Future chip management system at Sandvik Coromant Gimoverken

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Abstract

Framtidens spånhantering system på Sandvik Coromant Gimoverken

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This thesis aims to change the way Sandvik Coromant handles their chip management system. The need arose when a larger project, involving the implementation of AGV (automatic guided vehicles) fork lifts to handle all the internal transports of goods. This forced Sandvik Coromant to change the current system of transporting metal chips.

The work started with a three days orientation in the factory. This was mainly to get a sense of how the chip management system works today and what kind of solutions that could work given the circumstances.

Idea generation resulted in a number of candidates, where only one was found to be realistically implementable, namely having the AGVs transport big bags placed on EUR pallets.

Tests were conducted which showed that the bags leak cutting fluid along the seams. Discussions have been established with suppliers regarding having specially made big bags which would be waterproof. If it is not possible to find waterproof big bags there are complementary equipment that solves the problem discussed in Chapter 11 Recommendations.
Sammanfattning

Detta examensarbete har som syfte att utveckla Sandvik Coromant’s spånhantering. Behovet uppstod när ett större projekt, vilket involverade implementeringen av AGV (automatic guided vehicles/automatiskt styrda fordon) truckar som ska ha hand om alla interna transporter av gods. Detta tvingade Sandvik Coromant att ändra det nuvarande systemet för att transportera metallspån.

Arbetet startade med en tredagsorientering i fabriken. Detta var huvudsakligen för att ge en känsla för hur spånhanteringssystemet fungerade idag och vilka typer av lösningar som skulle kunna fungera under rådande omständigheter.

Idégenerering resulterade i ett antal kandidater, där endast en konstaterades vara realistiskt implementerbar, nämligen att låta AGV:erna transportera storsäckar placerade på EU-pallar.

Tester genomfördes som visade att storsäckarna läckte skärvätska från sömmarna. Diskussioner har upprättats med leverantörer angående att få specialtillverkade storsäckar som då ska vara vattentäta. Om det inte är möjligt att finna vattentäta storsäckar, finns kompletterande utrustningar som löser problemet diskutade i kapitel 11 Recommendations.

Search terms: Metal chips, chip management, big bags, chip transportation
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Gimo in May 2013
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1 Introduction

1.1 Sandvik Coromant
Sandvik Coromant Gimoverken is located in Gimo, with over 1550 employees\(^1\) worldwide. There are two main factory sites in Gimo, one manufactures cutting inserts and the other manufactures tool holders (mainly tools for milling, drilling and turning operations).

1.2 Background
Sandvik Coromant Gimoverken Tool Production faces a restructuring regarding how they transport goods internally between departments. They will introduce AGV (automated guided vehicles) fork lifts instead of having manually operated fork lifts. The driving force behind this project is to increase the safety of the personnel, since Sandvik Coromant on a daily basis encounter a number of “close call” incidents related to the fork lift traffic.

As part of the AGV project, the transportation of metal chips must be changed radically. Metal chips are produced when the shape of a metal workpiece is altered to the producer’s specifications. The most common shape-altering operations that produce metal chips are turning, milling and drilling. Any given workshop has to handle and transport the chips from the machines to a collection point for recycling.

Metal chips are collected in customized containers, vastly varying in size and shape, as seen in figure 1.1 below, depending on where the container is located and geometry of the chips etcetera. When the containers are filled, an operator will roll the container out to the fork lift aisle where a driver collects the container when he or she spots it. The container is transported out to the collection point where it is emptied and then returned to where the driver picked it up.

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The way that the chip handling process is carried out must be changed in order to be able to implement the AGV fork lifts. Since the aisles at Gimoverken are narrow, the combination of manual fork lifts and AGVs in not desirable or even probable.

There are many different ways to do this, but there is not a single best way of coping with the transportation of the metal chips. It all depends on a number of variables, such as volume, factory layout, available floor space and so forth. A solution which suits one type of factory could prove insufficient in another.

AGVs do not handle interaction with manual fork lifts in a satisfactory way. The limited aisle space is an contributing factor to this. A new chip management system must be developed in order to enable an implementation of AGV traffic in the factory.

More detailed information regarding the current metal chip transportation system and the demands that need to be fulfilled to enable a successful implementation can be found in appendix I.

1.3 Thesis aim

The aim of the thesis is to develop a new way of evacuating the metal chips, without the need of manual fork lifts. The final solution must be in accordance with a plethora of demands placed by different departments and limitations in the factory.

A thorough specification of demands will be made which will be vital in order to be able to evaluate the new system’s feasibility in the factory.

Since the new method of transporting metal chips has to be cost efficient. Quotations from suppliers will be complied in order for Sandvik Coromant’s further efforts to implement the solution.
1.4 Method
The first three days were spent in the factory, visiting different departments, mainly to get familiarized with how the current chip management system works and to get a sense of what kind of solutions that is possible given the existing conditions.

A specification of demands was created through informal interviews with different department heads to get an understanding of the different kinds of demands and conditions that are placed on the chip management system.

With the basis of the specification of demands, work begun with different concepts and kept a divergent way of idea generation. This was done parallel to evaluating what kind of solutions suppliers can deliver.

In order to validate the big bag concept a benchmarking was performed. This method enabled a better understanding of how an implementation could look like and made it possible to study all aspects of the concept during production.
2 Theory

2.1 Metal chips
Metal chips are produced when a metal work piece is altered in shape using either turning, milling and/or drilling operations. Every factory that uses these operations has to deal with metal chips, and foremost how to evacuate the chips from the machine to the designated collection point.

There are probably as many different ways and variations of handling this as there are factories. The systems and methods used differ because of the vastly different conditions that are present in the factories. Examples of these conditions are available floor space, the level of sorting between different materials, geometry of the metal chips, distance to the collection point.

2.2 Controlled convergence
Controlled convergence is used to weigh different concepts against each other based on a number of criteria and compared to a reference concept (usually the competitor’s product).

The concepts are ranked with “+”, “-” or “0” for better, worse or equal (respectively) compared to the reference product. This is later summed up, with every “-” being -1 and every “+” being +1. A grade is formed to see which concept is best; all this is can be seen in figure 2.1.

![Table of controlled convergence]

Figure 2.1 Controlled convergence

The next step is to borrow criteria from concepts which had a plus to concepts which had a zero or a minus to try and form new and improved concepts. This step is repeated until no new concepts can be generated.²

2.3 Quality Function Deployment

Quality function deployment or QFD in short, is also called “the house of quality”. It is a very technical and complex technique to transform customer demands into design elements.

The first step is to list the customer requirements and the design elements required to fulfill the customers’ demands. These are then sorted in a matrix on different axis, see figure 2.2.

![Figure 2.2 Quality Function Deployment](image)

A symbol to indicate strong, medium and weak relationship is determined and placed in the matrix.

The QFD matrix can be elaborated to include ratings for competing product analysis and a “roof” of the quality house to include a correlation matrix to find attributes that enhances others, and attributes that counteracts other.³

2.4 Combination of QFD and controlled convergence

Neither QFD nor controlled convergence can satisfactorily demonstrate how our concepts are ranked against each other. This is mainly because the concepts are vastly different in nature and embodiment. It proves difficult to borrow elements from one concept to another because of this.

The same applies for the QFD, where it is known what the system must handle but since a specific solution is not determined the QFD method could not be used in a satisfactory way.

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However, a mixture of the two can in a easily understandable way show which concept is best suited by grading the concepts viability and then multiplying this with how important the specific criteria is for the operation.

2.5 Benchmarking

Benchmarking is, roughly put, a way for a company to investigate and analyze how other companies perform a certain process, amongst many other possible areas of interest. In other words, benchmarking can be a way to get insight of how a competitor solved a particular problem.

Benchmarking is used in this thesis in order to analyze and compare how one company deals with its chip management process.\(^4,^5\)

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3 Summary of the specification of demands

3.1 Introduction

3.1.1 The purpose with the procurement
In an effort to automate the transportation of goods with AGVs at the Tools Production at Gimo, the current way of handling the evacuation of chips must be changed. The driving force behind the AGV project is mainly to ensure a more safe work environment.

3.1.2 Type of containers
There are several different types of customized containers. There are 52 different containers with customized dimensions and the total count is 132 containers. Some of the different sizes and shapes can be seen below in figure 3.1. The high amount of customized containers is necessary in order to fit the bin at the vastly differing collection places. The sizes of the containers are also different mainly depending on the chip sizes (e.g. volume of the chips), in what quantities the chips are produced and/or how much space is available at the station.

