parts Management	10	7	70	7	70	8	80	7	70
18	Floor Management	15	4	60	4	60	9	135	10	150
<b>Totals</b>		<b>200</b>		<b>1660</b>		<b>1435</b>		<b>1775</b>		<b>1950</b>

Table 9: Weighted Factor Comparison



#### Improved Material Flow:

- Book-in was moved to a section where it does not collide with dispatching of electrical motors. Through this movement traffic that might occur during the book-in stage in the facility is cancelled out.
- Stripping Department is moved closer to book-in and forms a straight line (makes material handling more accessible). Accordingly after a motor is booked –in it can directly be sent to the sandblasting department to be blasted.
- The Stripping Department is placed near the Office, the Winding - and New Parts Store Room Department. This makes it much easier to keep track of parts and ensure that the correct job number will be used during the repair of the stator. When the winders need information about a specific job they can easily go to an employee in the Stripping Department for assistance.

#### Improvement in security

- Use of cameras in the shop to minimize theft in the facility, the Winding Department remain on the same place to ensure that no copper wire can be stolen from the facility

#### Improved Floor Management

- A maintenance area was brought into the design so that when a forklift needs to be repaired, the repair of the forklift can be done in the space allocated to maintenance. This section also ensures that floor space is managed better and that nothing is standing in any individual's way, or in the way of the flow of materials.

## Products for improvement

The normal hardwood pallet currently used at Benco and Fakkkel, can be purchased for R480. After doing research, it is found that there is a more ergonomically pallet, namely Nestable Presswood which is much less expensive than the current pallet. They are 60% lighter than the hardwood being used inside the facility. They are safer towards the employees and prevent less damage to the products, because the dry deck design eliminates the need for moisture barrier sheets. Also, there are no nails nor splinters and rounded edges. The four-way forklift entry pallet can be picked up from any direction, making it more flexible with material handling. They save storage space, because a stack of 50 Nestable Presswood pallets measures only 2.1336 meter in height.



For the storing of copper wires, we have decided to change the current container to something more ergonomically and organised. The current cabinet has 4 shelves, far apart, and wide doors that makes it inconvenient in the small space. The Arc Rotary File works well in small limited spaces seeing that it has no doors, but rotates easily to provide access to both sides. The flexible cantilever-style shelves are organised and easy to access the wires needed providing the most unobstructed filing per level with the easiest installation possible. This cabinet is expandable if needed, so it has no limits and no matter how your needs grow or change it is incredibly easy to add on to your current system without the hassle of starting over.



Figure 29: Nestable Presswood Pallet

Figure 30: Current Pallet Racks



The current pallet racks are not enough for storage, seeing that there are motors left on the floor, which makes the area for storage larger. It is better to store on top of each other. The racks are also not 100% safe – a small human mistake can cause the pallet or motor to fall off in the gap, if placed wrongly onto the shelf. We have decided to add more pallet racks, but to get safer ones. The safer rack has rugged, high-strength steel construction allows 5.08cm beam adjustability and a patented Bowlock safety clip that securely attaches the beam to the upright direction. The wire decks help preventing the pallet or motor from falling off.



Figure 31: Pallet Rack

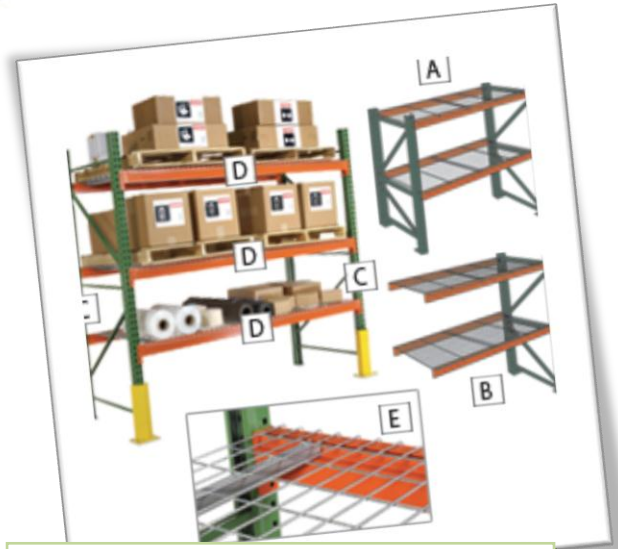


Figure 32: WIREWAY Invincible Pallet Racks

Figure 33: Chrome Wire Shelving



The current shelving for inventory is very unorganized with small space to walk between the shelves. We searched for an ergonomic shelving rack that is more organized. The Chrome Wire Shelving with QUANTUM Dividable Grid Containers consolidate inventory into one convenient location. The chrome wire shelves are adjustable. The blue dividable grid containers that can be sub-divided into small compartments can come with 12, 24 or 36 containers. This wire shelving will help with space and keep everything in a neat, organized way.



Figure 34: Spares Containers

By the different workstations like stripping, fitting, assembly etc. the tools of the employees are lying everywhere, making it easy to waste time when looking for a specific tool. Having one of these containers shelving at each of the workstations, won't only increase work area, but increase material flow between stations.



In order to save money on the monthly cost of R3000 for the fuel of the forklift, we decided it would be better to put a Bridge Crane in the facility. Their prices are quite high, but will make up in the long run by cutting down on fuel costs and continuous maintenance of the forklifts.

Figure 35: Bridge Crane

There aren't enough cameras in the facility. There have been complaints of copper wire being stolen. Copper wires are very expensive and have to be kept under a close watch. A camera is needed overlooking the copper wire cabinet, and the rest inside the facility. There are two packages of choice: The "Do-it-yourself" kit and the Silver Package.



The Silver Package has extra features that aren't really needed and comes with installation, which is also not necessary. So it's better to take the cheaper option, of R8999. These cameras are easy to install by the "average handy man". The D.I.Y. kit comes with a recorder, making playback easy to go over the following day, on the LCD monitor which is included.



Figure 36: CCTV Cameras

## Conclusion

From the results obtain through running a simulation on one specific type of motor, it's clear that certain workers are working harder than other and some of them are waiting for work to be send their way. When comparing the winding department with both the assembly and testing department you will notice a huge difference in resource utilization. Thus assigning or employing more workers to this department will improve work flow and prevent workers from exhaustion. Thus workers in the assembly department could be used in the varnish/oven department to make the work lighter in this department. It's clearly that the company will manage with only one forklift since the idle time for all three are high. This will reduce cost on fuel for the forklifts and these drivers can be placed in the company where needed. The operators in the testing departments can also be placed in departments were their help can reduce their idle time and improve work flow in the company.

Its clear that when taking all the other types of motors into account certain departments will wait for work and the time for a worker to wait to do something, means that his being paid for doing nothing. Thus to solve this type of problems arising in near future, workers should be allocated to departments were work are building up to reduce the work load on the specific department if they have nothing to do in their department. Training of workers will also be needed because the painter in the painting department will not be able to wound a stator in the winding department and the advantage also with trained workers is that if a worker from one department is on leave there would be a substitute to help out in the specific department.





A facilities requirements analysis was performed on their existing facility.

The main focus was on the current AS-IS layout. Benco and Fakkel's layout is a Process Layout. The production planning and scheduling approach used is the first-in-first-out (FIFO) method, however, planning cannot be done very thoroughly, as it is based largely on the motors that are received on the specific day from customers. The three repair types also have an influence on the scheduling of the motors. In the simulation model we only focus on motors that come in regularly and assume no breakdown charges. The product positioning strategy employed by Benco & Fakkel is quality, quality of goods used for repairs, such as bearings and grease, as well as quality of service.

Alternative layouts were generated for the implementation of a sandblasting department for Benco and Fakkel and evaluated using the Weighted Comparison Factor method. The factor that carried the most weight was material flow. Two types of layouts was selected on the basis that it scored the highest. Depending on the choice of the customers it will play a role in the time and cost to implement the new department.

The recommendations for Benco and Fakkel's facility layout includes: expansion of the existing facility to separate receiving and dispatch, installing a bridge crane to improve material handling and lesson the distance of material flow, centralizing essential storage areas, improving floor management by allocating specific areas to work-in-progress (WIP) parts (and thereby also improving space utilization).

Balancing department needs more research as it seems that implementing this new department will incur a few years to cover cost and it might broaden the light whether or not it's profitable to implement. So why invest in a machine that takes floor space and the need to use it aren't that often in comparison with the sandblasting machine? The cost to repair a damaged shaft seems to be cheaper than sending the rotor away for balancing, taking all costs into account such as transport to Johannesburg and the time used to send the driver to Johannesburg, were he could have done other deliveries or fetching material to be used in the companies repair process.



