TAMPEREEN
AMMATTIKORKEAKOULU

Reduction of Lead Time in Screens and Feeders

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Bachelor thesis
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Degree Programme in Mechanical Engineering
Production engineering

TIIVISTELMÄ

Tampereen ammattikorkeakoulu
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MÄÄTTÄNEN, JANNE:
Screens & feeders lead time reduction
Opinnäytetyö 79 sivua, joista liitteitä 23 sivua
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Opinnäytetyön ideana oli todentaa Sandvik Mining and Constructionin, Hollolan toimipisteen toimitusajan tilanne. Hollolassa vastataan kaikista Sandvikilla valmistettavien syöttimien ja seulojen tilauksista. Opinnäytetyön ideana oli tutkia millainen toimitusajan tilanne on tällä hetkellä, mitä ongelmia siihen liittyy, missä on onnistuttu tähän asti ja mitä voidaan parantaa. Tutkittavien asioiden myötä pyrittiin luomaan mahdollisia korjauskeinoja toimitusajan parantamiseksi.

Opinnäytetyössä on käytetty Hollolan toimipisteen omaa tietokantaa tilanteen todentamiseksi. Opinnäytetyö ei kuitenkaan huomioi, kuinka paljon suunnitellut parannukset voisi lyhentää toimitusaikaa ja kuinka paljon parannukset maksaisivat yritykselle.

Syöttimien ja seulojen tilauksista tutkittiin neljää eri vaihetta: tilauksen käsittelyä, piirustuksien valmistusta, osien hankintaa ja laitteen valmistusta sekä kuljetuksen tilausta ja laitteen lähtöä. Jokaisesta vaiheesta tutkittiin ongelmakohtia, ja niihin pyrittiin löytämään mahdollisia ratkaisuja.

Suurimmaksi ongelmaksi muodostui laitteen valmistuksessa esiintyneet ongelmat. Laitteen valmistus on isoin osa prosessia ja se koostuu sekä laitteen valmistuksesta, että osien tilaamisesta. Osien tilaamiseen tulisikin kiinnittää paljon nykyistä enemmän huomiota, jotta toimitusaikaa pystyttäisiin pienentämään. Toisena ongelmana korostui joko liika kommunikointi tai liian vähäinen kommunikointi eri osastojen välillä tietyissä vaiheissa.

Jotta pystytään pyrkimään parempaan toimitusaikaan, tulisi siis keskittyä erittäin paljon laitteen osien tilaamisen järjestämiseen. Osat tilataan hyvin tilauskohtaisesti, joten suuria varastoja ei valmistuspaikoilla ole. Varastojen kokoa tulisi suurentaa, jotta valmistaminen pystyttäisiin aloittamaan tavallista nopeammin ja osien odotusaika saataisiin pienenemään.

Asiasanat: toimitusaika, toimitusajan kehittäminen, syötin, seula

ABSTRACT

Tampereen ammattikorkeakoulu
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Reduction of Lead Time in Screens and Feeders
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March 2016

The purpose of this thesis was to identify the current situation with lead times of screen and feeder orders at the Hollola office of Sandvik Mining and Construction. The Hollola office is responsible of all the orders of screens and feeders. The objective of thesis was to discover the current situation, to find out what problems there are, and to examine the order handling process and what effects these have on the lead time. Along these themes the overall goal was to consider how it is working in the company and where they could improve to get the lead time possibly shorter.

The Hollola office's database was used as primary source of information. The thesis doesn't take into account how much the improvements suggested here will improve the lead time and how much they would cost to the company.

Discovering the lead time of screens and feeders four phases of the process were researched: handling the order, making drawings, ordering the parts and manufacturing the machine, ordering the transport and departure of the machine.

Manufacturing the machine included the biggest problems for lead time. Manufacturing the machine is biggest part of the process and it consists of manufacturing the machine and part ordering. Assembly centers should pay more attention for part ordering for reducing the lead time. Another problem is either excess communication or slight amount of communication in certain phases.

Reducing the lead time requires a lot of focusing for part ordering. Parts are ordered for one order at the time, so there are not big storages. Sizes of storages should be improved, so that the manufacturing could be started earlier and the delivery time of parts could be reduced.

Key words: lead time, lead time reduction, screens, feeders

TABLE OF CONTENTS

ABBREVIATIONS

S&F	Screens and feeders
LF	Linear motion screen
MSO/SC/SK	Circular motion screen
SG	Grizzly screen
SS/SF	Free-fall screen
SR	Roller Screen
SH	Reciprocating plate feeder
SP	Pan feeder
SV	Grizzly feeder
AC	Assembly center
GPP	Global production plan
OF	Order form
PDC	Sandvik S&F's drawing center
ST	SalesTools
TC	Teamcentre
BOM	Bill of materials (Term used in Sandvik for unit's material list)
GA	General arrangement drawing

1 INTRODUCTION

The purpose of this thesis was to identify the current situation with lead times of screen and feeder orders at the Hollola office of Sandvik Mining and Construction. The thesis focuses on the problems what Hollola office's has with the screens and feeders orders. The thesis also contains results for what the situation is at the moment and how the situation should be improved.

First the thesis contains information about the company and the screens and feeders. Then the thesis has been divided for four sections which are the main keys for the lead time of screens and feeders. Each section tells how the things are done at the moment, what problems there are and how the problems could be fixed. In the end of the thesis there is summary which contains the big picture of the situation.

2 SANDVIK MINING AND CONSTRUCTION

2.1 General

“Sandvik is globally working metal and mining industry group. Sandvik has five different business areas Sandvik Mining, Sandvik Machining Solutions, Sandvik Materials Technology, Sandvik Construction and Sandvik Venture.