Figure 3.1 Examples of the different type of containers
3.1.3 Future system
Sandvik Coromant is in the process of automating the transport of goods with the help of AGV system and need to reduce the manual fork lift traffic in order to accommodate the new transportation system.

A fully automated system is preferred, but depending on limitations some manual work might be necessary.

The current system is highly customized mainly due to the lack of space there is available at the stations as well as in the transportation routes they are transported in. Due to this reason one of the key factors an implementable solution need to achieve is to be as space sufficient as it possibly can be.

3.1.4 Safety aspects
The new system cannot compromise on the safety standard that is achieved with the introduction of an AGV-system.

3.2 Scope

3.2.1 Transport volume
The system needs to handle approximately 70 different pick up points from which the chips are produced. These points are spread out throughout three different production facilities located by the machines that produce chips. Some facilities have more pick up points than others, depending on how many machines that is present. A schematic overview can be seen in figure 3.2.

![Figure 3.2 Schematic overview over the production facilities](image-url)
The forklift drivers estimate a total of 8-10 pick-ups of chip containers with today’s system and sizes of the containers per shift. This means 16-20 per day, with the occurrence of minor variances.

The chips are produced in quantities of 22,000 kg per week, which totals to an average load of 3,000 kg each day spread out on approximately 70 workstations. The production of chips is, for the most part, evenly spread over working hours.

The produced chips are divided between the three production facilities and five different departments. Some departments produce more chips than others. GVH3 is mentioned to be the department that produces the most chips.

### 3.2.2 Type of chips

The chips vary both in regard to materials and geometry. The geometry varies from small, fine chips (mainly from milling and drilling operations) to longer swarfs from turning operations. The swarfs can reach over one meter in length in some scenarios. Examples of different metal chips can be seen in figure 3.3.

![Figure 3.3 Examples of metal chips](image_url)

The materials are divided in three different classes, which are sold at different price points. The chip management system must be able to handle the separation of a minimum of three metal classifications.

More in-depth information can be found in appendix I.
4 Concepts

4.1 Concept 1 - Magnetic conveyor

A magnetic conveyor could be formed into an enclosed design for minimum space usage and at the same time minimizing the risk of spillage. Sandvik Coromant already uses magnetic conveyors to transport fine metal chips (mainly from milling operations) from the machine to the bin, an example is shown in figure 4.1.

Figure 4.1 Magnetic conveyor

The magnetic conveyor could be installed all the way from the chip producing machines to the recycling bin. To reduce costs it could be installed from each production chip to a more convenient pick up point for further transport.

The magnetic conveyor is a well-used and tested solution which decreases the margin of error for an eventual implementation.

The magnetic conveyor is an energy efficient alternative but it is time consuming to relocate when the need arises.

Pros

- Energy efficient
- Well used
- Low risk of failure
- Good ability to separate cutting fluid
Cons

- Possibly high initial investment cost
- Dependent of a chip cutter
- Difficulty handling when the conveyor needs to turn
- Very low flexibility, problematic if a machine is moved

4.2 Concept 2 - Screw conveyor/Archimedes screw

By the use of a helical screw, or Archimedes screw as it is sometimes referred to, to feed metal chips from the machine to the collection point. A schematic view of the principal function of a helical screw can be seen in figure 4.2. This system could be built above ground using stands, hung from the ceiling or buried in the factory floor.

![Figure 4.2 Helical screw](image)

Turns and level differences could be solved by having the chips drop down from one conveyor to another, which turns or alter the elevation.

Pros

- Could help to dissolve nesting, breaking the longer spring-like chips
- Reliable and durable (assuming the screw could break long chips)
- Low operation cost
- Low manual input

Cons

- Difficulty dealing with level differences (when installed above ground)
- Difficulty dealing with turns
- Space issues when installed above ground, more so than with a traditional conveyor belt which more easily can handle level differences
- Same restrictions as the trench-idea concerning digging up the factory floor
• High initial investment
• Customized process which may cause the need for external help from consulting firms
• Cost and complexity when moving machines/installing new ones possibly too high

4.3 Concept 3 - Ceiling mounted conveyor belt

A ceiling mounted conveyor belt that transports the metal chips to the desired collection point. Said system would be running either on full speed in intervals or continuous on a slower speed setting. Speed and dimensions would have to be calculated depending on the volume of cutting fluid and production rate of the metal chips.

The idea originated from the lack of available floor space. If the conveyor is mounted in the ceiling, the impact on current factory space would be minimized. There would have to be conveyors (or perhaps some kind of Archimedes screw) to transport the metal chips from the machines up to the ceiling, where the chips are dropped onto the conveyor belt.

The conveyor belt can be adjusted in height depending on obstacles and could either be open-faced upwards or enclosed with protective plates.

One way of dealing with the factory layout (with three different factory facilities) would be to have a central line transporting the chips out to the fork lift aisle where the chips drop off to another conveyor belt that transports the chips to the desired location.

Cutting fluid may be separated during the transport and ideally collected from the line directly to the recycling. Or, the cutting fluid could be separated when transported up to the ceiling.

Pros
• Possible to obtain a low operating cost
• Low impact on work environment
• Needed floor space is kept to a minimum
• Low level of manual input needed

Cons
• Difficulty transporting the chips up to the ceiling
• Ceiling space is somewhat limited with pipes and such running seemingly at random (e.g. no clear path where the system can be fitted, may need a lot of level differences in the different facilities)
• High cost and complexity when moving machines/installing new ones
• Larger metal chips (and clews) could prove a significant problem, possibly jeopardizing the reliability of the system
• Difficulty separating the different types of material

4.4 Concept 4 - Buried trench

A buried trench in the floor operated either by a conveyor belt or a “power trof”\(^6\), the latter seen in figure 4.3 below. The power trof uses a rod with a predetermined stroke that pushes the metal chips forward. The flanges, both on the rod and on the borders, make sure that the metal chips do not move backwards when the rod is retracted.

Conveyors, ideally small in size, transport the metal chips from the machines and drops them in openings in the floor. Magnetic or traditional hinged conveyors could be used depending on chip geometry.

![Figure 4.3 Power Trof](image)

The placement of this trench could be the space between the machines and the outer walls of the production facilities, where it may be possible to implement the solution without having long and costly downtime.

The trench could be built all the way to the area before the chip collection point, or to rearrange today’s collection to have separate collection points in each of the production facilities.

Pros

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• Low operation costs
• Reliable and durable operation
• Could include drainage of the cutting fluid
• Tendency of nesting should be reduced when pushed through a power trof

Cons

• High initial investment
• Difficult to build the trench without disrupting day to day operation
• Does not cope with sorting of different materials
• Space issues when building the trench
• Cost and complexity when moving machines/installing new ones possibly too high
• Must be built in a straight line, otherwise complex construction
4.5 Concept 5 - Transport in big bag with AGVs
Since there will be AGV traffic, one way of utilizing this would be to let the AGV’s collect big bags standing on EUR pallets. Since the bags themselves do not need to be transported back to its origin (as is the case with the metal chip containers) the number of transports will be cut in half. Furthermore, indications are given that the bags can hold more volume than the metal chip containers.

Big bags are available in different versions with parameters such as fabric, coating and size. An example of a big bag is shown in figure 4.4.

![Figure 4.4 Big bag](image)

With the use of disposable big bags the opportunities for an economically viable recycling process greatly increases due to the possibility of sorting metal individually for each metal sort, as today’s system handle the different types of material.

With the help of small chip cutters located directly adjacent to the machines, the volume could be reduced greatly. The small cutters also help to sort out possible bar ends. The chip cutters are only necessary where long swarfs are present.

If a metal chip briquetter is installed, either small ones adjacent to the machines or a larger one which handles chips from all the operations, the volume of the metal chips can be greatly reduced further. More information regarding Briquetting machine is found in Chapter 8.

The reduced volume (and increased density) could enable only nightly transports of the metal chips.
**Pros**

- Easy to relocate
- Halve the amount of chip transports
- Lower the transport priority of chips
- Facilitates the recycling process
- Use a low amount of floor space
- Low investment cost (with the briquetting facility excluded)
- Easy to implement without disturbing the production

**Cons**

- Possibly low durability (regarding the bags)
- Chance of breakage
- Chance of a cutting fluid spill
- Depending on external transport of an AGV
4.6 Concept 6 - Industrial vacuum system

The metal chips can be evacuated with the help of an industrial sized vacuum system. Pipelines which are attached to the ceiling, with smaller pipes running down to the individual machines uses force of vacuum to evacuate the metal chips. The basic principle can be seen in figure 4.5.