## References

Goosen, W.T.2012. Interview B.J Heyns, 8 April 2012

Goosen, W.T.2012. Interview P Enslin, 8 April 2012

MDH Mobile Industrial Sandblasting and Spray Painting.[Online] Available : <http://www.mdhsandblasting.co.za/> [Accessed 1 May 2012]

SSES – Sand-Shot Equipment Supplies [Online] Available: <http://www.sandshot.co.za/> [Accessed 1 May 2012]

Sandblasting [Online] Available :< <http://www.signequipmentservices.co.za/sandblasting.htm>> [Accessed 1 May 2012]

The art of Rotation – Schenck [Online] Available : < <http://www.schenck-rotec.co.za/index.php>> [Accessed 28 April 2012]

COETZ Technologies (PTY) LTD – Manufacturer of Balancing Machinery [Online] Available :< <http://www.coetzbalancing.com/>> [Accessed 28 April 2012]

Simio Simulation Software [Online] Available: < <http://www.simio.com/index.html>> [Accessed 28April 2012]

Simulation with Arena. [Online] Available: < <http://nsl.pusan.ac.kr/lecture/MAutomation/simulation01.pdf>> [Accessed 28 April 2012]

Informs online- Institute for Operations Research and the Management Sciences [Online] Available : < <http://informs.org/ORMS-Today/Public-Articles/October-Volume-38-Number-5/Software-Survey-Simulation-Back-to-the-future>> [Accessed 28 April 2012]

Modeling and Simulation Software [Online] Available :< <http://www.promodel.com/products/>> [Accessed 28 April 2012]

JL Sandblasting Equipment [Online] Available: < <http://www.sand-blast-machine.com/>> [Accessed 1 May 2012]

Sign Machinery Supplies [Online] Available : < <http://www.signequipmentservices.co.za/sandblasting.htm>> [Accessed 1May 2012]



Bellemare, M. et al. 2006. Allowing for MSD Prevention During Facilities Planning for a Public Service: An a Posteriori Analysis of 10 Library Design Projects. *International Journal of Occupational Safety and Ergonomics (JOSE)*, 12(4). [Online]. Available: <<http://www.ciop.pl/19589>> [Accessed 15 August 2012].

CCS Card Control. [Online]. Available: <<http://www.cardcontrolsyste.ms.co.za/>> [Accessed 15 August 2012]

Chrome Wire Shelving with QUANTUM Dividable Grid Containers. [Online]. Available: <http://www.chdist.com/1/1/717-chrome-wire-shelving-quantum-dividable-grid-containers> [Accessed 18 August 2012]

Comparison Shopping Search Engine. [Online]. Available: <<http://www.formulagti.com/product/Mayline-7-Tier-Four-Post-Shelving-with-Divider>> [Accessed 18 August 2012]

Deb, S.K. & Bhattacharyya, B. 2004. *Fuzzy decision support system for manufacturing facilities layout planning*. *Decision Support Systems* 40 (2005): 305-314. [Online]. Available from *Science Direct*. Elsevier.

D.I.Y. Kit Special. [Online]. Available: <http://www.cctvinstallations.co.za/d-i-y-kit-special> [Accessed 18 August 2012]

Free Standing Bridge Cranes, Overhead Bridge Crane and Hoist. [Online]. Available: <[http://www.fsindustries.com/more\\_info/nomad\\_free\\_standing\\_overhead\\_bridge\\_crane\\_hoist](http://www.fsindustries.com/more_info/nomad_free_standing_overhead_bridge_crane_hoist)> [Accessed 19 August 2012]

Free Standing Work Station Bridge Cranes, Overhead Bridge Cranes. [Online]. Available: [http://www.fsindustries.com/more\\_info/4000\\_capacity\\_free\\_standing\\_bridge\\_crane/4](http://www.fsindustries.com/more_info/4000_capacity_free_standing_bridge_crane/4) [Accessed 19 August 2012]

Product positioning in Five Easy Steps. [Online]. Available: <[http://www.otmmarketing.com/Portals/42226/docs/product\\_positioning.pdf](http://www.otmmarketing.com/Portals/42226/docs/product_positioning.pdf)> [Accessed 20 August 2012].

Singh, S.P. & Sharma, R.R.K. 2006. A review of different approaches to the facility layout problems. *International Journal of Advanced Manufacturing Technology*, 30. [Online]. Available: <<http://www.springerlink.com/content/y1247473n10n5r67/fulltext.pdf>> [Accessed 20 August 2012]

Shohet, I.M. 2006. Key Performance Indicators for Strategic Healthcare Facilities Maintenance. *Journal of Construction Engineering and Management*, 132(4): 345-352. [Online]. Available: <<http://scitation.aip.org/getabs/servlet/GetabsServlet?prog=normal&id=JCEMD400013200004000345000001&idtype=cvips&gifs=yes>> [Accessed 20 August 2012]



SPANCO Industrial Bridge Cranes : Bridge Cranes : C&H Distributors. [Online]. Available: <<http://www.chdist.com/displayproductdetail.do?Ntx=mode%2Bmatchallpartial&base>> [Accessed 24 August 2012]

Tompkins, J.A. *et al.* 2010. *Facilities Planning*. Fourth Edition. John Wiley & Sons, Inc.: Hamilton, United States of America.

Walk Through Metal Detectors. [Online]. Available: < <http://www.boomgatesystems.co.za>> [Accessed 28 August 2012]

Mi Build.[Online] Available: <http://www.mibuild.co.za/index.php> [Accessed 30 August 2012]

Krost Shelving[Online] Available:< <http://www.krostshelving.co.za/contact-krost.html?gclid=CJfqu6ajnLICFXIQtAod1wcA0A>> [Accessed 30 August 2012]

West End Cement Bricks Calculator [Online] Available: < [http://cementbricks.westend.co.za/brick\\_calculator.html](http://cementbricks.westend.co.za/brick_calculator.html)> [Accessed 30 August 2012]

## Appendix

Data Table of all departments with average processing times.

Basic Floor Layout.

Process Flow at Benco and Fakkell.

Process Flow at Benco and Fakkell with Sandblasting Department

Software Comparison Tables.

Quotations from JL Sandblasting and Sign Equipment Services.

Quotation on Container from Route21

Information on Vacuum Sandblaster

Layout A

Cost for Sandblasting Department

Layout B

Cost for Sandblasting department(Container)