PICTURE 1. Logo of Sandvik (Sandvik, 2016)

Sandvik Mining and Sandvik Construction are two different business areas but mostly talked as one company; Sandvik Mining and Construction. It produces material handling and mining units and services for them. Sandvik Mining and Construction offers the world’s widest range of equipment for rock drilling, rock excavation, processing, demolition and bulk-materials handling”. (Sandvik Mining and Construction 2016, Sandvik Mining 2016, Sandvik Construction 2016)

Key facts about the Sandvik Group*

Sales	89 billion SEK (approx.)
Number of employees	47,000 (approx.)
Chairman of the Board	Johan Molin
President and CEO	Mats Backman (acting)
Investments in R&D	3 billion SEK (approx.)
Number of active patents	8,000 (approx.)
Head Quarters	Stockholm, Sweden
Founded year	1862

*Figures are for 2014

PICTURE 2. Sandvik in numbers, figures of 2014 (Sandvik 2014, about us)

"Sandvik Mining and Construction has product factories in Finland in five different cities. Besides this they also have a sales company, which is responsible of Sandvik product's sell and maintenance in Finland". (Sandvik Mining and Construction Finland 2016)[1]

The business areas in figures 2014

	Sales	Earnings		Employees
	MSEK	MSEK	% of invoic.	
Sandvik Mining	26 831	2 398	9	11 815
Sandvik Machining Solutions	30 856	6 159	20	18 972
Sandvik Materials Technology	14 907	1 880	13	6 914
Sandvik Construction	8 553	45	0.5	2 815
Sandvik Venture	7 658	888	12	4 074
Group activities	16	-1 250	–	2 728
Group total	88 821	10 120	11.4	47 318

Invoiced sales by market area 2014

Market area	Sales, MSEK	Share, %
Europe	33 554	38
NAFTA	17 310	19
South America	7 038	8
Africa, Middle East	8 020	9
Asia	17 101	19
Australia	5 798	7
Group total	88 821	100

PICTURE 3. Sandvik's business areas and invoiced sales 2015 (Sandvik 2015, about us, key figures)

Sandvik Mining and Construction's products are breakers and demolition tools, crushers, screens and feeders, rock tools, surface drill rigs, tunneling equipment bulk materials handling equipment, exploration drill rigs, mechanical cutting equipment, mine automation system, underground drill rigs and underground loaders and hauling equipment. The products needed depends on customer's needs, planned purpose of use and material.

[1]"Sandvik Mining and Constructionilla on Suomessa tuotetehtaita viidellä eri paikkakunnalla ja lisäksi myyntiyhtiö, jonka vastuulla on Sandvikin tuotteiden myynti ja huolto Suomessa". (Sandvik Mining and Construction Finland 2016)

2.2 Sandvik Mining and Construction Finland Oy

In Finland the company works as Sandvik Mining and Construction Oy. The company owns Sandvik Mining and Construction Finland Oy which is responsible of selling and maintenance the products in Finland.

As told above Sandvik Mining and Construction has factories in Finland in the following five different cities:

- Tampere: Produces opencast mining units, tunnel-boring machines, underground drilling, production hole drilling units and bolting machines.
- Turku: Produces transport units and shovel loaders.
- Lahti: Produces hydraulic percussion hammers and cutting crushers
- Hollola: Designs worldwide projects for handling the bulk cargo and they are responsible of all the screen and feeder orders world-wide which is produced in different factories.
- Vantaa: Wide selection of tools and equipment for material handling and mining units.

(Sandvik Mining and Construction Finland 2016)

The thesis concentrates on Hollola office's work with screens and feeders.

3 SCREENS AND FEEDERS

Sandvik Mining and Construction Finland Oy, Hollola product manufacturing plant is responsible of all the screen and feeder orders world-wide which are produced in different factories. These units are essential for crushing operations. Below are explained the basic data of some of these units. More detailed info of the units are in appendix 1.

3.1 Screens

“Screens are used for scalping and classifying minerals and coal. Sandviks’ has a wide range of sizes and in several types – both individual units and complete systems”. (Sandvik Mining 2016, products, screens and feeders)

For more detailed info see appendix 1.

3.2 Feeders

“Sandvik offers wide range of feeders for crushers and other applications include robust, impact-resistant grizzly feeders, reciprocating plate feeders, and pan, belt and apron feeders to swiftly and economically transfer material.” (Sandvik Mining 2016, products, screens and feeders)

For more detailed info see appendix 1.

3.3 Screening media

“Screening media is used in screens of Sandviks’. Its idea is to make smaller the size of the material. Sandvik offer high-quality screening media for all your process material, feed sizes and separations. Available in tensioned, pre-tensioned, modular and self-supporting designs and a range of thicknesses, aperture shapes, sizes and patterns - which can be tailored to your need”. (Sandvik Mining 2016, products, screening media)

For more detailed info see appendix 1.

4 IMPROVING THE LEAD TIME OF S&F

4.1 Basis

The purpose of this thesis was to identify the current situation with lead times of screen and feeder orders at the Hollola office of Sandvik Mining and Construction. Sandvik has many manufacturing places for their screens and feeders (S&F) but I used Slovakia's subcontractor company Remeslo as an example. Talking about refers to screens and feeders, of which the orders are handled in Hollola. Ordering of S&F works the same way despite of manufacturing place but, however, the manufacturing methods varies. Nonetheless the actions for manufacturing are almost the same kind, so researching of one manufacturing place gives a lot of details about how things works generally at S&F manufacturing places. The objective of thesis was to identify the current situation, research phases of lead time and what effects these have on the lead time. Along these themes the overall goal was to consider how it is working in the company and where they could improve to get the lead time possibly shorter.

The thesis was limited by using only lead time phase where Hollola office is somehow partial. Therefore selling the machines doesn't belong to Hollola office and are not included in the thesis. The selling belongs for Sandviks' sales people whom are mentioned in this thesis and working with them is taken part for the thesis also.

The lead time consists of next phases:

1. Handling the order. In thesis there is taken into account only a phase when order appears to Hollola office's database SalesTools
2. Making drawings in PDC; either creating the drawing or billow of materials (BOM). PDC is a center where the drawings designing are taken place.
3. Ordering the parts and manufacturing the S&F in assembly center (AC)
4. Ordering the transport and departure of the machine

In Sandvik Hollola there are handled three different types of orders depending of cutomer's need:

1. Project deliveries. They consist of several of machines and different kind of product families. Their lead time could be as long as six months. In Hollola office about 10% of the orders are like this.
2. Standard deliveries where customer's need is 1-2 machines. Lead time for this is 8-16 weeks. About 80% of orders are like this.
3. Emergency deliveries. This means that already an existing machine has broken down, for example on a fire and customer needs immediately a new one. Lead time is instant, meaning as soon as possible. 10% of the orders are like this.

Percentages are from Hollola and based on how they assess their orders are like. Based on a database got from Hollola I calculated the real customer need for table 1.

TABLE 1. Customer need

Customer need (sampling 1834pcs)			
Type of order	**Amount (pcs)**	**Lead time (d)**	**Amount (%)**
Emergency delivery	527	0-45	29
Standard delivery	1017	46-120	55
Project delivery	255	120-	14
Doesn't count	35		2

Delays of the orders effects a lot to the results but in reality the amount of emergency delivery orders is higher than imagined. 2 % of orders weren't been able to take into account because of the missing details.