![Image of Industrial vacuum system](image)

*Figure 4.5 Industrial vacuum system*

Because of the scope of the production facilities and the quantities of metal chips, one system is not enough and different vacuum units must be installed.

**Pros**

- Relatively easy to relocate
- Facilitates the recycling process
- Use a low amount of floor space

**Cons**

- Chance of breakage
- High operating costs
- High investment cost
- Does not deal with bar ends very well
- Will probably cause higher than desired sound levels by the inlets
- Does not deal with separation of materials without building an intricate system
5 Combined QFD and controlled convergence

As explained in chapter 2.4 Combination of QFD and controlled convergence, the method is used by listing the criteria, giving them a coefficient to reflect the importance of the criteria. Then the different concepts are graded regarding how well they perform the specific criteria.

The result of the modified QFD/controlled convergence can be seen below in figure 5.1. The big bag concept is, as shown, the best solution by far. The importance column is an estimation made from the specification of demand, which can be found in appendix H.

![Figure 5.1 Concept ranking](image)

*Figure 5.1 Concept ranking*
6 Concept selection

The concept that was chosen for further investigation was concept 5, which is the big bag concept. The big bag concept has an opportunity to divide some of its investment costs and operating costs with the ongoing AGV project. This will minimize the economic factor, which has been one of the main factors for concept dismissal. By using the big bag concept the amount of metal chip transports in the fork lift aisle would be cut in half. This is due to the lack of need to transport the big bags back into the production, implied that the big bags are specified for single use only. Due to the fact that Sandvik Coromant had not investigated the big bag concept earlier made it even more appealing to investigate.

The briquetting concept was investigated simultaneously due to the time consuming task of getting quotes. The briquetting concept is a complementary solution to either the big bag concept to the existing chip transporting system. With metal chips pressed into briquettes the density will increase and therefore lower the amount of transports to the recycling process and/or in the forklift aisles depending on chosen layout.

The briquetting concept has the ability to sort out pellets (end of the raw material which is not adequate to process) and the ability to separate approximately 98% of the cutting fluid that is mixed with the metal chips. More information regarding briquetting is found in Chapter 8.
7 Big bag

7.1 Dimensions
One of the criteria for the use of a big bag is that it can fit on a EUR pallet to enable the AGVs to transport it. Evaluation of the optimal dimensions were estimated during our testing period by checking how much the big bags enlarged when filled to the intended capacity of about 750 kilograms. The big bags were estimated to enlarge up to 7 centimeters at each side which will make the big bag 14 centimeters wider at the middle. This implies that the dimensions of the big bag should be approximately 66 centimeters in width and up to 106 centimeters in length to fit on the EUR pallet.

Recent information regarding the AGV project showed that the proposed AGVs would be 88 centimeter wide. This enables expansion of the dimensions by 8 centimeters. This led to a width of 74 centimeters. The width was chosen to 75 centimeters due the fact that the manufacturer of the best suitable big bag had 75 centimeter in width as a standard manufacturing dimension. The length of the big bag was to be around 106 centimeters. Through contact with the intended supplier it was revealed that the type of big bag was round stitched and therefore required to have a square cross section. The controlling factors regarding the height of the big bag is the height of the chip transporter which approximately varies from 75 centimeters to 115 centimeters. These measurements are inclusive the 15 centimeter height of the EUR pallet which the big bag will be standing on.

In an effort to keep both the inventory and the purchase cost down it is desirable to keep as few different sorts of big bags in stock as possible. For this reason the height of the big bag should be 115 centimeters inclusive the height of the EUR pallet to ensure that the big bags will fit all height variations on the chip transporters. This makes it possible to order larger quantities and therefore ensure a lower purchase cost.

The resulting dimensions for the big bags are 75 x 75 x 100 centimeters which is equivalent to a volume of 0,56 cubic meters or 560 liters.

7.2 Quantities
The current chip handling system with containers requires 333 transports per week and approximately 14600 transport per year. More detailed information is found in appendix A. With the use of big bags instead of containers the amount of transport is reduced to 84 transports per week and approximately 3700 transport per year which is a reduction of 75%. This is due to the fact that the big bag is only used once and does not need to be transported back into the
production and the fact that the big bag can at a minimum be loaded with twice the amount of metal chips than the average container. Because of the possibility that the big bags cannot optimally be filled due to the lack of personnel working overnight and the risk of wastage, we have together with our supervisor assessed the need for a safety factor of 1,4 to ensure stock levels. With the safety factor the total order quantities will be 5000 big bags per year.

The qualities that need to be tested and determines the possibility for a well carried out implementation of big bags in the production is the durable enough to withstand the pressure and the sharp edges of the metal chips without being punctured. The big bag need to be proof enough to ensure that leakage of cutting fluid does not occur on the production floor. It should also be possible to empty the big bag in a smooth and satisfactory way. This demand will differ between one time use and the possibility of reusing the big bag. When filled the big bag needs to be stable enough to be transported on a EUR pallet without tipping over.

These qualities were summarized and used as a checklist to enable a fast and accurate documentation during live testing in the production.

7.3 Summarized version:

Leakage

- No leakage can occur during loading and transport.

Durability

- Withstand the pressure forces acting on the bag once filled
- Integrity of the structure.

Loading and unloading

- Possibility of reuse

Transport on EUR pallet

- Stable during transport on EUR pallet

7.4 Execution of test

The testing was performed in four steps as listed below. If the tested big bag did not perform up to standard in the first two steps the last two steps were excluded.
**Testing phase one**
The first testing phase was initially performed separated from the production. To study if or how much the big bags leaked, the bag were suspended in a forklift and filled with water.

**Testing phase two**
The second testing stage was performed live in the production. The durability of the big bag were tested by replacing the steel container that is used today for chip collection with a big bag standing on a EUR pallet and fixated in a temporary manor and filled with either wet or dry metal chips. During the second testing phase the weight of the big bag were checked continuously to ensure that the maximum load capacity were not exceeded.

**Testing phase three**
The third testing stage was performed to ensure that it was safe to transport a filled big bag on a EUR pallet. The forklift driver was instructed to drive faster than normal when turning. This was done to evaluate the stability of a filled big bag placed on a EUR pallet.

**Testing phase four**
The fourth testing stage was performed on a full big bag to ensure that the eyebolts on the big bag were strong enough to withstand the sharp edges on the forks without breakage.

**7.5 Testing results**

**7.5.1 Experimental period 1**
The big bags that were tested came from three different suppliers, more specifically from Bluepack, SafeSack and Accon with a variety of four different designs. When collecting test specimens the cost factors were excluded to optimize the possibility of reaching a satisfactory testing result.

The number of specimens were kept low because of the specific properties that we seek are not kept in stock. Therefore the bags were often tailored for our intents and purposes, resulting in a postponed delivery.

The first two big bags that we tested were provided by Bluepack. The bags are called 30995 and 30018. 30995 are coated with a waterproof plastic on the inside and can withstand weight up to 1500 kilograms. 30018 are not coated and can withstand weight up to 1000 kilograms. Specification of 30995 and 30018 can be found in appendix E.

**Testing phase one**
When performing the first testing phase the polypropylene weave in 30995 were
waterproof but the seams at the edges leaked, as seen in figure 7.1. 30018 leaked extensively and were therefore excluded from further testing, as seen in figure 7.2.

![Figure 7.1 Big bag 30995, leakage from the seams](image1.png)

![Figure 7.2 Big bag 30018, showing leakage through the weave](image2.png)

**Testing phase two**

In testing phase two 30995 showed no sign of breakage even though the big bag was loaded with four times as much as the metal chip container it was replacing. The total weight of the dry metal chips that were loaded was 648 kilograms. The information obtained through this test was that a big bag that is used for chip transportation only needs to withstand a maximum weight of 1000 kilograms. In this assessment the varying metal chip density, depending on the amount of cutting fluid and size included. The setup can be viewed in figure 7.3.
Testing phase three
In the third testing phase 30995 showed great stability when transported on a EUR pallet. Even when performing turns with approximately three times the proposed speed of a 0.5 meter per second that the AGV’s will have when turning. 30995 showed no signs of breakage or tendencies of tipping over.