Layout C

Layout D

Cost for Moving Tea Room

Cost for Store Room

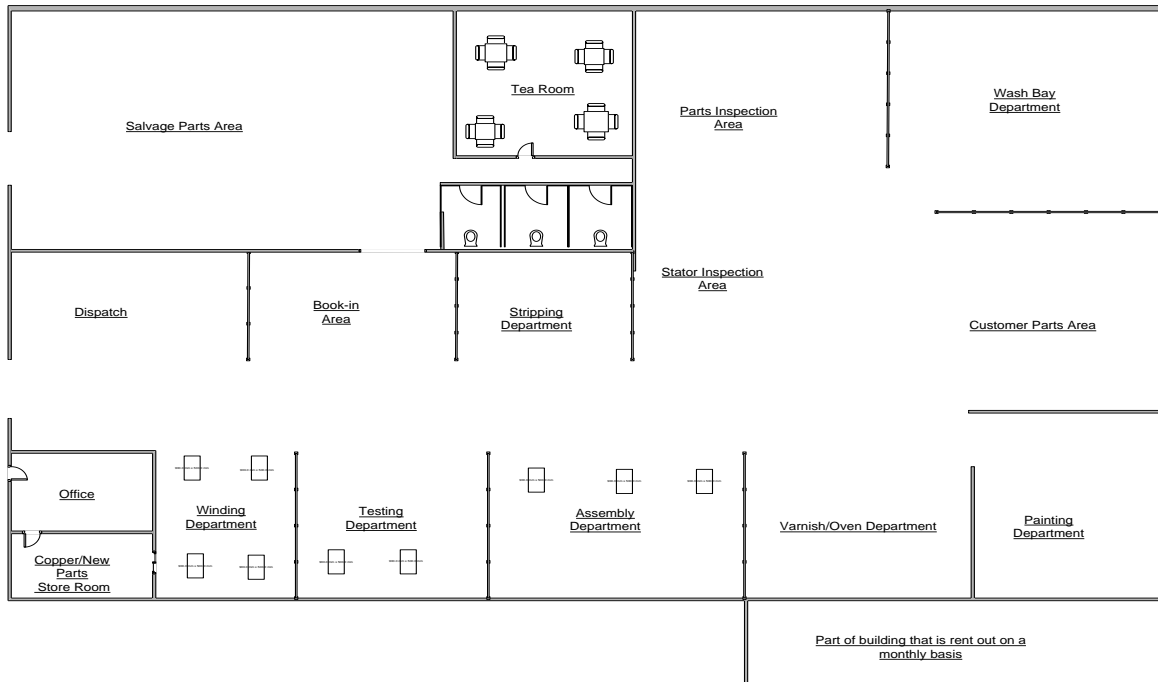


## Data Table

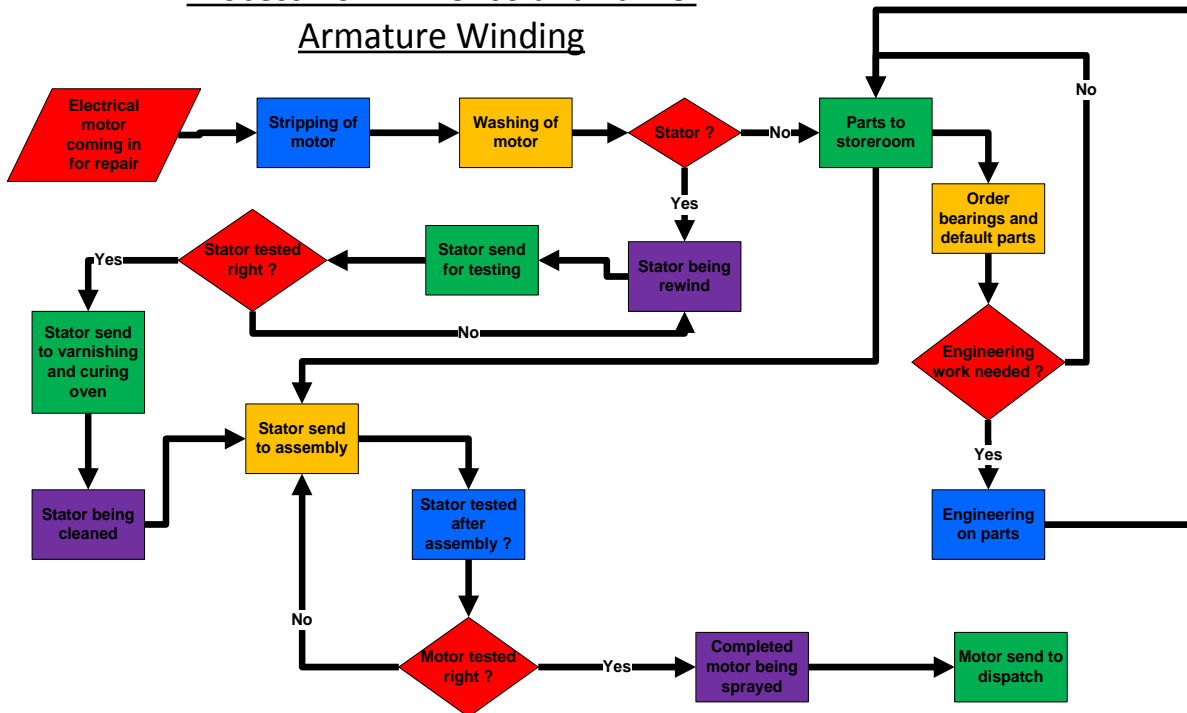
<b>Average time spent in each department in hours</b>										
<u>Motor in</u>	<u>Average</u>	<u>Stripping</u>	<u>Wash Bay</u>	<u>Winding</u>	<u>Varnish/</u>	<u>Assembly</u>	<u>Painting</u>	<u>Testing</u>	<u>Parts</u>	<u>Stator</u>
<u>KW</u>	<u>Arrivals per</u>	<u>Department</u>	<u>Department</u>	<u>Department</u>	<u>Oven</u>	<u>Department</u>	<u>Department</u>	<u>Department</u>	<u>Inspection</u>	<u>Inspection</u>
	<u>month</u>	<u>Department</u>	<u>Department</u>	<u>Department</u>	<u>Departme</u>	<u>Department</u>	<u>Department</u>	<u>Department</u>	<u>Area</u>	<u>Area</u>
0.37	4	0.5	0.5	1	1.5	0.75	0.15	0.15	3	0.5
0.55	7	0.5	0.5	1	1.5	0.75	0.15	0.15	3	0.5
1.1	6	0.5	0.5	1	1.5	1	0.15	0.15	3	0.5
1.5	6	0.5	0.5	1.5	1.5	1	0.15	0.15	3.5	0.5
2.2	7	0.5	0.5	1.5	1.5	1	0.15	0.15	3.5	0.5
3	6	0.5	0.5	2	2	1	0.15	0.15	3.5	0.6
4	8	0.5	0.5	2	2	1	0.15	0.15	3.5	0.6
5.5	5	1	0.5	3	2	1.5	0.15	0.15	4	0.75
7.5	12	1	0.5	3	2	1.5	0.15	0.15	5	0.75
11	8	1	0.75	5	4	2	0.5	0.5	5	0.8
15	11	1	0.75	5	4	2	0.5	0.5	5	0.8
22	11	1.5	0.75	5	4	2.5	0.5	0.5	6	0.8
30	8	1.5	0.75	10	4	2.5	0.5	0.5	6	0.8
45	7	2	0.75	10	4	2.5	0.5	0.5	6	0.8
55	3	2	1	14	8	3	0.6	0.5	6	1
75	3	2	1	14	8	3	0.6	0.5	6	1
90-110	2	2	1	14	8	3.5	0.75	0.5	6	1
160	2	2	1	14	8	3.5	0.75	0.5	6	1
280	2	2	1	16	8	4	0.75	0.75	6.5	1.2
355	1	2	1	16	8	4	0.75	0.75	6.5	1.2
<b>Arrivals:</b>	119									
<b>Amount of workers in each department:</b>		4	5	6	3	4	2	2	1	1
<b>Total workers in the workshop:</b>		28								