Considering the Hollola office's earlier results it takes on average 13 weeks for delivering the machine, which is one week less than the officially promised delivery time of 14 weeks by Sandvik.

From the table 2 we can observe that delivering the standard machine it takes average of 13 weeks which Hollola's office has counted. On the other hand delivering of customer specifics takes as long as 21 weeks.

Customer need affects much of the processes total time. For example some project deliveries production takes more time than normally or beginning the production might be started later on.

TABLE 2. Total time of process

d=days	Total time of process		
	All the machines (d)	**Standard machines (d)**	**Customer specific (d)**
Average	95	95	146
Standard deviation	57	58	80

4.2 Research methods

When verifying the lead time's current situation I sent multiple e-mails to the people who are in charge of the different phases of lead time. At first I interviewed them on how things are done in the company, who are responsible for the different phases, who they are working with, what problems there are in the phases and what are the reasons for the delays. This is how I got the starting points for my thesis and some thoughts of the procedures of lead time's phases.

Hollola collects the information of the orders and manufactured S&F for their own database GPP-data (Global Production Plan) which is made to a base of Microsoft Access. I got this data for my use and I used every order they have got during years from 2012 to the early 2015 for my thesis. This data included every screen and feeder that was ordered via Hollola and a mark on every date when some phase of making the order is made. There were a total of 1834 orders during the studied period and this number is used as a sampling in my thesis.

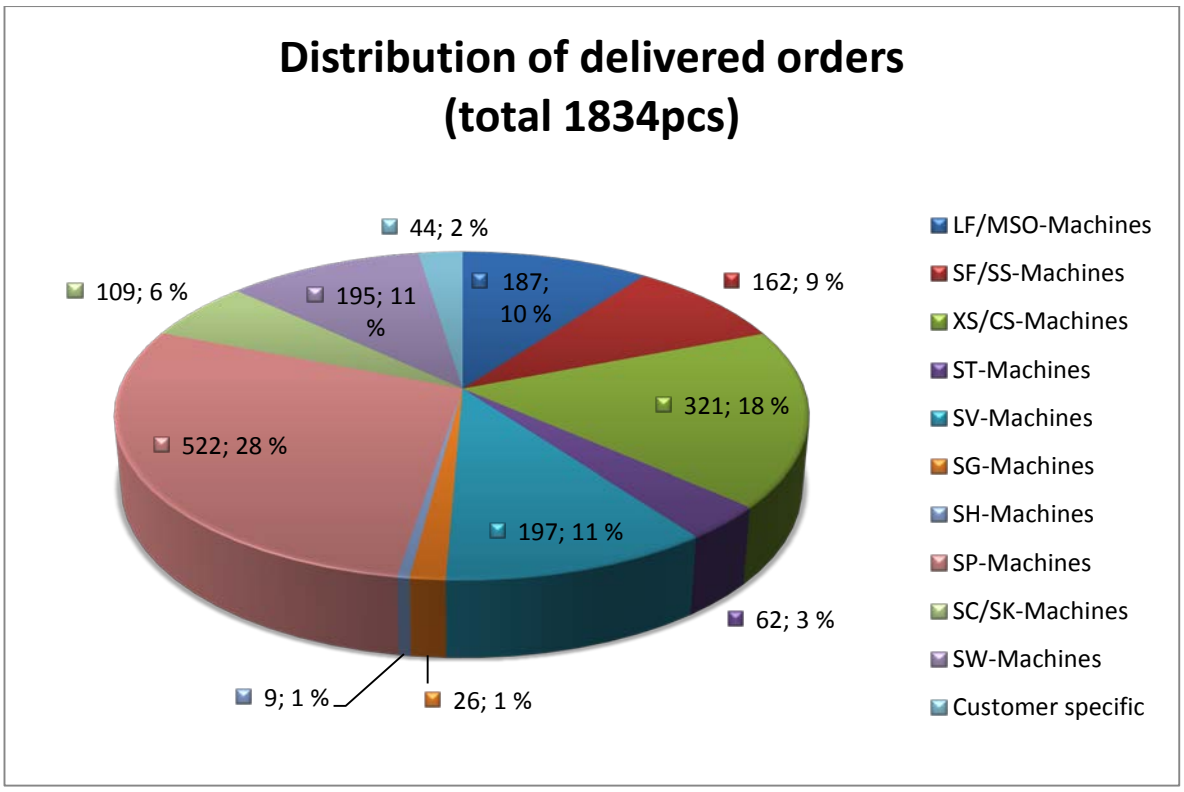


FIGURE 1. Distribution of delivered orders by product families

From the figure above we can see how the ordered S&F have split up to different product families by percentages. SP-feeders are the most ordered product family. SP-feeders have been ordered 522 times from whole sampling which makes it 28 %. This is the most manufactured product family in Sandvik when focusing on screens and feeders production.

GPP database includes following dates (see appendix 2):

1. Order form's appearance date to SalesTools.
2. Order form's completing date
3. Order form's sending date to PDC
4. Order form's sending date to assembly center (AC)
5. Date when drawings are done in PDC and sent to AC
6. Machine is ready in AC waiting for delivery
7. Pick-up date of the machine

With these dates I was able to count data by using the knowledge of how long it takes to complete each phase and examine phases of lead time more closely as well as finding possible faults. With these results I made conclusions:

- Average or arithmetic means, describes central tendency of the sum of numbers
- Standard deviation which describes variability of a population or dispersion of data. Close to 0 indicates that the data tend to be close to expected value and high standard deviation indicates that data are spread out over a wider range

After analyzing the data I consulted people who are responsible of the phase by e-mail and got some facts why something has been done like that. Then I was able to make some possible solutions for problems and create solutions to improve the lead time. This is how I was able to create a clear picture of different factors that affect the Hollola office's lead time. For correcting the results I removed either negative values or oversized positive values over 250 days' numerical values. The oversized values are results from bigger delays, for example if the customer is not sure of machine's destination, delivery date has been changed or some other inhumane reasons. In this situation it is important to notice customer's needs. Depending on the customer's needs some S&F need longer lead time and in some situations it is not useful to start machine's production too early.

5 ORDER SERVICE OPERATIONS

5.1 Handling the order

Handling the order in Sandvik Hollola happens by SalesTools program. A sales person makes the order with the customer and checks that everything according to appendix 3 can be found from the order. After this new orders can be seen in SalesTools "new orders" tab where it is also possible to modify them. The handler of the order checks business and technical sections of the order and its transfer price. Unclear information will be clarified.