Testing phase four
During the fourth testing phase 30995 showed no tendency of breakage when fully loaded and suspended in the forklift, as seen in figure 7.4.
7.5.2 Experimental period 2
Experimental period 1 gave us important knowledge regarding the quality we needed to improve, which was the waterproofness. Two new types of big bag had been delivered, called FXT193 and NB (short for Nordic Brass).

FXT193 were supplied from Accon and consists of three layers with a water resistant coating in the middle. Detailed information is found in appendix F. NB was supplied from SafeSack and consists of two layers with a water resistant coating on the inside. NB is round stitched which mean that it has four instead of eight seams.

Testing phase one
When performing the first testing phase it was discovered that these big bags had the same flaw as the ones provided earlier from Bluepack, they leaked through the seams. FXT193 leaked heavily and NB leaked mildly and was therefore the most suitable big bag we had tested. FXT193 was excluded from further testing.

Testing phase two
In testing phase two NB was hanging on a forklift while it was being filled, demonstrated in figure 7.5. In order to get the conditions as realistic as possible it was decided to conduct the test with very wet chips. The NB showed great promise and even though the seams were moist the NB did not cause dripping. To increase the workload approximately 20 liters of water was added that showed no effect, NB still did not leak. The underside of the big bag during testing can be seen in figure 7.6.
During our third test, which was to place a filled bag on a EUR pallet, the big bag leaked through the seams. This is because the structural integrity is changed when placed on a flat surface, lowering the pressure working on the seams. The test is showed in figure 7.7.

**Testing phase three**

In the third testing phase the NB showed no signs of instability.
Testing phase four
The fourth testing phase was performed simultaneously with testing phase two and NB showed no signs of breakage.

7.6 Safety aspects
The primary safety aspect of using big bags made out of plastic, more particularly polypropylene instead of containers made out of steel are the fire hazard. This is something that is seriously taken into account and together with Sandvik Coromant’s safety inspector Pelle Johansson, information regarding the material’s burning characteristics has been gathered and processed. This information which can be found in appendix D states that polypropylene upon complete combustion emits carbon dioxide and water. It also states that polypropylene often is used as packaging for groceries that needs to be heated before consumption and that the packaging therefore needs to withstand some degree of heating. One negative aspect is that if polypropylene is ignited it is not self-extinguishing.

Fire safety test
The test is designed to determine at what temperature polypropylene ignites and an estimation has been made regarding the possibility of a fire starting in production due to hot metal chips igniting a big bag. The test would be performed with the use of a thermal camera which can measure the temperature at the start of ignition. The test has not been performed but it is something that is recommended to be done before a full scale implementation is carried out.

There is a possibility that the metal chips that leaves the conveyor belt is gloving and therefore has the capability to ignite the big bag. An estimation have been made regarding the possibility there is to be a chance of the cutting fluid need to be turned off or compromised in some way, the conveyor belt needs to be dry and at its highest speed possible. The processing machine itself have several security systems for avoiding overheating and excess load that also need to be dysfunctional and for there to be any chance of direct contact between the hot metal chips and the big bag needs to be almost completely empty. With those assumptions made it is safe to claim that the chance of a metal chip igniting the big bag and therefore starting a fire is slim to none.
8 Briquetting machine
A briquette machine enables metal chips to be pressed into briquettes therefore brings an increase in density and an increase of revenues made from the recycled metal chips.

One prioritized reason for Sandvik Coromant to use a briquetting machine is its ability to separate the cutting fluid from the metal chips. It will enable the cutting fluid to either circle back into the metal processing for reuse without risk of contamination or to be destructurised in Sandvik Coromant’s destruction facility for reuse of the water. Both of these reasons enable a higher degree of environmental friendliness.

8.1 Cost and usage of footprint
Two different layouts that a briquetting machine could be used in at Sandvik Coromant have been investigated.

*Mounted directly after the metal processing machines*
A briquetting machine that is mounted directly after the metal processing machines could be a complementary solution to either the existing chip transporting system or to the big bag concept. This layout of briquetting machines enables metal chips to be pressed into briquettes which will increase the density and therefore lower the amount of transports both to the recycling process and in the forklift aisles. By significantly lowering the amount of chip transports in the forklift aisles the briquetting machine enables for a safer work environment which is one of the main reason this project is issued.

Lack of space is a fact that Sandvik Coromant in Gimo needs to adapt to when planning for new equipment. Because of the lack of floor space an extensive research has been performed regarding the possibility of excluding the need of a chip crusher. A chip crusher is needed for chips origin from a turning operation to lower the risk of failure when briquetting the chips. Excluding the chip crushers would lower both the usage of floor space and lower the investment cost. The research showed that with the length of the metal chips that occurs at the turning operations today, the usage of a chip crusher before a briquetting machine is a necessity. The research also showed that by combining a briquetting machine with a chip crusher the usage of floor space can be reduced. This is obtained by placing the chip crusher on top of the briquetting machine.

One of the downsides of using a separate briquetting machine for each processing machine is that it requires a relatively high investment cost that varies from 425 000 Skr up to 570 000 Skr per machine depending on the occurrence of extra-long metal chips at the turning operations. More information can be found
in the quote located in appendix C. There are roughly estimated 15 turning machines and 55 milling machines in the production. The investment cost of fitting 70 briquetting machines and 15 cutting machines on the processing machines is just over 26 million Skr.

**Central chip handling facility**
Implementing a central chip handling facility will not lower the transports in the forklift aisles but it will lower the transport cost to the recycling facility. The facility needs to be able to process over the 1100 tons of metal chips that are produced every year.

Mercatus which is a supplying company, proposed a solution that consists of a chip handling facility which has the ability to separate cutting fluid, crush up to 650 tons of metal chips per year and briquette up to 1360 tons of metal chips per year which is a sufficient capacity for our intended use. There will also be a possibility to sort up to four different sorts of metal chips and it will include some sort of equipment that transports the metal chips from the AGVs into the chip handling facility.

The roughly estimated investment cost of this chip handling facility is 3.5 to 4 million Skr. More detailed information is located in appendix G. By using briquetting machines and therefore make it possible to sell metal briquettes instead of metal chips to a recycling company is estimated to increase the revenues with approximately 450 000 Skr per year depending on the quantity of metal chips. More information is found in appendix H.
9 Benchmarking at ESBE

ESBE AB manufactures rotary valves, rotary actuators and other products associated with hydronic system control. The factory and headquarters is located in Reftele, Sweden. Their main market is parts for heat pumps, radiators and systems for solar power.

All manufacturing (except for some cases of assembly) is located in Reftele. ESBE have been family owned and operated up until recently, however the organization chart states that the core business must remain in Reftele. ESBE approximately employ 180 people in Reftele.

ESBE is of great interest because they transport brass chips with cutting fluid in big bags, and have done so for a period of time. The use of big bags is a request from their largest supplier of brass, Nordic Brass. This is because ESBE sells all of its brass chips back to Nordic Brass, who demands that ESBE deliver dry chips to their recycling facility.

ESBE produce on average 300 tons of brass chips per year.

ESBE has an interesting take on the chip management system. Many of the solutions and methods which they use as a result of Nordic Brass’ request of having the recycled brass chips sent in big bags.

9.1 Brass chip handling

ESBE has two main different methods of collecting the brass chips. Firstly, they collect the brass chips with moderate quantities of cutting fluid directly in containers placed adjacent to the chip conveyors. Small valves are placed at the bottom of the containers which enables some drainage of the cutting fluid. This is very similar to how Sandvik Coromant handles the metal chips as of today.

When the containers are filled, the operator empties them in a big bag which is suspended in customized equipment, see figure 9.1. A grid at the bottom enables further drainage of the cutting fluid.
The other method is having the chips drop directly into a big bag, which also is suspended in the above mentioned customized construction. The bag (with the associated equipment) is then moved when the bag is full and a new setup is placed underneath the chip conveyor.

In common for both cases is that the bags need to drain for at least 24 hours before they can be moved from the customized equipment, because of the cutting fluid, after which the bags are placed on EUR pallets. The EUR pallets have been provided with a tray made from sheet metal, as seen in figure 9.2, to ensure that it does not leak any cutting fluid during transport.

As with the bags we have currently tested, ESBE has problems with leakage along the seams at the bottom of the bags. The polypropylene weave is practically waterproof.
9.1.1 ESBE’s bags
ESBE uses bags which are provided by Nordic Brass. The bags are sold by SafeSack, and are coated on the inside, quadratic cross section with four eyebolts. The dimensions are 90 x 90 x 100 centimeters. Leakage occur along the seams, but the coated weave is waterproof.