Basic Floor Layout

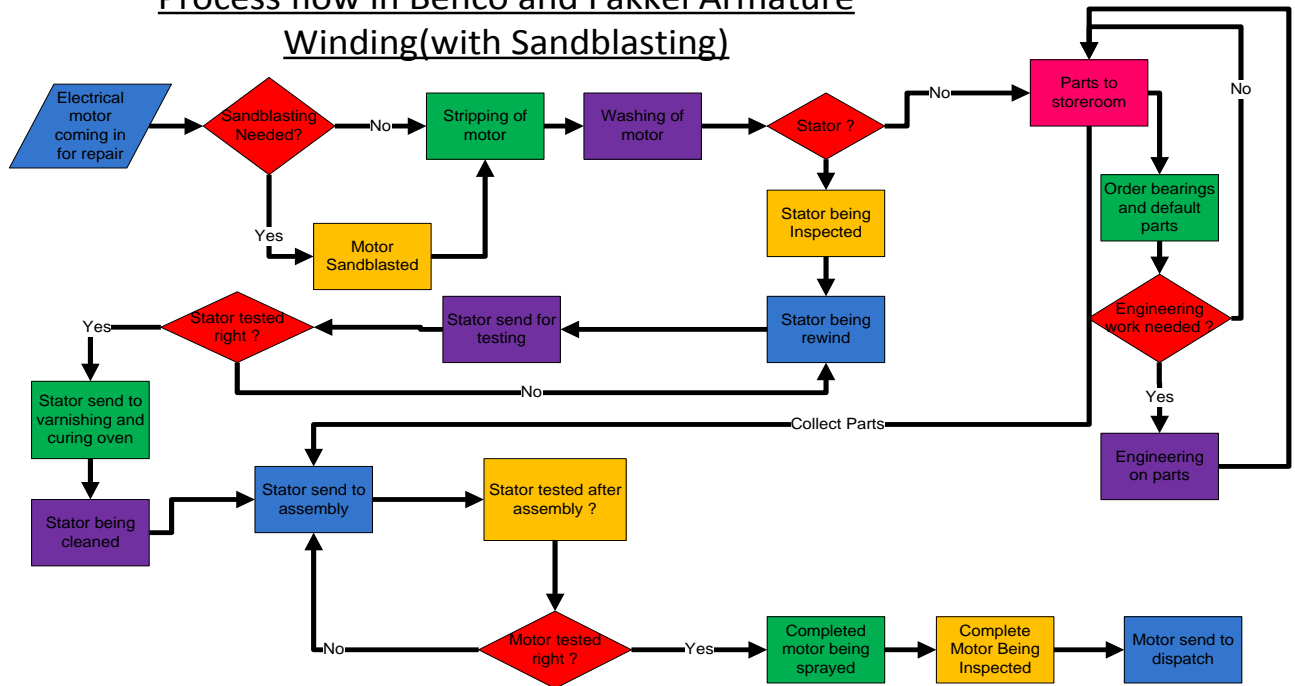


Process flow in Benco and Fakkell  
Armature Winding





## Process flow in Benco and Fakkell Armature Winding(with Sandblasting)



### Software Comparison Table

Software	Vendor	Typical Applications of the software	Primary Markets for which the software is applied
Arena Simulation Software	Rockwell Automation	Purpose DES software tool. Any process you can describe can be modeled in Arena.	Manufacturing, 6-Sigma, Packaging, Supply Chain, Airports, Healthcare, Military/Defense, Service, Call Centers, Mining, Ports
ExpertFit	Averill M. Law & Associates	Fitting probability distributions to a data set	manufacturing, defense, transportation, healthcare, communications networks
ExtendSim AT	Imagine That Inc.	Simplifies the modeling and analysis of complex systems; plus simulates rate-	Industries operating in high-speed/high-volume or mixed-mode environments: eg. packaging line, chemical process,
ExtendSim OR	Imagine That Inc.	Message-based discrete event architecture to model processes involving physical or	Manufacturing and business modeling; healthcare, supply chain, six sigma, transportation, communication, logistics,
ExtendSim Suite	Imagine That Inc.	When impressive presentations count. Professional 3D modeling of continuous,	Management presentations, traffic and transportation systems, emergency rooms, production lines, customer
GoldSim	GoldSim Technology Group	engineering risk analysis, strategic planning, system design and reliability,	environmental engineering, mining, water resources, energy, nuclear, waste management
Integrated Performance Modelling Environment (IPME)	Alion Science & Technology MA&D Operation	Human performance modeling and manning studies	US and International commercial and military
Simio Express Edition	Simio LLC	Risk and ROI analysis, process optimization, capacity planning by rapid modeling in 3D standard objects with no coding	Aerospace, Defense, Mining, Health Care, Engineering, Airport Security, Transportation Logistics, Electronics, Automotive
Simio Design/Team Edition	Simio LLC	Risk and ROI analysis, process optimization, capacity planning by rapid modeling in 3D standard objects with no coding	Aerospace, Defense, Mining, Health Care, Engineering, Airport Security, Transportation Logistics, Electronics, Automotive
Simio Scheduling / Risk Analysis	Simio LLC	Lower delivery schedule risk and cost. Factor supply chain and process variation in planning for early problem detection.	Aerospace, Defense, Mining, Health Care, Engineering, Airport Security, Transportation Logistics, Electronics, Automotive
Oracle Crystal Ball Suite	Oracle Americas Inc.	Risk analysis with Monte Carlo simulation, simulation optimization and time series forecasting	Risk and predictive analysis in different verticals including manufacturing, supply chain, education, legal, healthcare etc.







## JL Sandblasting Equipment Co., Limited

Quotation

tel:86-571-22855116 fax:86-571-22855117 Email:sales@sand-blast-machine.com

2012

Model	Description	Unit price (FOB Ningbo)	remarks
 300L pressure type	Pot Diameter (mm): 500 Heigh (mm): 1350 Weight (kg): 200 Load Capacity (L): 200 Outlet: 1 Blast hose ID (mm): 1-1/4" Compressed air consumption (m3 /min): 3 (100-140CFM) Woking pressure (bar): 4-8 control: manual control Portable or Stationary: Portable the machine with blast hose,coupling,cloths	\$1,650	pressure nozzle
	this kind of pot can reduce 10USD/set	\$1,550	pressure nozzle
 machine with this suits	 with 20meter hose and nozzle,coupling,holder	 this helmet cost USD120	

The machine comes with:blast hose(20meter),blast clothes and nozzle

MOQ:1SET

Delivery:15days(after we receive your payment)





SIGN MACHINERY SUPPLIERS CC - REG 2002/022443/23 TRADING AS

# **SIGN EQUIPMENT SERVICES**



PO BOX 4619  
KEMPTON PARK  
1620  
www.signequipmentservices.co.za

TEL JHB: 011 826 1521  
TEL JHB: 011 826 1068  
TEL PTA: 012 804 7397  
FAX: 086 538 9016  
MOBILE: 082 970 8780  
sales@signequipmentservices.co.za

## FAX TRANSMISSION

TO :  
FAX :  
ATT :  
DATE : /04/2011  
PAGES : 2  
SUBJECT : Quotation  
FROM : Jose

Please advise if you do not receive all the pages clearly

We thank you for affording us the opportunity of presenting a quotation for a sandblasting pot system and take pleasure in enclosing the following financial and technical information.

We will contact you shortly to answer any questions that may arise from this quotation and to supply any information that will assist you in selecting the optimal solution for your requirements.

60L Industrial Sandblasting Pot 4,5mm Nozzle = 45 cfm 6mm Nozzle = 100cfm Includes Safety Helmet, Apron, gloves and hoses	R15895,00
100L Industrial Sandblasting Pot 4,5mm Nozzle = 45 cfm 6mm Nozzle = 100cfm Includes Safety Helmet, Apron, gloves and hoses	R20435,00
200L Industrial Sandblasting Pot 8mm Nozzle = 150 cfm 10mm Nozzle = 240 cfm Includes Safety Helmet, Apron, gloves and hoses	R24750,00
300L Industrial Sandblasting Pot 8mm Nozzle = 150 cfm 10mm Nozzle = 240 cfm Includes Safety Helmet, Apron, gloves and hoses	R29750,00

cfm = cubic feet per minute

Compressor Size (hp) = cfm / 4



Deadmans Handle with Remote Valve

R8500,00



All models are equipped with a concave head for easy filling; automatic pop-up valve for pressurizing and a bottom conical cone ensure easy flowing of abrasives. Plumbing of blast machines will ensure unrestrictive flow of air. Wheels are standard on most machines for easy mobility.

Blast machines are manufactured in various sizes to accommodate different abrasive storage capacities.

At present our models consist of the following:

MODEL	DISCRIPTION	CAPACITY		DIMENTIONS			WEIGHT	PIPING
		LITRES	KG	Ø	X	H	KG	INCHES
7 l	Mobile Porta Blast	7	5	127	X	900	8	3/8
60 l	Single Chamber	60	60	250	X	976	51	3/4
100 l	Single Chamber	100	125	400	X	1340	125	1 1/4
200 l	Single Chamber	200	250	610	X	1310	156	1 1/4

All Blast Machines are for manual operation and can be supplied with a Deadmans Handle & Remote control valve that increases the safety of the blasting operation.

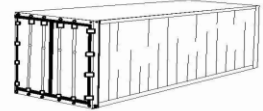
Air consumptions are crucial for performance of all blast machines. Make sure that your Air Supply is Sufficient.

4,5 mm	45 CFM	At 7 Bar
6 mm	100 CFM	At 7 Bar
8 mm	150 CFM	At 7 Bar
10 mm	240 CFM	At 7 Bar
12,5 mm	350 CFM	At 7 Bar

Understand that this is your Actual Consumption and that it is always better to have more air.



# Route 21 Storage & Containers



CC Reg No. 2003/035830/23 VAT Reg. No. 4400209906

Rentals & Sales of:  
1. Secure self storage garage units  
2. Steel shipping containers

No 7 Viceroy Link  
Route 21  
Corporate Park  
Irene

P. O. Box 74905  
Lynnwood Ridge  
0040  
E-mail: route21storage@absamail.co.za

Trevor: 082 5540 779  
Tel: 012 - 345 2364  
Fax: 012 - 345 3473

## QUOTATION

**To:** Theunis  
**Tel:** 0729857034  
**Fax:**  
**e-mail:** Thegoose878@gmail.com  
**Date:** 30/08/2012  
**Quote no:** EQ1617  
**Att:** Theunis

Description	Qty	Unit Price	Total
6m x 2,4m Pre-owned Storage Container to purchase	1	18 500.00	18 500.00
Transport 6m to Middelburg MP	1	4 850.00	4 850.00
12m x 2,4m Pre-owned Storage Container to purchase	0	28 500.00	0.00
Transport 12m to	0	0.00	0.00
6m x 2,4m Pre-owned Storage Container to rent p/m	0	520.00	0.00
Transport to and from	0	0.00	0.00
6m x 2,4m Pre-owned Std. Office Container to rent p/m	0	1 180.00	0.00
Transport to and from	0	0.00	0.00
<b>BANKING DETAILS:</b>		<b>Sub-total</b>	R 23 350.00
ABSA Bank Hatfield		<b>14% VAT</b>	R 3 269.00
Acc. Number: 405 897 5986 / Code: 634 356		<b>Amount payable</b>	R 26 619.00

### PLEASE NOTE:

1	Terms & Conditions apply ( refer to lease agreement with regards to rentals)
2	Quotation valid for 3 days and subject to container availability
3	Full payment required with order
4	Containers are wind and water tight and sold "as is"

Please fax accepted quotation, proof of payment & lease agreement to 012 345 3473

Quotation accepted: \_\_\_\_\_ Date: \_\_\_\_\_



NEW!