After this the assembly center is chosen. There are four AC's at the moment; Pune, India; Jiading, China; Hollola, Finland and Remeslo, which is located in Slovakia. GPP-data includes also other assembly centers because the number of ACs has been reduced during the years. However also these ACs has been taken into account. All of the ACs have been described below. All of the information is attached to GPP-data which includes information about manufacturing S&F model, dates, assembly center and destination. Serial number is given for every order which is based on assembly center, for example 1188E14136 means that the S&F is manufactured in Slovakia.

- 1188 = Production unit
- Letter = Assembly center
  - B=Ballygawley, Northern Ireland
  - C=Chauny, France
  - P=Pune, India
  - J=Jiading, China
  - V=Vespasiano, Brazil
  - H=Hollola, Finland
  - E=Remeslo, Slovakia
- 14 = Year
- 136 = Running number

Order is handled again in SalesTools and it is checked that order includes all the necessary information so that it can be sent forward to PDC. PDC is responsible for the machine's

drawings. In addition the order is also sent to the sales unit, finance unit and assembly center. Then the order is given a “Received” status.

The manufacturing factory of the order is often determined by certain market area. In other words every assembly center has its own market area. Market areas are created to make it easier for delivering the machine. In this way the transport is made as easy as possible and the costs can be minimized. Also certain product families are assembled in certain factory.

The assembly center confirms the lead time when they have planned a manufacturing schedule. Information about this is put down to GPP-data. Since spring 2015 PDC has taken care of attaching general arrangement drawing to SalesTools. This has removed one useless middleman and excess e-mailing from the process.

Basis is that the order should be ready for PDC for drawing within two days after receiving the order. Lead time starts running when customer has made the order. By basic understanding the customer’s order is accepted and it takes a week from that before the order is in SalesTools.

5.2 Results

5.2.1 Order form ready from PDC

With GPP-data I started to clarify how long does it take to get the order form (OF) to PDC after receiving it. The result has got from the difference between drawing request date and order form received date (see appendix 2). With the results I counted either all of the machine’s average or also standard- and customer specific S&F’s average.

TABLE 3. Order form ready for PDC

d=days	Order form ready for PDC

	All the machines (d)	**Standard machines (d)**	**Customer specific (d)**
Average	2	2	1
Standard deviation	5	5	3
Maximum	68	68	15

Above results describes that how fast the orders are ready for PDC from the date when the OF is shown up to SalesTools. The order doesn't have to be fully completed, but it will be sent to PDC so that they can make the drawings when the all the necessary information is known. Missing information might be for example the delivery destination, terms of delivery, possible unclear media information or so on. Due to these changes, the order might be modified at this point. Some of the standard S&F drawings are done already because they have manufactured them earlier. In these cases general arrangement drawings are ready instantly and they are updated to the order form SalesTools.

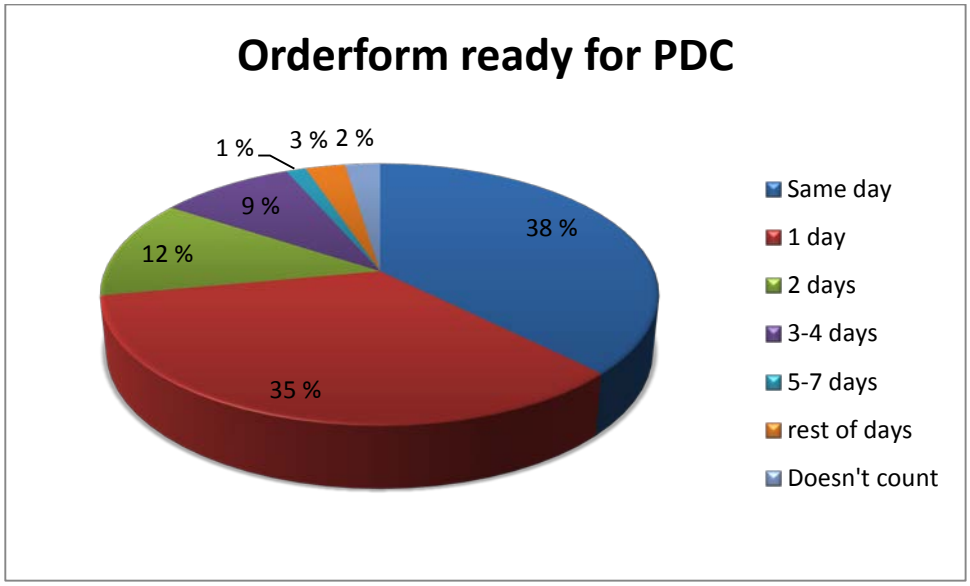


FIGURE 2. How fast the order form is ready for PDC

Based on the table 3 and figure 2 we can see that order is sent to PDC in less than two days. This is pretty good result because the goal is to get it for drawing in two days. As much as 38 % of the orders are sent to PDC during the same day. We can also notice that 73 % of the orders are sent to PDC during the same or the next day.

2 % of the data's results weren't able to take into account because of the missing dates. Also the results don't take the weekends into consideration, so in some situations sending the order to PDC might be delayed because of the weekends.