9.2 Conclusion
The workarounds that have been necessary for ESBE to implement to be able to use big bags as a carrier for the brass chips is not realistically possible for Sandvik Coromant to mimic. The sheer amount of metal chips produced daily at Sandvik Coromant would force them to sacrifice precious floor space in order to facilitate the drainage section.

The use of metal trays on the EUR pallets could be a realized solution if waterproof big bags cannot be found that satisfies Sandvik Coromant’s conditions or if such a bag simply costs too much. The trays might need a higher collar in order to deal with the increased quantity of cutting fluid, although this should be investigated further.

It was disappointing to find out how much the bags actually leaked and the processes which ESBE needed to use to cope with the problem of having wet chips in bags that was not waterproofed. Valuable information was gained regarding how their method is carried out.
10 Discussion and Conclusions

Out of the concepts we had, the only one we found worthwhile of pursuing was the big bags. The other concepts had one or more serious flaws which prevented them from being realistically implementable. The first and foremost limitation was the floor space limitations in the production. There was also the limiting factor that a single system that takes care of all the chip removal is not a desirable option. This is due to both the risk of failure and the need of scheduled maintenance would bring significant consequences for the production lines in the factory.

We have a strong belief in that there is a big bag which will meet Sandvik Coromant’s demands regarding leakage, or that some other solution which will curb the problem with leakage (e.g. metal sheet tray on the EUR pallet).

Our tests have shown that the problem with the big bags is that leakage occurs through the seams. This is because the seams puncture the polypropylene weave when the bags are sewn. Big bags with sealed seams and coated weave should prove sufficient regarding the waterproofing.

With experiences achieved through several dialogues with companies supplying big bags combined with the performed benchmarking with ESBE we conclude that it is possible to find a big bag that is waterproof and suitable for the intended purpose of use. We can also conclude that it is possible to get around the leakage by using supporting equipment, such as using a collection plate between the big bag and the EUR pallet.
11 Recommendations

The solutions that are recommended for further research is where big bags with waterproof seams are found and they should be transported on EUR pallets which have proven to be a viable solution. Develop a holder for the big bags eyebolts to maintain the integrity of the big bags structure while it is being filled. The use of a central chip handling facility is strongly recommend. It will separate cutting fluid from the metal chips and increase the density of the metal chips. The chip handling facility could with advantage be placed on one more central place like at the end of any of the aisles in production to reduce distance of AGV routes. The chip handling facility should include briquetting of both metal swarfs and chips and a swarf-crushed which has been learned to be necessary to enable briquetting of longer swarfs.

With the goal of increasing the automation level there is an option to investigate the possibility of implementing a machine that automatically can empty a big bag into the briquetting machine.

This solution is worth investigating further and if this solution would become reality the benefits are:

- Lowering of the amount of in-house metal chip transports from 14600 transports per year to approximately 3700 transport per year.

- Make a profit of an estimated 450 000 Skr per year by briquetting the metal chips which could be enough to make the chip handling facility an economically justifiable option.

- The chip handling facility would also contribute Sandvik Coromant’s ambition of being environmentally friendly by minimizing the amount of cutting fluid that is spilled from trucks transporting the metal chips to the recycling company which instead could be destructurised directly in Sandvik Coromant’s own destruction facility to enable reuse of the water. It will also lower the amount of truck transports to and from Sandvik Coromant by increasing the amount of metal chips per truck transport.

- By placing the chip handling facility on a more central place like at the end of the aisle in production facility 66 could have the possibility of lowering the investment cost of the AGVs by reducing the distance of AGV routes and therefore lowering the occupancy of the AGVs.
12 References


13 Appendices

13.1 Appendix A: Data regarding chip transports

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Sum of transports at GV per week | 333 | 74 358 |

Sum of transports at GVR per week | 207 | 44 338 |

Sum of transports at GVR per week | 126 | 36 020 |
13.2 Appendix B: Companies which has been contacted

**Company:** Bluepack

**Name:** Ingvar Andersson  
**E-mail:** ingvar@bluepack.se  
**Telephone number:** +46 46 70 67 10  
**Web page:** www.bluepack.se

**Company:** Jubilo

**Name:** Victor Stenmark  
**E-mail:** viktor.stenmark@jubilo.se  
**Telephone number:** 0727443049  
**Web page:** http://www.jubilo.com

**Company:** SafeSack Scandinavia AB

**Name:** Daniel Segerpalm  
**E-mail:** Daniel.Segerpalmsafesack.com  
**Telephone number:** +46 435 54933  
**Web page:** http://www.safesack.com

**Company:** Nordic brass

**Name:** Lars Engström  
**E-mail:** lars.engstrom@nordicbrass.se  
**Telephone number:** 0123-54121  
**Web page:** www.nordicbrass.se
Company: ESBE
Name: Magnus Ivansson
E-mail: Magnus.Ivansson@esbe.eu
Telephone number: 0371-570076
Web page: www.esbe.se

Company: Svenska Miljö Logistik
Name: Anders
Telephone number:
Web page: www.svelog.se

Company: Nederman
Name: Rolf Derefalk
E-mail: rolf.derefalk@nederman.se
Telephone number: 016-16 07 81
Web page: www.nederman.se

Company: Accon AB
Name: Tobias Svensson
E-mail: tobias@accon.se
Telephone number: 0480-270 20
Web page: www.accon.se

Company: Mercatus
Name: Erkki Lahti
E-mail: Erkki.l@mercatus.se
Telephone number: +46 492-171 21
Web page: www.mercatus.se
13.3 Appendix C: Quote and blueprint of the “single machine” briquetting solution

Svenska MiljöLogistik
Kompetensområdet Rilupspackning & övrig utvärdering för miljöämningsint och logistiskt stift hantering av återvinningsbara avtorkningshåll

Sandvik AB
Christian Tuxén Björlinghult
Box 510
10130 STOCKHOLM

Deltagare: 2013-05-28
Budgetoffert 1305281420

Bäste Christian,

Jag har röpt att lämna följande budgetoffert enligt Din förfrågan.

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Detaljsumma kvarn 148726 kr

Brihettmaskin RAP Vertikal

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Detaljsumma brihettmaskin 423957 kr

EJ BESTÄMDA ELLER KÅNDA KOSTNADER

Ej kända anpassningar marginal kostnader markerat 1 50 000 kr

Montage per dag exkl. reskostnader 1 7 200 kr

(Mera enheter kan i bästa fall monteras på en dag)

Komplicerad Rilupspackning & övrig utvärdering för miljöämningsint och logistiskt stift hantering av återvinningsbara avtorkningshåll

Sandvik AB, Christian Tuxén Björlinghult
Box 510, 10130 Stockholm

Deltagare: 2013-05-28
Budgetoffert 1305281420

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Detaljsumma kvarn 148726 kr

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</tr>
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<td>4.x Uppgradering med bytt till container höjdpunkt</td>
<td>1</td>
<td>6 491</td>
</tr>
</tbody>
</table>

Detaljsumma brihettmaskin 423957 kr

EJ BESTÄMDA ELLER KÅNDA KOSTNADER

Ej kända anpassningar marginal kostnader markerat 1 50 000 kr

Montage per dag exkl. reskostnader 1 7 200 kr

(Mera enheter kan i bästa fall monteras på en dag)
Noteringar:

Her vi kvarn ovanpå så kan tratten ovanpå denna maximaliseras till ca 100 liter och
under kvarn i brikettmaskinen trätt tillkommer ca 120 liter.

utan kvarn kommer trätt att komma maximaliseras till ca 250 liter.

Presselen inklusive kvarn håller sig inom ramen med L 1800 x B 613 x höjd >1200
utan kvarn skulle pressesyn kunna hållas sig inom mätten L 1200 x B 613 x H 1200
Hydrantkot och öiskop ca 700x700 mm kan ställas upp till 10 meter bort vid behov.
Rajekt utkast kapshar på brakettmaskin ansönt är ej möjligt men det går dock att montera vibrerande skakgaller ovanför trått på brakettmaskin. En sådan kräver dock nödvändig renings då framton kapshar även längsstran kan bli tiggande kvar.

Utyp för braketter ligger på relativt låg höjd och denna maskin kan inte skjuta braketter speciellt långt eller högt, max 350 mm, vilket innebär att andra har man en liten tippklock framför utlopp eller specialanpassning som är inuti om transportera upp i höjd (på räkning 911 m/upp och 19 m/ut åt bort från pressdelen.)