Nederman Vacuum Blasters

**Blast exactly where needed.**

**Clean and dust-free without affecting the surrounding area**



The cleanest and most economical blasting method

With a new range of vacuum blasters, Nederman takes blasting technology one step further by eliminating the traditional drawbacks of blasting. It is a completely dust-free process where the surrounding area is not exposed to flying blasting media. The blaster can therefore be used in premises where other activities are going on without disturbing them.

The unit is mobile and can be easily moved for use indoors, outdoors and in confined spaces where conventional blasting is not permitted.

Nederman's vacuum blasters also offer great economical advantages. The blasting agent is automatically drawn back into the unit, where it is cleaned and recycled as part of the process. Work can be carried out more effectively with fewer interruptions for refilling of blasting agent and the premises do not have to be cleaned after work.

#### **DUST-FREE AND SAFE**

- Clean and interruption-free for work colleagues and surrounding area
- Does not require screening or special protective equipment

#### **ECONOMICAL**

- Blasting media can be reused at least 3 times
- No post-cleaning required

#### **ENVIRONMENTALLY FRIENDLY**

- Blasting replaces chemicals and rust agents
- All approved blasting media can be used, e.g. glass beads and nutshells
- The air from the unit is purified and can be returned to the premises
- Blasted material is collected in a waste bag

#### **FLEXIBLE**

- Compact, mobile unit – easy to move between work stations



## Versatile, safe and convenient



*Cleans structures and removes harmful isocyanates that are released during welding and heating*



*Removes rust on vehicles, metal structures etc.*



*Always to hand for maintenance work and cleaning*



*Cleans and clears tanks and vessels safely – even inside*



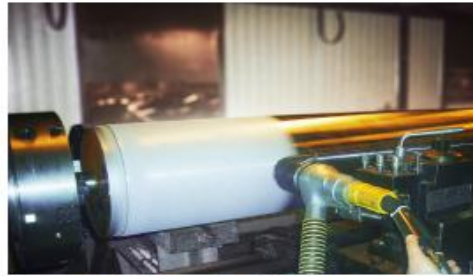
*Cleans castings*



*Effectively cleans welding joints without the need of grinding tools*



*Removes casting beads of aluminium, composites etc.*



*Removes paint, rubber/plastic coverings on floors, rollers, etc. to give a new surface coating good adhesion*



With electric motor  
or air powered



- 1 Silo with internal sieve ensures that larger extracted particles cannot enter the blast vessel.
- 2 Long life filters with automatic filter cleaning
- 3 State-of-the-art abrasive metering valve ensures a precise and even injection of abrasives into the air stream
- 4 A pneumatic valve empties dust into a collection bag

**Electric or compressed air powered vacuum unit?**

The blaster unit's vacuum unit can be powered by either an electric motor or compressed air. The electric version is recommended if you have limited access to compressed air. The air powered version requires a compressor output of 2 -2.5 m<sup>3</sup>/min, in addition to the consumption required for blasting.



Ab460



Bb418

Model	Bb460	Ab460	Bb418	Ab418
	Electric	Compressed air	Electric	Compressed air
Vacuum unit				
Order no.	40056604	40056602	40056603	40056601
Weight (+ hose)	242 (+17)		193 (+17)	
Dimensions L x W x H	1280 x 800 x 2233 mm		1800 x 670 x 1850 mm	
Output kW	2,4	Air powered	2,4	Air powered
Voltage	230V		230V	
Compressed air consumption	-	2,2 Nm <sup>3</sup> /min		2,2 Nm <sup>3</sup> /min
Max. air flow	460 Nm <sup>3</sup> /min	360 Nm <sup>3</sup> /min	460 Nm <sup>3</sup> /min	360 Nm <sup>3</sup> /min
Max. vacuum	21,5 kPa	42 kPa	21,5 kPa	42 kPa
Blast vessel	60 lit	60 lit	18 lit	18 lit
Pre-separator	60 lit	60 lit	18 lit	18 lit
Operation	2-lines pneumatic		2-lines pneumatic	
Total air consumption	2 bar = 0,7 m <sup>3</sup> /min	2 bar = 2,9 m <sup>3</sup> /min	2 bar = 0,7 m <sup>3</sup> /min	2 bar = 2,9 m <sup>3</sup> /min
	3 bar = 1,0 m <sup>3</sup> /min	3 bar = 3,2 m <sup>3</sup> /min	3 bar = 1,0 m <sup>3</sup> /min	3 bar = 3,2 m <sup>3</sup> /min
	4 bar = 1,3 m <sup>3</sup> /min	4 bar = 3,5 m <sup>3</sup> /min	4 bar = 1,3 m <sup>3</sup> /min	4 bar = 3,5 m <sup>3</sup> /min
	5 bar = 1,7 m <sup>3</sup> /min	5 bar = 3,9 m <sup>3</sup> /min	5 bar = 1,7 m <sup>3</sup> /min	5 bar = 3,9 m <sup>3</sup> /min

**Nederman**  
www.nederman.com

**Nederman Sales companies in:** Australia, Austria, Belgium, Brazil, Canada, China, Czech Rep., Denmark, Finland, France, Germany, Hungary, India, Ireland, Northern Ireland, Norway, Poland, Portugal, Romania, Russia, Slovakia, Spain, Sweden, Thailand, Turkey, Ukraine, United Kingdom, USA, Vietnam  
**Nederman Agents in:** Bulgaria, Cyprus, Egypt, Estonia, Finland, Greece, Holland, Hong Kong, Iceland, Israel, Ireland, Italy, Japan, Korea, Latvia, Lithuania, Malaysia, New Zealand, Philippines, Saudi Arabia, Serbia, Singapore, Slovenia, South Africa, Switzerland, Taiwan R.O.C., Thailand, United Arab Emirates

09/2015 11



**Nederman**

## Vacuum Blaster

Mobile dust free blasting unit with superior productivity, suction power and separation efficiency



Bb418 Electrical Unit



Ab460 Air Powered Unit

### Mobile vacuum blasting

Nederman Vacuum Blaster units are suitable for different purposes and applications, and have superior suction power and separation efficiency. The units are based on pressure vessels in combination with compressed air filters and pressure regulators that ensure sufficient speed of operation in a dust free environment. Nederman has been operating in the field of environmental equipment for more than 60 years, and has extensive experience in equipment and systems for blasting applications.

The Vacuum Blaster comes complete, mounted on a trolley with a grit separator, silo with an internal sieve, filling valve, efficient vacuum producer and compressed air filters. A pneumatic valve in the bottom of the silo empties the dust into a plastic bag.

Furthermore, the unit is equipped with a pneumatic control device for automatic filter cleaning. The Vacuum Blaster also comes with 10 m hose with a blasting and suction head.

The capacity of the vacuum unit is determined by the maximum blast pressure and the type of blasting abrasive used. The sieve ensures that bigger extracted particles can not enter into the blast vessel. The filling cone is pushed up by the blasting abrasive and the lid above it ensures sufficient clearance to eject the abrasive.

### Advantages

- Cover larger surfaces faster - The Nederman Vacuum Blaster is a real productivity booster day in and day out thanks to the design of the vacuum head along with the continuous, non-pulsing stream of blasting abrasive.
- Less downtime and blasting abrasive costs - What happens to productivity when you have to refill new blasting abrasive nonstop? With the Nederman Vacuum Blaster you can operate continuously and re-use the same abrasive several times, depending on the type of abrasive. All types of blasting abrasive suitable for recycling can be used.
- Less back strain - Collecting the dust in plastic bags rather than in a metal bin that adds dead weight, saves your back. Collected metal dust can weigh up to 5 kg / l.
- Long life filters - Efficient pre-separation of abrasive with automatic reverse air jet filter cleaning. Mobile vacuum blasting

### The Benefits of Vacuum Blasting

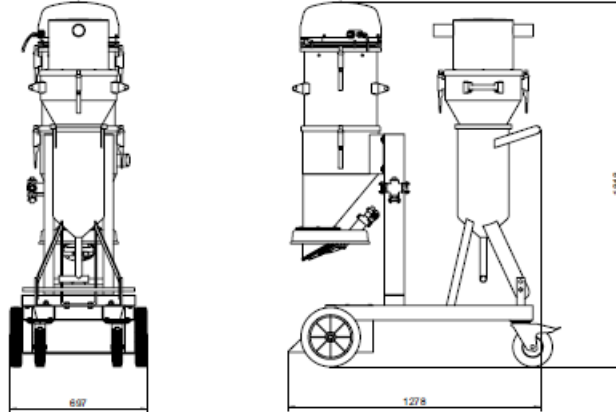
- Vacuum blasting can be used both outdoors and in enclosed spaces where regular blasting is not permitted.
- No need for special blasting rooms.
- Dust free blasting makes it possible to blast without people around you getting exposed to airborne dust and blasting abrasive.
- The dust generated from the blasting operation is immediately and continuously extracted together with the blasting abrasive to the grit separator that separates the dust from the active blasting abrasive.
- The unit is mobile, flexible and offers low start-up costs.
- The vacuum unit can be operated either electrically or by compressed air.
- With a simple manoeuvre, the function of the Vacuum Blaster can be changed so that it can be used for collection of blasting abrasive from a smaller blasting room!