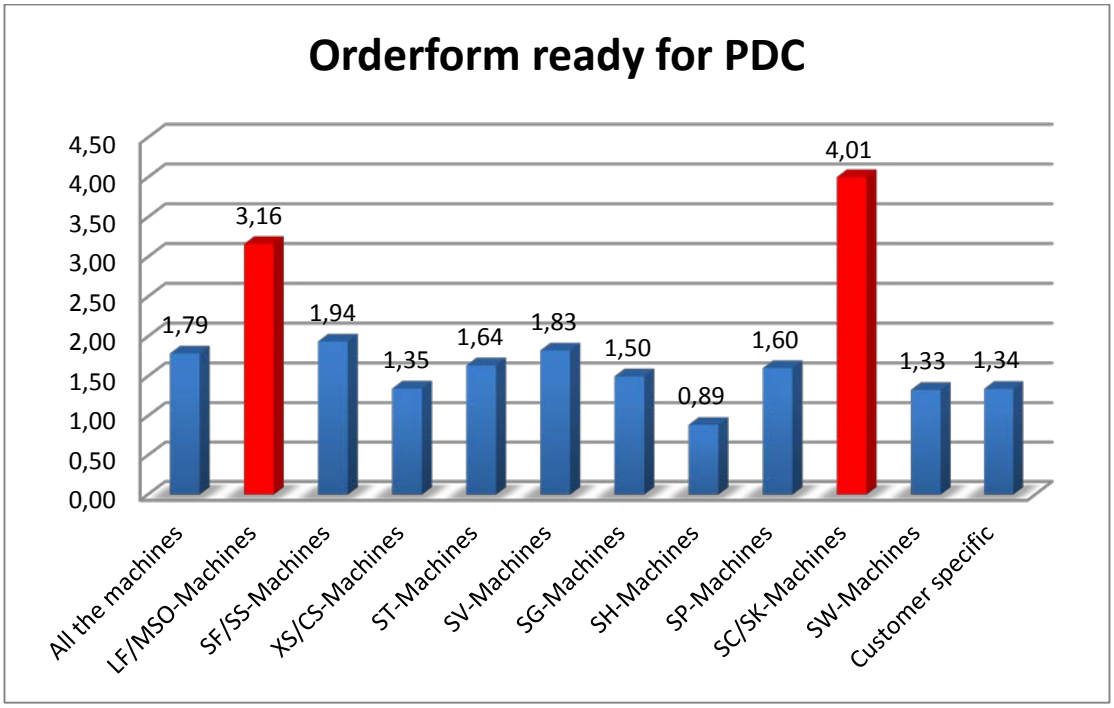


FIGURE 3. Order form ready for PDC in product families

Figure 3 describes which product family causes the biggest delays on how quick the orders are sent to PDC. Numbers above the bars describes the average time when certain product family S&F orders are sent to PDC. Amount of manufactured machines can be found from figure 1. Based on above figure we can see that the biggest delays are caused by LF/MSO- and SC-machines. This is because SC/SK-machines are rather new product family, put on market in 2009, thus there are many adjustments made for it. Sales persons might have some uncertainty for making the orders because of that. LF/MSO-machines high numbers result from when MSO-machines had a big project which Sandvik started already to plan but did not finish in the end.

I also compared if there are any differences between the buyer countries in getting the order ready for PDC. This can be seen from figure 4. I used few of the larger buyer countries as an example so that the example countries are from different parts of world. I examined the results by using all the S&F.

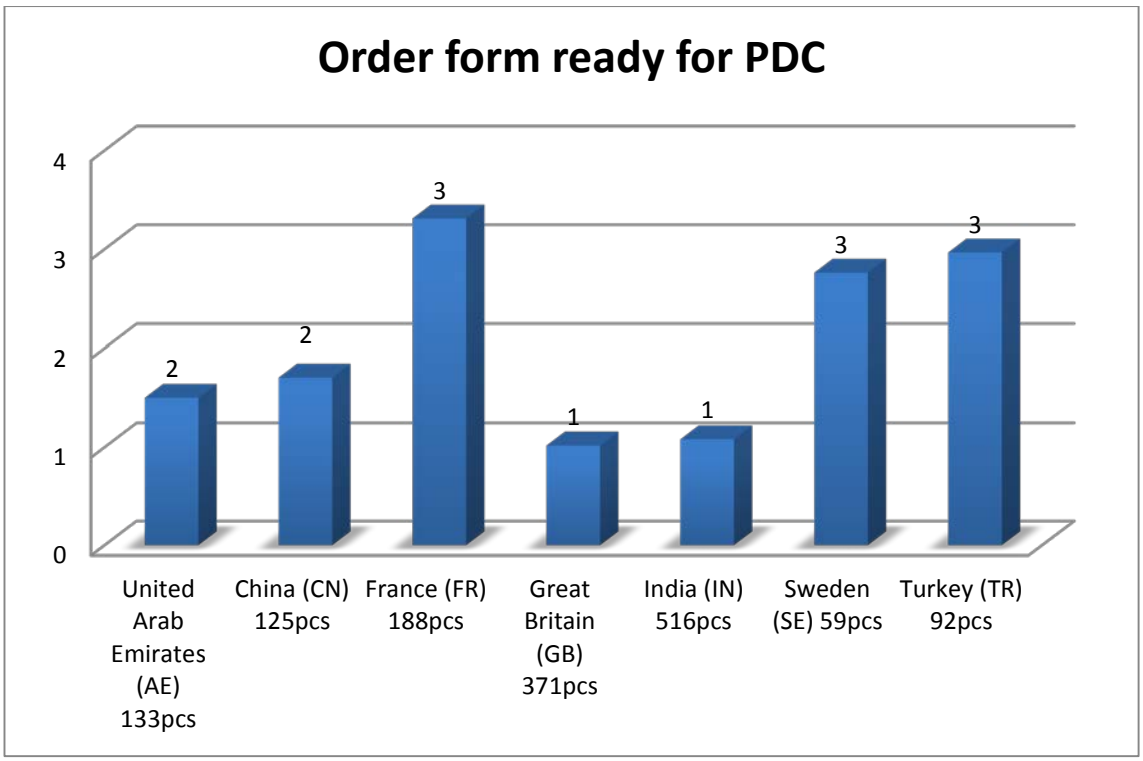


FIGURE 4. Order form ready for PDC by buyer countries

Based on the figure 4 we can see that there are not big differences between the buyer countries. The results of European countries are a little bit higher when compared to other countries.

5.2.2 Quickness of completing the order form

I also researched the speed of completing the order form. In assessing this I counted the difference between the order forms complete and order form received dates. This result describes how long it takes to get the order form complete when Hollola gets the order form.

TABLE 4. Order form complete

d=days	Order form complete		
	All the machines (d)	**Standard machines (d)**	**Customer specific (d)**
Average	3	2	13
Standard deviation	9	8	27
Maximum	136	112	136

Indicator of order form complete measures the speed of handling the order and quality of the order so it is an important measure. This has a very important meaning for the next phases. That is because already completed order is easier to handle either in PDC or in AC when they already know that there will not be any changes. There is a big difference in average times between the standard S&F and the customer specifics, because there are a lot more changes and option changes for customer specifics than standard S&F after an order has come to the SalesTools.