En liten tippkladd lågt placerad 500 x 500 x 400 skulle kunna hålla ca 100 liter och när denna är full skulle den våga någonstans mellan 300-400 kg, beroende på volymvikt av braketterna.

Alternativ till utloppskunnel special är en liten elevator, pris är ej känt men ligger troligen runt 18 – 25,000 kr. (Då blir den totala längden ca 500 + 1500mm, dvs ca 2300mm)
<table>
<thead>
<tr>
<th>Priser:</th>
<th>Budgetoffert exklusive mervärdeskatt</th>
</tr>
</thead>
<tbody>
<tr>
<td>Garanti:</td>
<td>1 år, allsidiga ansvarsområden</td>
</tr>
<tr>
<td>Priser:</td>
<td>Exkl. mervärdeskatt, avzöktningar, emballage, montage etc.</td>
</tr>
<tr>
<td>Lev. till:</td>
<td>Fritt vår fabrik - Tyskland</td>
</tr>
<tr>
<td>Lev. best:</td>
<td>NL gällande leveransregler</td>
</tr>
</tbody>
</table>

Jag tackar för förståndet och ser fram emot möjligheten att lämna en offert efter behovsattredning.

Med vänliga hälsningar,

Anders Carlberg
Bli en medveten plastkonsument

Ur nr 2011-1

VARDAGEN ÅR FULL av plast, nästan alla heter något på poly. En del sorter går du klot i att försöka undvika. De allra flesta plastprodukter har en stämpel som visar vilken sort det är.


Anders Friström

Sju olika plastsorter och deras miljöegenskaper

1 PET, polyethylen Flatalet

PET står för polyethylen flatalet. Det används ofta i drickesflaskor. Denna plast är svårt att bli av, men detta gör den bra i returflaskor. Polymere i 1999 är samma som PET.

Målsättning. Nivå smittar inte risk för ökning i flackorna. En ny studie visade att vatten i PET-flaskor hade högre halter av hormonsättande ämnen än vatten i plastflaskor.

2 Polyetylen - hög densitet, PE-HD

Detta är en vanlig plast i förpackningar för flytande produkter. Den är kraftigare och tillverkas av en vanlig polyetylen (material nr 4).

Målsättning, Ingår i dag kända, bör dock inte upphävas.

3 Polyvinylchlorid, PVC (uvändig)


Målsättning, Undvik om du kan.

4 Polyetylen - låg densitet, PE-LD

Det här är material av vanliga plastprodukter görs av.

Målsättning, ingår i dag kända, bör dock inte upphävas.

5 Polypropylen, PP

Polypropylen är vanlig i förpackningar som ska hålla eller, exempelvis till åtskilt produkt som sådana i special, men finns i alla saker som mätrettsforpackningar.

Målsättning, ingår i dag kända.

6 Polystyren, PS (uvändig)


I kontroll medföljer. Tidsvapna har cellplast bärs upp med hjälp av olja och givna på olika onödigt stora ämnen. Cellplast kan vara impregnerad av bromsida från att dom rutiner.

Målsättning, ingår i dag kända.

7 Övriga plasters (uvändig)

Sjuan återförs på mjuka eller olja i plastprodukter, att från od modeller till nappedar och matlådor. Den snabbare plaståtervinnning till被动banan än är gjord av tillförselämnen. Nylön är en polyamidplast. ABS-plast är vanlig i plastkonstruktioner av olika släkter, kastar i de danningsavakt. Här finns också...
VI har egna tillverkning av produkter i mjuk- och hårdplast.

Vi har egna produkter samt nära kontakt med andra tillverkare. Genom möjlighet att erbjuda mätanpassat tillverkning av plastfickor, fodral, pärmar mm. Vi kan även trycka exemplariska förteckningar eller visuellering på olika standardprodukter eller specialtillverkade produkter.

Det material vi arbetar med är polyetylen, polisprängpulver samt pvc.


Polyvinylklorid (PVC) utvinnas av salt (60%) och dyli, bostäder av klorerade klibba samt stabilisatörer och uppehållare. Framställning processen kräver ett energidiskaktalt. Vid förbränning anses säten. PVC är långrikt insamlad och kan lätt återvinnas. PVC är värdefullt och uppskattande.

Kontakta oss gärna för mer information eller skicka en offertförfrågan per e-post till info@sidewalk.se.

http://www.sidewalk.se/product.php?productId=13

2013-05-03
13.5 Appendix E: Specification of 30995 and 30018

Specifikation Storsäck 30995

Benämning: Tunggods

Art Nr: 30995

Lyftsystem: 4-öglor, 30cm + 5cm fri söm
Inner Mått: 87x87x100cm
Modell: Planvävd
Liner: Nej

SWL: 1500kg
SF: 5:1
UV: Ja

Topp: Öppen
Botten: Plan
Väv: 200g ±7% / m²
Beläggning: Ja

Tryck: Nej/ Efter offert
Dokumentficka: Ja, A4
Vakuumbehandlad: Nej
Metalldetecterad: Nej
Övrigt:

Kvantitet/ pall: 200st
Material i säcken: Polypropylene
Material i lyftöglor: Polypropylene
Material i sommar: Polypropylene
Material i dokumentfickan: Polyethylene
Specifikation Storsäck 30018

Benämning: Medium

Art Nr: 30018

Lyftsystem: 4-storlar, 30cm + 5cm fri som
Inner Mått: 75x75x105cm
Modell: Planvävd
Liner: Nej

SWL: 1000kg
SF: 5:1
UV: Ja

Topp: Öppen
Botten: Plan
Väv: 160g ±7% / m²
Beläggning: Nej

Tryck: Nej/ efter offert
Dokumentficka: Ja, A4
Vakuumbehandlad: Nej
Metalldetekterad: Nej
Övrigt:

Kvantitet/ pall: 350st
Material i säcken: Polypropylene
Material i lyftoglor: Polypropylene
Material i sömmar: Polypropylene
Material i dokumentfickan: Polyethylene
Storsäck 4 öglor, Krage & plan botten (Heavy Duty)


Nedan finns några alternativ som vi även har i vårt lager samtidigt. Dessa storsäckar har plastbelagd väv som skyddar mot fukt och inte är anpassade till transport med lastbil, lop och sjöfart. Storsäcken används bland annat till: Spannmål, mineraler, jord, återvinning, bräcker och pallets.

<table>
<thead>
<tr>
<th>Artikelkod</th>
<th>Storlek</th>
<th>Volym SWL</th>
<th>S:F Öglor Topp</th>
<th>Botten Sänmar</th>
<th>Antal/pall</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(om)</td>
<td>(m3)</td>
<td>(kg)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>926</td>
<td>75x75x90</td>
<td>0,8</td>
<td>1500</td>
<td>5:1 4</td>
<td>Krage Plan Standard 150</td>
</tr>
<tr>
<td>937</td>
<td>75x75x70</td>
<td>0,5</td>
<td>2000</td>
<td>5:1 4</td>
<td>Krage Plan Standard 165</td>
</tr>
</tbody>
</table>

Vid köp om mindre än full pall tillkommer kostnader för embalage.

Accon AB, Tjuvbackevägen 5, 392 39 Kalmar, Sweden
+46 (0)60 26050 Fax +46 (0)60 20295
13.7 Appendix G: Quote of the chip handling facility

AB Sandvik Coromant, Gimovägen
SE-747 44 Gimo

Vimmerby: 2013-05-27
Ve refr: Erik Lahti
Erref: Christian Taxén

Ouffert nr: 102426-003
Projekt nr: 102426-003

Med referens till er förfaling har vi nöjet att återkomma med teknisk beskrivning och riktlinj
på ett upplägg för briktetning av er spånsön.