### Positive Health Effects of Vacuum Blasting

Did you know that there are isocyanates and polyurethane in paint, coatings, adhesives, sealants, etc? If a treated surface such as a painted surface is heated up as a result of a welding or grinding operation, hazardous gases containing isocyanates are released into the air. These isocyanates can be harmful to the respiratory tract. The concentrations can even reach levels that are high enough to cause asthma. So, blasting is an important precaution.



**Dimensions Bb418/Ab418**



Bb418 Electrical Unit

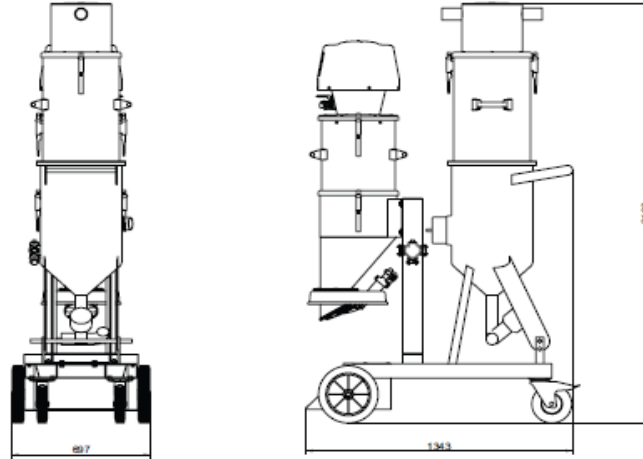
**Technical Data Bb418/Ab418**

	Bb418 230V/50Hz	Bb418 110V 50/60Hz	Ab418 Air Powered
Part No	40056603	40056605	40056601
Weight	193kg	193kg	193kg
Weight with hose	+17kg	+17kg	+17kg
Power, kW	2,4	2,4	-----
Voltage	230V	110V	-----
Compressed air consumption			2,2 Nm <sup>3</sup> /min
Max air flow	460 Nm <sup>3</sup> /h	460 Nm <sup>3</sup> /h	360 Nm <sup>3</sup> /h
Max vacuum	21,5 kPa	20 kPa	42 kPa
Blasting method	Pressure blasting	Pressure blasting	Pressure blasting
Blast vessel	18 lit	18 lit	18 lit
Pre-separator	18 lit	18 lit	18 lit
Control device	2-line pneumatic	2-line pneumatic	2-line pneumatic
Air consumption total	2 bar = 0,7 m <sup>3</sup> /min	2 bar = 0,7 m <sup>3</sup> /min	2 bar = 2,9 m <sup>3</sup> /min
	3 bar = 1,0 m <sup>3</sup> /min	3 bar = 1,0 m <sup>3</sup> /min	3 bar = 3,2 m <sup>3</sup> /min
	4 bar = 1,3 m <sup>3</sup> /min	4 bar = 1,3 m <sup>3</sup> /min	4 bar = 3,5 m <sup>3</sup> /min
	5 bar = 1,7 m <sup>3</sup> /min	5 bar = 1,7 m <sup>3</sup> /min	5 bar = 3,9 m <sup>3</sup> /min
<b>Vacuum Blasting Head</b>			
Standard nozzle head	Rounded 100 mm	Rounded 100 mm	Rounded 100 mm
Extraction connection	51 mm	51 mm	51 mm
Blast nozzle	Boron carbide 6,5 mm	Boron carbide 6,5 mm	Boron carbide 6,5 mm





**Dimensions Bb460/Ab460**



Ab460 Air Powered Unit

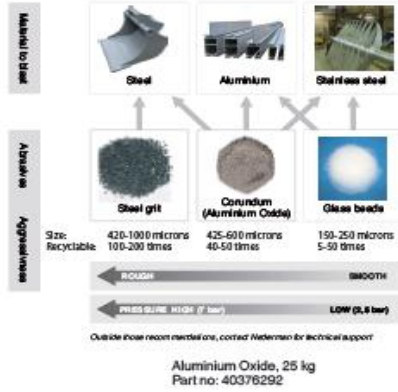
**Technical Data Bb460/Ab460**

	Bb460 230V/50Hz	Bb460 110V 50/60Hz	Ab460 Air Powered
Part No	40056604	40056606	40056602
Weight	242kg	242kg	242kg
Weight with hose	+17kg	+17kg	+17kg
Power, kW	2,4	2,4	-----
Voltage	230V	110V	-----
Compressed air consumption			2,2Nm <sup>3</sup> /min
Max air flow	460 Nm <sup>3</sup> /h	460 Nm <sup>3</sup> /h	360 Nm <sup>3</sup> /h
Max vacuum	21,5 kPa	20 kPa	42 kPa
Blasting method	Pressure blasting	Pressure blasting	Pressure blasting
Blast vessel	60 lit	60 lit	60 lit
Pre-separator	60 lit	60 lit	60 lit
Control device	2-line pneumatic	2-line pneumatic	2-line pneumatic
Air consumption total	2 bar = 0,7 m <sup>3</sup> /min	2 bar = 0,7 m <sup>3</sup> /min	2 bar = 2,9 m <sup>3</sup> /min
	3 bar = 1,0 m <sup>3</sup> /min	3 bar = 1,0 m <sup>3</sup> /min	3 bar = 3,2 m <sup>3</sup> /min
	4 bar = 1,3 m <sup>3</sup> /min	4 bar = 1,3 m <sup>3</sup> /min	4 bar = 3,5 m <sup>3</sup> /min
	5 bar = 1,7 m <sup>3</sup> /min	5 bar = 1,7 m <sup>3</sup> /min	5 bar = 3,9 m <sup>3</sup> /min

Vacuum Blasting Head			
Standard nozzle head	Rounded 100 mm	Rounded 100 mm	Rounded 100 mm
Extraction connection	51 mm	51 mm	51 mm
Blast nozzle	Boron carbide 6,5 mm	Boron carbide 6,5 mm	Boron carbide 6,5 mm

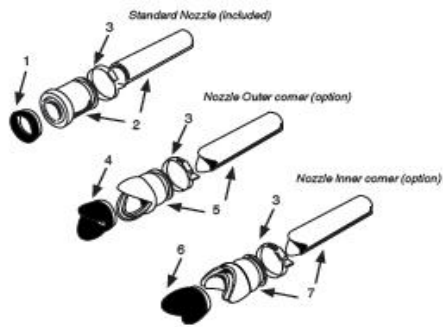


### Abrasive recommendations



### Nozzles

	Part No	Description
1	40375404	Brush ring standard
2	40375403	Inner tube kit standard
3	40375410	Clamp for brush holder.
4	40375408	Inner corner brush ring
5	40375406	Inner tube and brush holder inner
6	40375407	Outer corner brush ring
7	40375405	Inner tube and brush holder outer