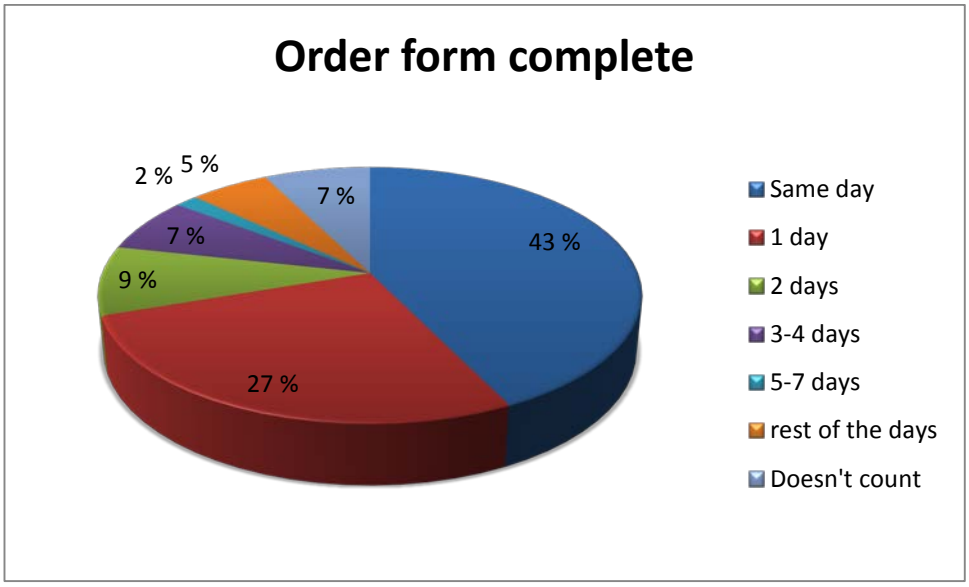


FIGURE 5. Order form complete

From figure 5 we can see that:

- 43% of the orders are ready during the same day
- 70 % of the orders are ready during the same or next day
- 23 % of the orders take 2 or more days to complete which is mostly because of the customer specific orders that slows the order handling because those orders get changed often after receiving the order.
- 7 % of the results wasn't been able to take into consideration because of the missing dates
- Figure doesn't take into account of weekends. Weekends might cause delays of completing order form.

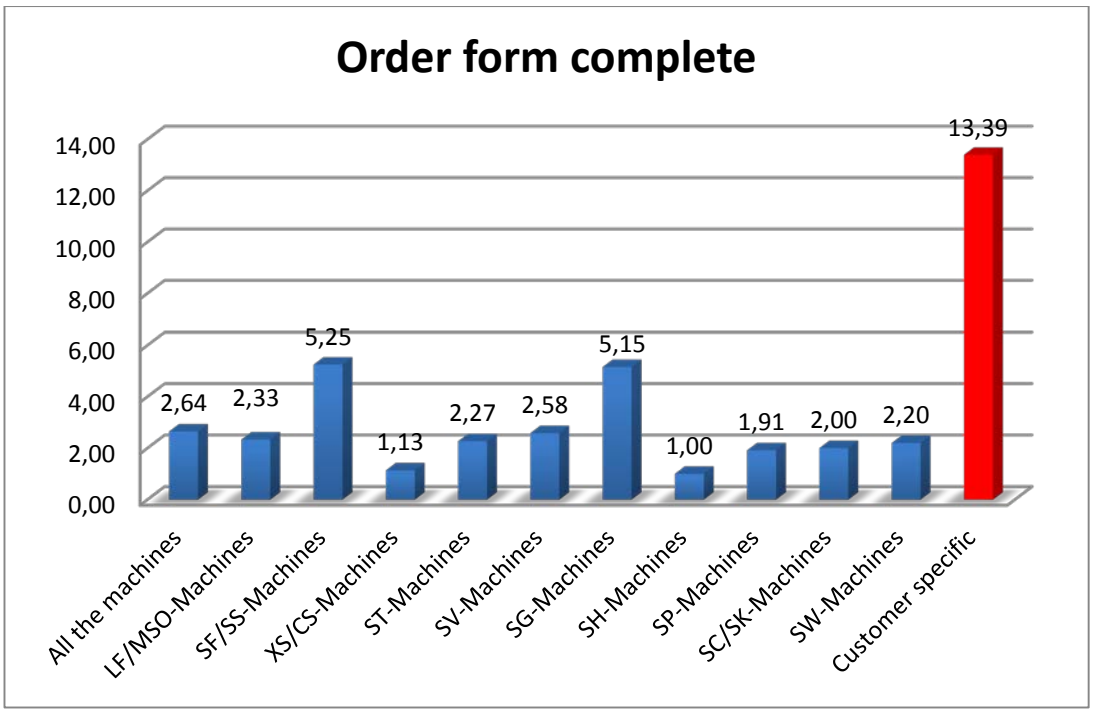


FIGURE 6. Order form complete in product families

Figure 6 describes which product family causes the main delays of completing the order. From this figure it can easily be seen that there are many problems in the customer specific order forms. Numbers above the bars describe the average of how long it takes to complete the order in certain product families. Amount of the produced machines can be seen from figure 1.

I also compared if there are any differences in the quality of the order between the order countries. I decided to use the same example order countries than in the section “5.2.1 order form ready for PDC” so that the countries are from the different regions of the world. I studied the results for taking into consideration of all machines.