Förutsättningar Sandvik Coromant Gimo:

Materialmängd: Totalt: 1100 tonnår (Stål THX2000)
Materialkaraktär: 50 % Långspår, 50 % kortspår
Typ av spånbehållare: Okänd
Spåntillförsel: 24 tim/dag
Utrustning för spånhantering och utrustningen: Okänd

Exempel på provlämning hos Mercatus:

Anläggning: Brikettmaskin RUF: RB4/3000/40
Spänkkilos: Knoll(områd) 2700/G40
Brikettskyld: 40x60x60 mm
Brikettvikt: 0,144 l
Brikettvikt: 0,650 gram

Provlämningen visade att RB4 an klarar ca 100 kg/himme.
RB11 som förestas i offerten beräknas med utgångspunkt från provlämningen klara
Ca 250 kg/himme (brikettskyld 0,70 mm, Längd 90 mm, Vikt ca 1,4 kg/brikett)
Mercatus leveransomfattning

<table>
<thead>
<tr>
<th>01</th>
<th>2 st LYFT OCH CONTAINERHISS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Typ: MD-6</td>
<td></td>
</tr>
</tbody>
</table>

Tekniska data:
- Containerlängd: 1520 mm
- Containerbredd: 850 mm
- Containerhöjd: 1060 mm
- Totalbredd: 1462
- Lyftkapacitet: 750 kg
- Tipphöjd: 2300 mm
- Effekt: 3,0 kW
- Bromssutförande: Fjädertrycksbroms
- Hand / 0 / Auto- omkopplare

Utförande:
- Komplett med erforderlig skyddssutsynning som ex. nödstopp
- Skyddsgaller runt hela anläggningen inkl. gallerdörr med förregling
- Etskäp med strömbrytare med bl.a. hand- och automatskift
- Droppplät under hela anläggningen
- Säkerhet enl. CE

(Vid beställning krävs en containerrättningar för att anpassa utrustningens lyftanordning)

<table>
<thead>
<tr>
<th>02</th>
<th>1 st VALSKROSS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Typ: JBF 100 / 54</td>
<td></td>
</tr>
</tbody>
</table>

- Längd: (aktiv krossdel) 1010 mm
- Bredd: 560 mm
- Antal axlar: 2
- Axeldiameter: 60 mm
- Effekt: 2 x 4 kW
- Spänning: 400 V 50 Hz / 24 V DC
- Kapacitet (max): 5000 kg/timme

Utförande:
- Inmatningsstratt med hydraulisk spännedtryckare (anpassad för max 600-700 liter spånor)
- Speciallåsning, oljebeständig
- Krossknivar av specialstål, 30 mm
- Drivmotorer med utväxling och säkerhetskoppling
- Stativ anpassad för containerlyft och spänntransportör
1 st ELSTYRNING /valskross
Äverer spänkross, transpörtör, och samordning mellan de övriga ingående komponenterna (containerlyft och brikettpress.)

2 st TRANSPORTÖR
Typ: 300 K-3
- Hörnkörtl inmatningslängd: 1600 mm
- Spantölmningshöjd: 1500 mm
- Spantölmningsvinkel: 60°
- Totalängd: Ca 3900 mm
- Bredd: 500 mm
- Höjd inmatningsödel: 235 mm

Utförande:
- Skastransportör med förstärkt mellanbotten och sidolister
- Kylmodulatoröppl öppet till tank
- Täckt utförande förutom i inmatningen

1 Drivning/transportör
- Effekt: 0,55 kW

Utförande:
- I transportriktning, höger
- Säkerhetsstyrkopling
- Reverserboytare med rostställning

1 Tank/transportör
- Monterad i sidan på transportör

1 st Lyfttransportör
Typ: T320-70/03-220
- Kapacitet: 30l/min
- Tryck: 0,6 bar
- Effekt: 0,33 kW

1 st Nivévakt/transportör
- Antal nivåer: 2 (pump On/Off)
2 st BRIKETTPRESS
Typ: R5 11/4000/70
Tekniska data:
- Längd: 2700 mm
- Bredd: 2000 mm
- Höjd: 2200 mm
- Inmatningshöjd: ca 1500 mm ∆g
- Kapacitet: Ca 300 kg/h* (Ø70 mm, L=80 mm)
- Antal bricketor: 3-3,5 st / minut
- Brikettddiameter: 70 mm
- Brikettängd: variabel mellan 40 - 110 mm
- Vikt: 3300 kg
- Spanning: 400 V 50 Hz / 24 V DC

* Kan varieras med brikettängd

Utrustning:
- Påfyllningsbehållare med omrörarmatning (400 mm x 600 mm, 150 liter)
- Tråg med pneumatisk membranpump för utpressad vätska
- Uppspansar för brikett, 45 grader
- Öljötank, volym 200 liter
- Öljöfiltrer
- Levereras komplett på ramstalv

1 st Hydraulpump/brikettpress
- Effekt: 11,0 kW
- Spanning: 3 x 400 V 50 Hz
- Hydraultryck: 300 bar
- Tvåstegs kugghjulsautomatic

1 st Melarringskruv/brikettpress
- Effekt: 1,5 kW
- Spanning: 3 x 400 V 50 Hz
- Komplett med övervakningsfunktioner

1 st Elektrisk utrustningsbrikettpress
- Komplett med intern styring IP 54
- Siemens Simatic S7 och operatorpanel OP 3
- Väderfunktion Hand / Auto
- Automatisk start via fotcell
- Klartextvänlig för larm och drift i display
- Driftstidsmätare

* Förändring, extrupphängning eller specialvarianter av utmatningsrännen beror innehåll mot ejfältvaxhut.

** Förlängning, extraupphängning eller speciella varianter av utmatningsrännen beror innehåll mot ejfältvaxhut.
05 MONTAGE och IDRIFTTAGNING
Komplett montage av ovan offererad anläggning
bestående av:
- Montering av 2 st lyhögar
- Montering av 2 st krossverk
- Montering av 2 st transportör
- Uppställning av 2 st brikettforss
- Interna skärning och anslutning mellan olika komponenterna

Komplett idrifttagning bestående av:
- Provlättning och infratäende av anläggningen
- Justering och programkontroll
- Utbildning av beställarens personal
- Överförande av komplexa driftsinstruktioner

Riktnings Pos 01-05: EUR 460 000,-
BESTÄLLARENS ÅTÅGANDE:
- Lötning, inomrörning och uppställning av anläggningen
- Samtliga arbeten gällande byggnader, ex. hålltagningar, fundamentförstärkningar, rörgrevar etc.
- Framdragning och anslutning dimotning till styrsäk, mfl.
- Installation av fyllskal i styr och av. kraftkabinett mellan anläggningen
- Styrsäk och ytter förbbruks, mfl. elektrisk leveransgräns
- Framdragning av trycksäk till av. trycksäk drifta komponenter
- Beställaren tillhandahåller tillhandahållning av (tavla, ussera, ufcruck etc.)
  vid montage. Utbildning förare, skall även ta skikte, vara behjelplig vid lyft
- Montageplatsen skall ha god ventilation, beonings, och vara uppvärmad
- Tillhandahållande av notvärdiga elanslutningar för olivert, under montage (240 V 10 A)
- Tillhandahåla och använt forsprängningskait for farligt avfall
- Erforderliga tillstånd från berörda myndigheter
- Avvikelse eller eventuella ändringar och avvikelse gällande tidpläner, leverans och montage i god tid

Mekaniska leveransgränsar är:
- Containerlyft
- Standard utmatningsrännor tretttonpress

Elektriska leveransgränsar är:
- Plintred i trumhållningen skyddat

Beställaren ansvarar för att inkommande matning, 3 x 400 V anslutes till inkommande plint.
Får:
Vafru RAL

Spännings: 3 x 400 V 50 Hz

Leveransbid: Ca 16 - 18 arbetsveckor efter order eller enl. överenskommelse

Leveransvillkor: Incoterms: Ex Works, Tyskland, exkl. emballage, i övrigt gäller allmänna leveransvillkor Orgelne SE01

Betalningsvillkor: 30% vid ordet
60% vid leverans av gods
10% vid godkänd idrifttagning
doek senast 30 dagar efter leverans
Alla betalningar 30 dagar netto

CE-märkning: Anläggningen levereras med överensstämmande CE-märkning och är godkänd enl. EU:s meddelande på svenska språket

Dokumentation: 2 ex fullständiga skickesanvisningar på svenska språket

Förzäkran: Mercatus Engineering innehä
försäkring för skador upp till 20.000.000,- SEK

Mercatus Engineering AB är miljöcertifierade enligt ISO 14001. Vi levererar system med högsta kvalitet till effektivitet, miljöpåverkan och kostnad.

För frågor gällande förslaget stör vi till ett föregående och hoppar delar som leder till förbättrade diskussioner.