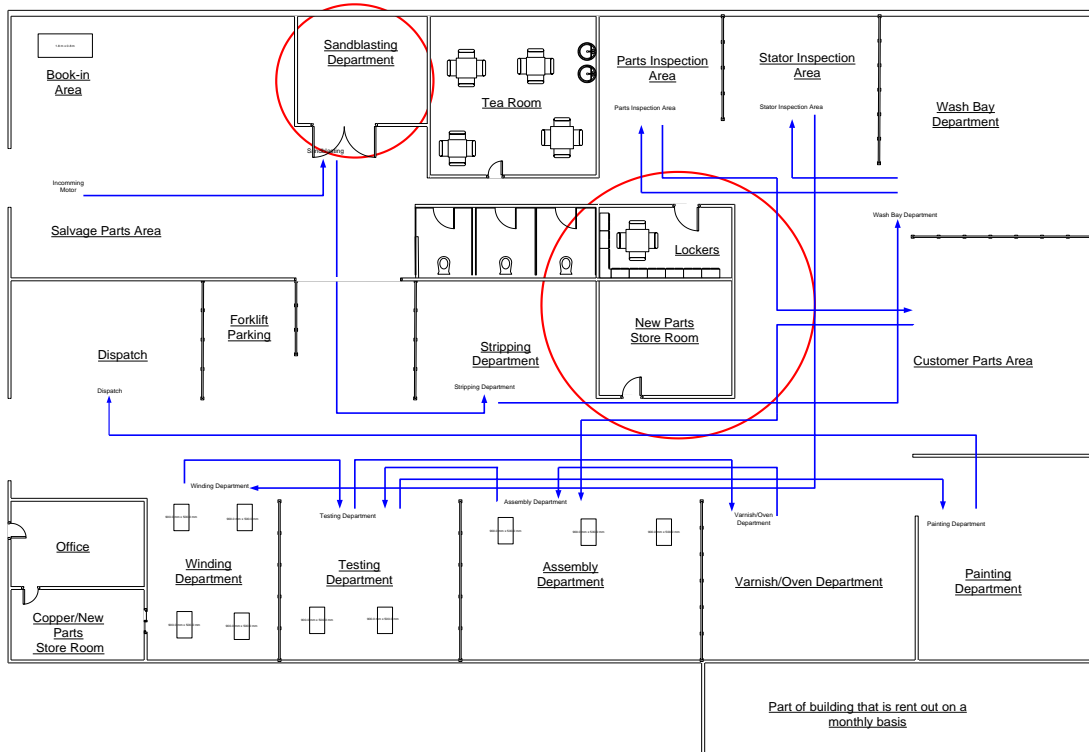
### Abrasion plate

	Part No	Description
	43625001	Abrasion plate





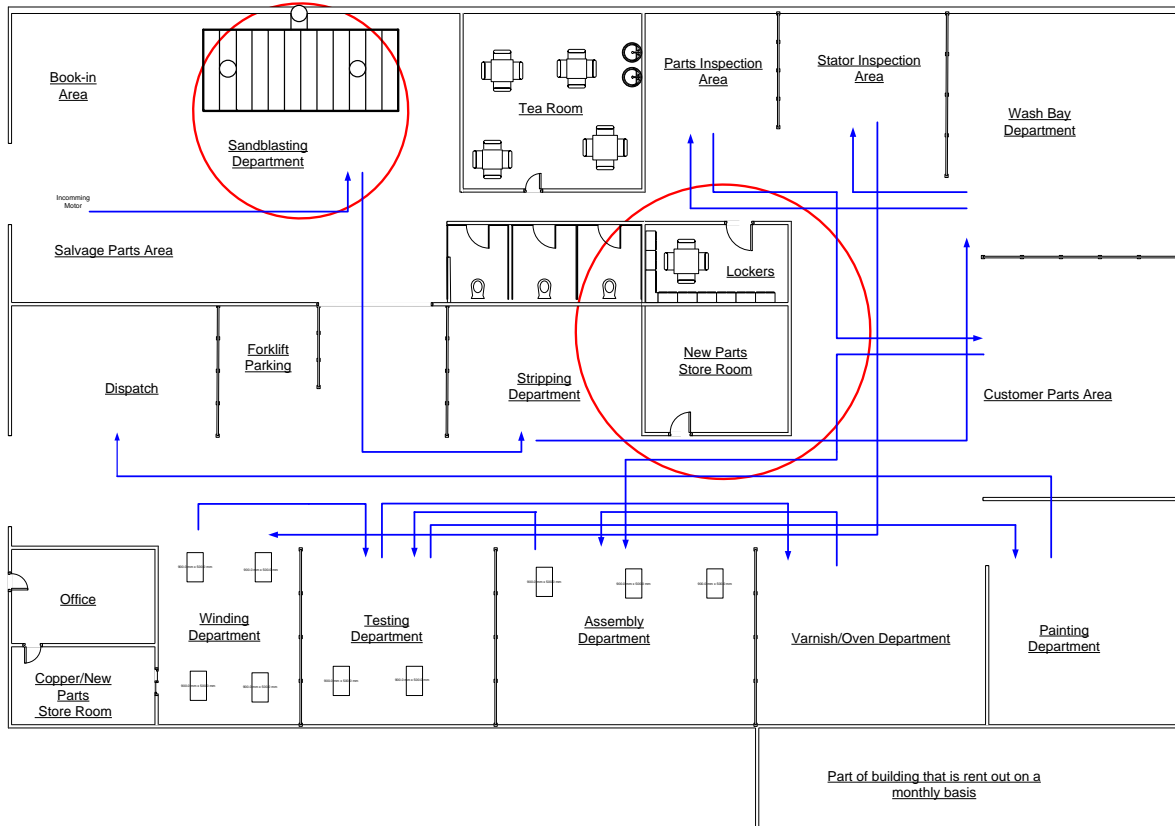
Layout A



<b>Building Material Needed for Sandblasting Department (All prices incl.VAT)</b>							
Length of walls:	2.3 m (3m high)	Bricks needed:	379	Sand Needed:	0.28 cubic meter	Cement:	1.24 bags
	4.4m (0.5m high)		123		0.09 cubic meter		0.4 bags
	3.75m (3.5m high)		618		0.45 cubic meter		2.03 bags
			<b>1120</b>		<b>0.82</b>		<b>3.67</b>
<b>Material supplied by Cash Build Middelburg</b>							
Cement:	R67,70 per 50kg						
Building sand washed:	R185,99 per cubic meter			<b>Cost Calculation:</b>			
Bricks( Mamparras):	R1,45 per brick			Cement:	4 bags	R 270.80	
Door(Mansonite Hallow core):	R204,98 per unit			Sand:	1 cubic meter	R 185.99	
Door(Aliminium sliding 2100*3000):	R4900 per unit			Bricks:	1200	R 1 740.00	
Corrugated Galvanized(610mm*4,2m) :	R228,27 per unit			Door:	1 door	R 4 900.00	
Structural Pine(38mm*114mm*4,2m):	R62,99 per unit			Corrugated:	7 lengths	R 1 597.89	
Florecent Light:	R147,80 per unit			Pine:	9 lengths	R 566.91	
Light Switch:	R72,50 per unit			Lights:	3 lights	R 443.40	
Extractor Fan:	Priceless			Light Switch:	1 switch	R 72.50	
Sandblasting Machine (200L Industrial Pot):	R 28 215.00			Labour:		R 2 500.00	
					<b>Total:</b>	<b>R 12 277.49</b>	
<b>Total Amount for Sandblasting Department:</b>	<b>R 40 492.49</b>						