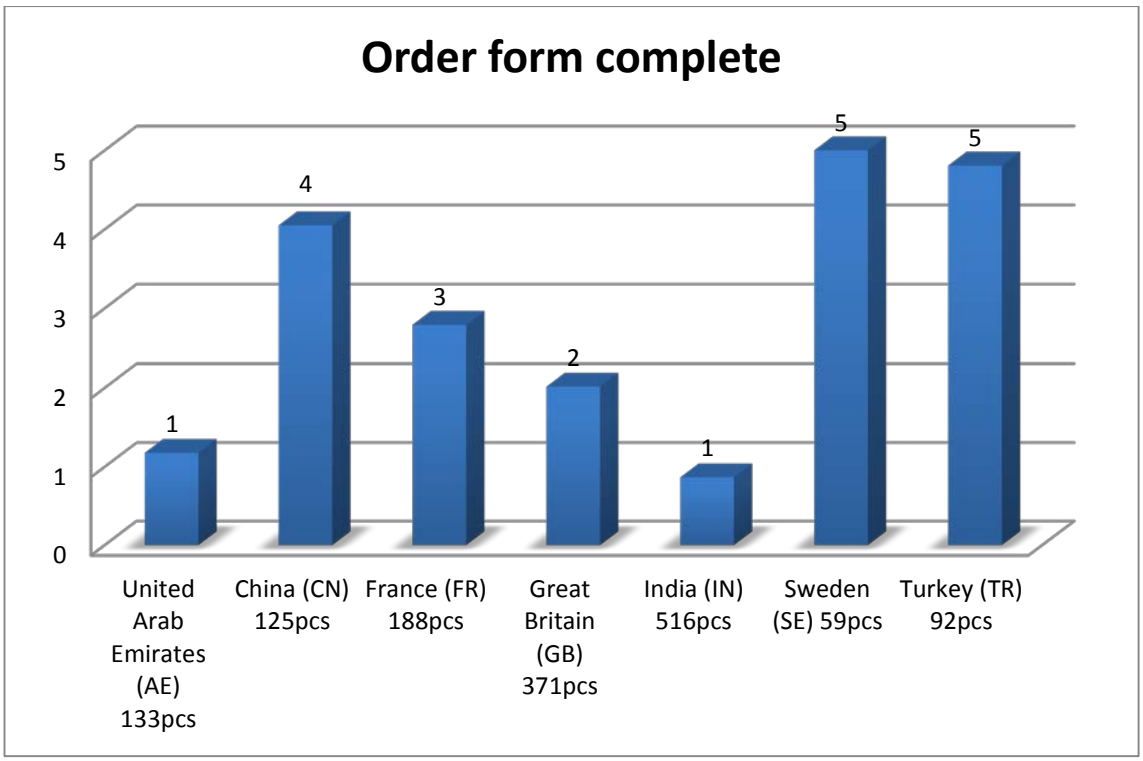


FIGURE 7. Order form complete in buyer countries

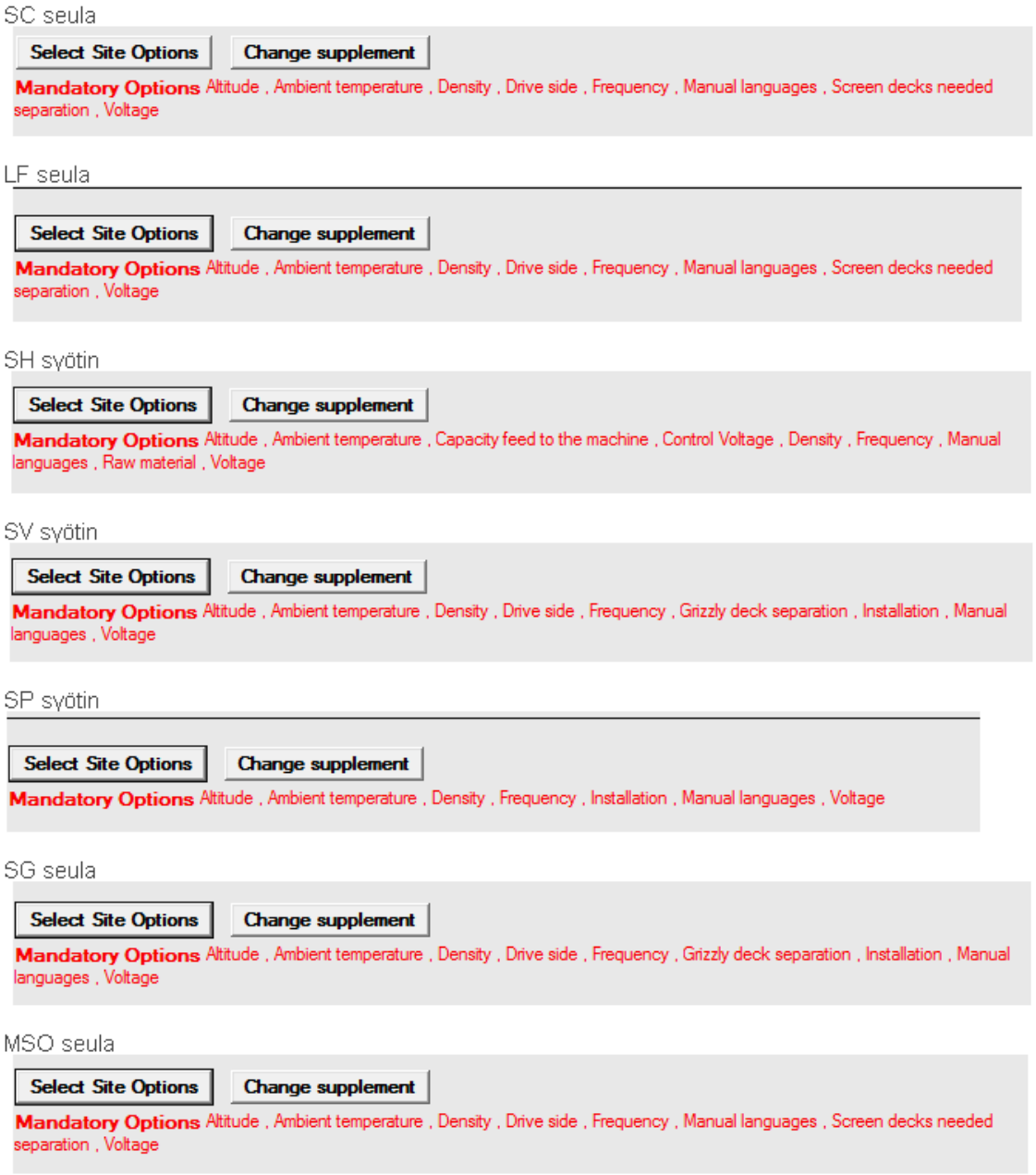
There are big differences in quality of the order especially between Europe and the eastern partners. It takes as much as five days to complete the order in Sweden and Turkey. Instead in United Arab Emirates and India it only takes by average of a day.

5.3 Problems

The indicators above have a big influence for other lead time phases. The delays in the first phase result consequently to the second phase, which suffers from that and after that other phases suffer even more.

One of the biggest problems seem to be that PDC has to work drawings on average of one day without the order been fully completed. On customer specifics this seems to take even 12 days. Of course there might be some information which is not necessary for the drawings for PDC but in some cases the waiting time becomes longer when some information is missing and PDC needs it for the drawings.

At the moment there has to be some basic spec information for each S&F in order form so that it will be available for Hollola in SalesTools. You can see the mandatory specs from picture 4.



PICTURE 4. Mandatory options for product families in SalesTools. (Koskinen T, Sandvik, E-mail conversation 28.7.2015)

However the order is received surprisingly incomplete and this is occurred because of the lack of co-operation between the sales person and customer. Sales people's knowledge of the S&F is limited and further information is asked from Hollola. This may cause delays for completing the order. Customer specifics don't have any mandatory options so the order form is blank and this is the reason why the customer specific order form lacks a lot of information.