Med vänlig hälsning

MERCATUS ENGINEERING AB

Erikki Lohté
13.8 Appendix H: Calculations regarding chip recycling

<table>
<thead>
<tr>
<th>Department</th>
<th>Year 2011: Metal Chips [kg]</th>
<th>Selling Price [SkR/kg]</th>
<th>Sales Value [SkR]</th>
<th>Year 2012: Metal Chips [kg]</th>
<th>Selling Price [SkR/kg]</th>
<th>Sales Value [SkR]</th>
</tr>
</thead>
<tbody>
<tr>
<td>V63 GVR3 (THG 2000)</td>
<td></td>
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<tr>
<td>V66 + GVR2</td>
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<tr>
<td>V72</td>
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<td>Total</td>
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<tr>
<td>Average weight year 2011 &amp; 2012</td>
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<tr>
<td>Transport cost per container (10m3) [SkR]</td>
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<tr>
<td>Average weight [kg]</td>
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<tr>
<td>Total recycling cost</td>
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<tr>
<td>Profits generated</td>
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<tr>
<td>Average profit year 2011 &amp; 2012</td>
<td></td>
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<tr>
<td>Profits generated (only mixed chips)</td>
<td></td>
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<tr>
<td>Average difference year 2011 &amp; 2012 (only mixed chips)</td>
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<tr>
<td>Chips in average [kg/week]</td>
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<tr>
<td>Chips in average [kg/day]</td>
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<tr>
<td>Profits generated with</td>
<td></td>
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<tr>
<td>- Briquettes</td>
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<tr>
<td>Total</td>
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<tr>
<td>Average weight [kg]</td>
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<tr>
<td>Total recycling cost</td>
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<td>Profits generated with</td>
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<td>- Briquettes</td>
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<tr>
<td>Average profit year 2011 &amp; 2012</td>
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<tr>
<td>Total profits generated with</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Briquettes</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>448 239 kr</td>
</tr>
</tbody>
</table>
13.9 Appendix I: Specification of demands

| Specification of demands for future chip handling system at Sandvik Coromant Gimoverken Tool production Ver2 |
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1 Introduction

1.1 The purpose with the procurement
In an effort to automate the transportation of goods with AGV (automated guided vehicles) at the Tools Production at Gimo, the current way of handling the evacuation of chips must be changed. The driving force behind the AGV project is mainly to ensure a more safe work environment.

1.2 Overall information
Sandvik Coromant production unit in Gimo has two factories with around 1,650 employees. The factory site that produces tools is more or less the only factory of the two that has a metal chip disposal.

2 System description

2.1 Current system
The metal chips are collected in customized bins from small conveyer belts that are attached to the machines (drilling, milling and/or turning operations). There are two different types of conveyer belts, one magnetic based and one with a traditional conveyer belt. The end result is the same, to get the chips far enough from the machine so that the chips drop in the bins.

The full chip bin can weigh up to 1,600 kg. The full bins are placed in the aisle and a fork lift driver collects them when he or she spots them.

These bins are emptied in the range of once a time per shift to once a week, depending on the size of the bins, workload and chip geometry.

2.2 Type of bins
There are several different types of customized bins. There are 52 different customized dimensions and the total count is 132 bins. The high amount of customized bins is necessary in order to fit the bin at the vastly differing collection places. The sizes of the bins are also different mainly depending on the chip sizes (e.g. volume of the chips), in what quantities the chips are produced and/or how much space is available at the station.
Examples of the different type of bins.

2.3 Future system

Sandvik Coromant is in the process of automating the transport of goods with the help of AGV system (automated guided vehicles) and need to reduce the manual fork lift traffic in order to accommodate the new transportation system.

A fully automated system is preferred, but depending on limitations some manual work might be necessary.

The current system is highly customized mainly due to the lack of space there is available at the stations as well as in the transportation routes they are transported in. So due to this reason, one of the key factors an implementable solution need to achieve is to be as space sufficient as it possibly can be.

2.4 Safety aspects

The new system cannot compromise on the safety standard that is achieved with the introduction of an AGV-system.
3 Scope

3.1 Transport volume

The system needs to handle approximately 70 different pick up points from which the chips are produced. These points are spread out in three different production facilities located by the machines that produce chips. Some departments have more pick up points than others, depending on how many machines present.

The folk lift drivers estimate a total of 8-10 pick-ups of chip bins with today’s system and sizes of the bins per shift. This means 16-20 per day, with the occurrence of minor variances.

The chips are produced in quantities of 22,000 kg per week, which totals to an average load of 3,000 kg each day. The production of chips is, for the most part, evenly spread over working hours.

This is divided between the three production facilities and five different departments. Some departments produce more chips than others. GVH3 is mentioned to be the department that produces the most chips.

More detailed data can be delivered if necessary.
3.2 Type of chips

The chips vary both in regard to materials and geometry.

The different types of material are “regular”, “mixed” and one that contains nickel (named THG2000). The chips are sold to a third party and different price points are given depending on quality, were the ones containing nickel are the most lucrative, followed by the “mixed” ones\(^1\). Because of this Sandvik divides the different chips as much as possible to maximize the revenue.

The other variables are the geometry and the occurrence of cutting fluid. The milling operations generally provide small, fine chips and the turning operations provide longer spring-like chips that tend to curl up to clews.

A small amount of aluminum chips are produced in “verkstad72”. The geometry is small, fine chips.

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\(^1\) We are currently waiting on data to more precisely differentiate the chips by their internal names.
4 Must and should demands

4.1 General
The transport system must be able to be up and running 24 hours every day.

4.1.2 User environment
Maintenance must be kept to a minimum where parts that need servicing are easily accessible. Ideally only scheduled maintenance is demanded.

Easy to use and low supervision is required if the suggested system needs to be operated manually by operators.

4.1.3 Work environment
The impact on the current work environment should be kept to a minimum. Ideally the system should show no negative impact on work environment. This includes sound levels, dust, loose chips in the factory etc.

4.1.4 Safety
The system must be safe to use where manual input is needed. Depending on the system different mechanics to ensure the operators’ safety is demanded.

4.1.5 Chip geometry
The system must be able to handle the different types of chip geometry. As stated in 3.1.1 there are mainly two different types of chip geometry. The turning operations have a tendency to produce long spring-like chips which more than often curl up into claws. The system must in some way be able to cope with this situation.

The milling operations produce small, fine chips which the system must be able to handle, as this type of geometry increases the weight to volume ratio.

Metal pellets are also present in some of the operations. The system must be able to in some way cope with these. The length of the pellets varies from small (2-3 cm) to longer (approximately 15 cm) with a diameter of up to 5 cm.

4.1.6 Separation of chips
The system should be able to separate the different materials of the chips in order to maximize the sales value of the metal.

4.1.7 Cutting fluid
Cutting fluid is present in different quantities depending on the geometry of the chips, when the chips drop from today’s conveyor belts. The system must be able to either transport wet chips or, ideally, separate the cutting fluid from the chips before the chips reach the final collection point. There should, in case of the possibility to separate the cutting fluid from the chips, be a simple way of extracting the excess cutting fluid in order to recycle the water from the cutting fluid. This is done in a boiler present in the factory.
4.1.8 **Space requirements**
The available floor space and space above the machines (i.e., the ceiling) is highly restricted. The system must be able to be implemented with these restrictions.

4.1.9 **Flexibility**
There are constantly ongoing changes in the factory. This means the system must be reasonably easy and cost efficient to reroute to new collection points. This should preferably be possible to be handled by Sandvik staff without any external help.

4.1.10 **Environment**
The transport system should be able to transport at least three different types of chips separately to maintain an existing system of environmentally sustainable recycling.

4.1.11 **Communication**

4.1.11.1 **Compatibility**
If the transport system is equipped with a communication system, it should be compatible with a delivery management system.

5 **Time plan**
The chip-handling system is a supporting system for other scheduled investments that cannot be implemented properly if this project is not tested and approved before the fall of 2013.
6 Acceptance tests

Sandvik will create acceptance tests of the investment. This will be performed true a
FAT (Factory Acceptance Test) before delivery and a SAT (Site Acceptance Test) after
delivery and before Sandvik Coromant completes final payments.

6.1 How tests are performed?

At FAT the system will be run in a simulation of our production environment as if it
was implemented in our factory. At SAT the system will be fully implemented and run
in full scale in our factory.

All of the demands in the procurement documentation must be fulfilled before the
system is approved.

6.1.1 Proposed properties to be tested

- Volume: Handling chip transportation at full production capacity.
- Flexibility: Set different priorities and check the end result.
- Safety: Handling of safety sensors.
- Economically viable: Achieve the estimated and agreed operating costs.
- Sorting: Ability to organize a minimum of three different chip materials to
  specified recycling containers.