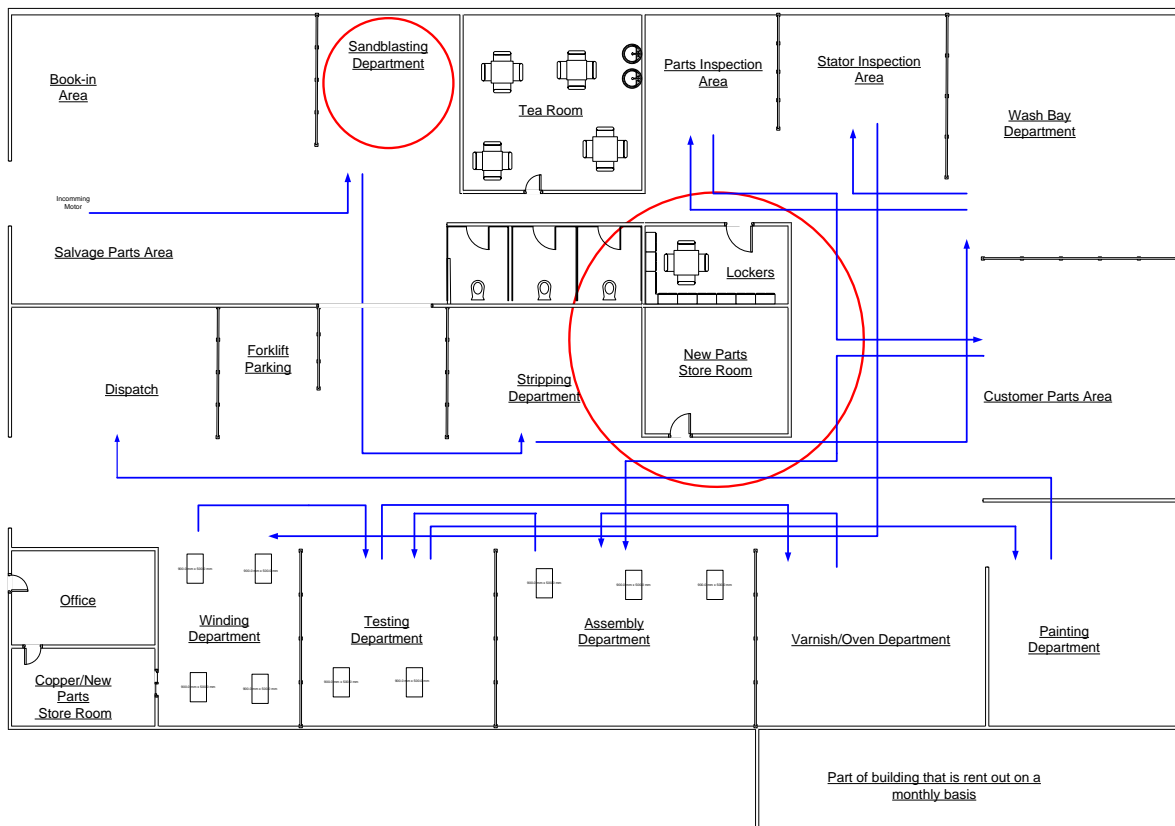
Layout B



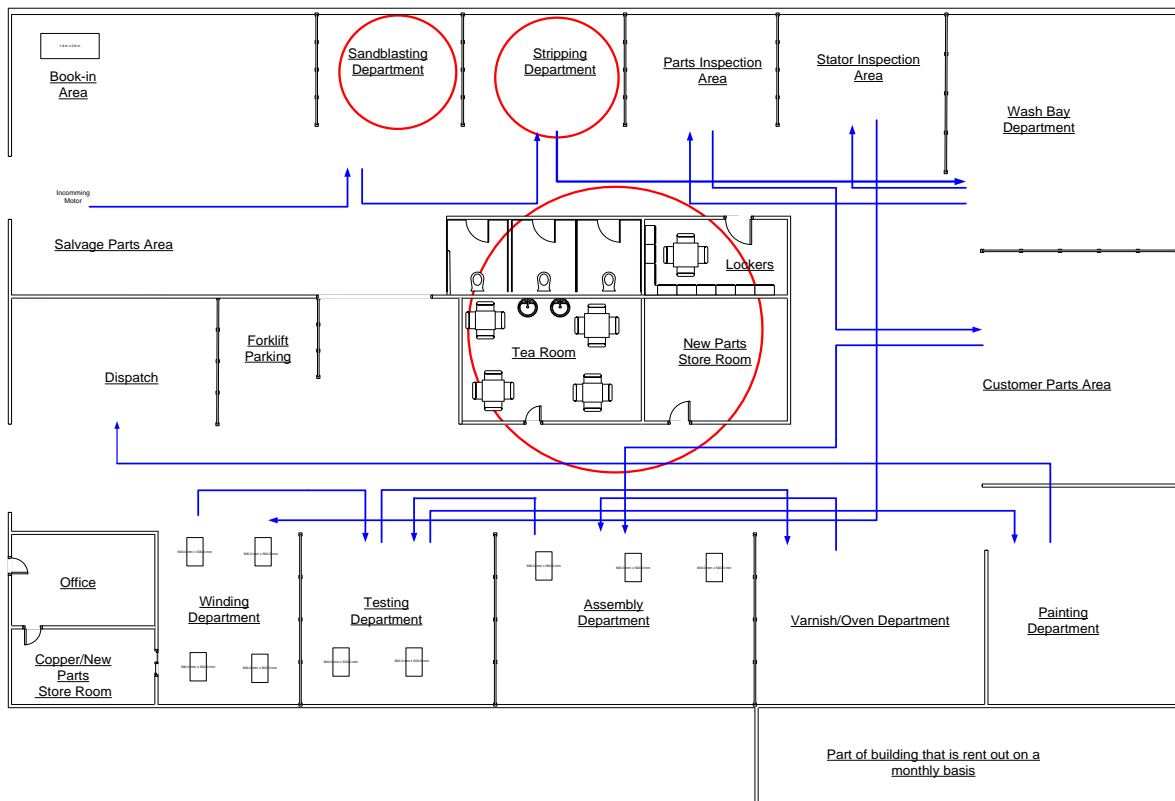
<b><u>Building Material Needed for Sandblasting(Container)</u></b>			
<b><u>Material supplied by Cash Build Middelburg</u></b>			
Price for Container( 6m*2,4m):	R 26 619.00	<b><u>Cost Calculation:</u></b>	
Sandblasting Machine (200L Industrial Pot):	R 28 215.00	Container:	R 26 619.00
		Sandblaster:	R 28 215.00
		<b><u>Total:</u></b>	<b><u>R 54 834.00</u></b>
<b><u>Total Amount for Sandblasting Department:</u></b>	<b><u>R 54 834.00</u></b>		



Layout C



Layout D





<b><u>Building Material Needed for moving Tea Room(All prices incl.VAT)</u></b>							
Length of walls:	4.6 m (2.5m high)	Bricks needed:	633	Sand Needed:	0.46 cubic meter	Cement:	2.07 bags
	3.99m (2.5m high)		549		0.4 cubic meter		1.8 bags
			<b>1182</b>		<b>0.86</b>		<b>3.87</b>
<b><u>Material supplied by MI Build and Cash Build Middelburg</u></b>							
Cement:	R67,70 per 50kg						
Building sand washed:	R185,99 per cubic meter			<b><u>Cost Calculation:</u></b>			
Bricks( Mamparras):	R1,45 per brick						
Door(Mansonite Hallow core):		R204,98 per unit		Cement:	4 bags	R 270.80	
Door Frame:		R145.99 per unit		Sand:	1 cubic meter	R 185.99	
Corrugated Galvanized(610mm*4,8m) :		R260.88 per unit		Bricks:	1200	R 1 740.00	
Structural Pine(38mm*114mm*6.6m):		R99,99 per unit		Door:		0 R 0.00	
Florecent Light:		R147,80 per unit		Corrugated:		0 R 0.00	
Light Switch:		R72,50 per unit		Pine:		0 R 0.00	
				Lights:		0 R 0.00	
Price for Double Door locker:		R680 per unit		Light Switch:		0 R 0.00	
				Door Frame:		0 R 0.00	
Sandblasting Machine (Vacuum Sandblaster):	R	50 000.00		Lockers:		0 R 0.00	
				Labour:		R 2 000.00	
				<b>Total:</b>		<b>R 4 196.79</b>	
<b>Total Amount for Store Room and Locker Room:</b>			<b>R 54 196.79</b>				

<b><u>Building Material Needed for Store Room and Locker Room (All prices incl.VAT)</u></b>							
Length of walls:	6.5 m (2.5m high)	Bricks needed:	894	Sand Needed:	0.65 cubic meter	Cement:	2.93 bags
	3.55m*2 (2m high)		391		0.28 cubic meter		1.28 bags
	4.45m*2 (0.5m high)		122		0.09 cubic meter		0.4 bags
	4.45m (2.5m high)		612		0.45 cubic meter		2 bags
	3.99m (2.5m high)		549		0.4 cubic meter		1.8 bags
			<b>2568</b>		<b>1.87</b>		<b>8.41</b>
<b><u>Material supplied by MI Build and Cash Build Middelburg</u></b>							
Cement:	R67,70 per 50kg						
Building sand washed:	R185,99 per cubic meter			<b><u>Cost Calculation:</u></b>			
Bricks( Mamparras):	R1,45 per brick						
Door(Mansonite Hallow core):		R204,98 per unit		Cement:	9 bags	R 609.30	
Door Frame:		R145.99 per unit		Sand:	2 cubic meter	R 371.98	
Corrugated Galvanized(610mm*4,8m) :		R260.88 per unit		Bricks:	2600	R 3 770.00	
Structural Pine(38mm*114mm*6.6m):		R99,99 per unit		Door:	2 door	R 409.96	
Florecent Light:		R147,80 per unit		Corrugated:	11 lengths	R 2 869.68	
Light Switch:		R72,50 per unit		Pine:	9 lengths	R 899.91	
				Lights:	3 lights	R 443.40	
Price for Double Door locker:		R680 per unit		Light Switch:	2 switch	R 145.00	
				Door Frame:	2 frames	R 291.98	
				Lockers:	12 lockers	R 8 160.00	
				Labour:		R 4 300.00	
				<b>Total:</b>		<b>R 22 271.21</b>	
<b>Total Amount for Store Room and Locker Room:</b>			<b>R 22 271.21</b>				