Missing information which causes big delays are:

- Specs of motors
- Missing ambient temperature
- delivery terms
- Specs of medias
- Density of material
- Capacity feed to the machine
- Motor size
- Price

In customer specific orders missing information will be emphasized even more because sales persons have to ask all of the missing information from Hollola which has to inform it back to the sales persons who informs it forward to the customer. Missing information can cause a lot of surprising changes afterwards. Comparing the both tables' 3 and 4 customer specific sections' average we can see that order is forwarded to PDC as quickly as possible but however from table 4 we can notice that order is forwarded to PDC as defective so there is lot of missing information. This happens when the order is pursued to PDC as quickly as possible because customer specifics need a lot more designing than the standard S&F.

Customer specific's biggest cause of delay is the radical and sudden changes on order form which causes unnecessary additional work. Changes on order form which causes sudden delays are:

- Drive side
- Specs of media
- Specs of motors

Controlling of these changes requires a lot of time and many e-mail sequences because the information has to be clarified from the customer. This might cause easily over one day delays.

Quality of the order for PDC has to be improved, but the fact that the SalesTools program is not that easy to upgrade has formed into the bigger problem.

We can easily think how much time we save from the day if the order would arrive more completed: unnecessary e-mails could get reduced and specifying information won't need to be gathered and asked. Order would get forward faster. We can imagine that during a day even two unnecessary e-mail less would save about 15 minutes of the day. This means that during one year, which is about 250 workdays, we could save as much as 62,5 hours.

5.4 Conclusions

Controlling the order is at good point and Hollola's office is making everything they can do for the handling the order at the moment. However small things are emphasized even more when things are examined more carefully. As a result we can conclude that SalesTools accepts the order form way too incomplete at the moment. If mandatory options of SalesTools' order form would be increased so that the SalesTools will block the sending the order forward if some needed facts are missing this would decrease the amount of incomplete orders. This would save a lot of time and would demand that customer and the sales people agree for making the order. Result from this would be that surprising and sudden changes for the order would be decreased and an order is easier to send ahead for PDC for drawing. But as mentioned above, SalesTools is not that easy to upgrade.

It would be a good idea to add raw material option as necessary option for SalesTool's mandatory options menu so it would be easy to see what kind of media spec would be most useful for the machine when we know what kind of raw material will be crushed with it.

From this we come into the fact that the unnecessary communication between different units should be reduced remarkably somehow. At this moment it takes a lot of time because sales persons, Hollola's office, customer and PDC don't communicate with each other so the information has to move between multiple units. For example if some information is missing Hollola's office asks it from the sales person that needs to ask it from the customer so there is one useless middleman in the communication.

Conclusion:

- The sales people need to have better and more accurate knowing of the S&F
- More accurate information about specs of media is needed
- On some sale areas there might have been their own order service group as additional for the salespersons which makes the orders

On these sale areas where sales persons have their own order service group the communication between different units should be improved. This, as well as the sales people's knowledge, is easy to improve by educating the sales people. There should be organized educations concerning the S&F so that their knowledge of it would improve.

- Order should be more encompassing when it arrives to SalesTools.
- Order should be distinct when arriving to SalesTools →Bigger changes and unnecessary e-mailing would be reduced.
- When a new S&F is designed, the training for it would be organized also for the sales personnel.

In the training, the following things should be presented: new machine; important parts of it for salespersons and procedure of the machine. Sales personnel should then further ask questions if something seems unclear.

After this the knowledge would be easy to maintain with the video meetings with Hollola office if any changes would appear or salespersons have any questions.

6 PDC OPERATIONS

6.1 Present situation

PDC is Sandvik's unit which is responsible of the drawings and bill of materials (BOM). The PDC is an office, where they design all the general arrangement drawings and specific drawings of the screens and feeders. PDC uses software packages like Solidworks and in some cases Autocad for the designing. The files are then managed within Teamcentre (TC) where revision control/engineering change process/BOM structures are handled. There is an effort that all the drawings would be in TC in some day and every unit gets them from there.

Making the drawings begins when PDC receives order form (OF) from Hollola's office. It is forwarded to the suitable engineer. Currently there are six engineers split by product families (see appendix 4). At this point they will review the OF for accuracy and complete info - for more customized orders like in many cases nonstandard media type needs some clarification with sales on solution. If available, general arrangement (GA) drawing is added to the order form to enable sales to retrieve it if needed by the customer. In most cases basic machine's GA is already done because they have sold same type of machines earlier. If the machine is customized engineer will report how much time he needs for customizing the drawings.

After this the drawing's start date and expected drawing complete date will be added to the GPP-database against the serial number and the engineer's name will be added in also. This is given to assembly center so they can already start to plan their manufacturing. Drawing complete date depends on a multitude of factors. Engineer capacity, unit lead time, clarity of order info etc. have an effect on the completing date. The specified engineer commences processing the order on the drawing start date.

If there is in question a basic machine order the engineer will configure the bill of materials to match the order specification so the engineer has to take into consideration every additional options. An example of BOM is in appendix 5. The BOM is then released to the AC. If the machine is being done for the first time in AC then drawings are also sent.

The plan is to move away from sending drawings & BOM's by email to Sandvik sites, instead they are trying to go for that only serial number is given to the AC and they create the BOM using function in TC and extract the drawings.

If the order in question is a customized one, the engineer will begin the design using Solidworks in most cases. Part and assembly manufacturing drawings will then be created. Files will be added to TC with all correct parameters example dimensions, material grade, material weight, etc. Then BOM Structure and bolt kit will be created and added to TC. The needed info is then released to the applicable AC.

After the drawings are finished the complete date will be added to the GPP-database. Installation, operation and spare parts manuals will be sent to the AC three weeks in before the estimated date. Spare part catalogues will be created for customized units once the designs have been completed. Once the unit is being processed at AC side the PDC will support with technical enquiries - amount of support usually increases if the machine is more customized. PDC also supports the AC with the final testing of some units.

These are the main steps of PDC. There are also many sub steps within the engineering process part of above but this will be captured better by looking on the appendix 6.

6.2 Results

6.2.1 Completing of drawings

One of the most important measures of PDC’s is how fast the drawings are completed. Table 5 below describes how long it takes to make the drawings until they are completed from the date when order form comes to PDC. For researching this I counted the difference between drawing completed and drawing request date (see appendix 2). For observing the results only positive values are used so I can examine only new orders that require drawings.

TABLE 5. Drawings completed

d=days	Drawings completed		
	All the machines (d)	**Standard machines (d)**	**Customer specific (d)**
Average	7	7	19
Standard deviation	13	13	13
Maximum	0	0	0

India's and France's internal orders have been deleted from the results as PDC does not make drawings for them. They have an own internal engineer whom is responsible for the drawings of the S&F. This is the reason why sampling is only 1295 orders.

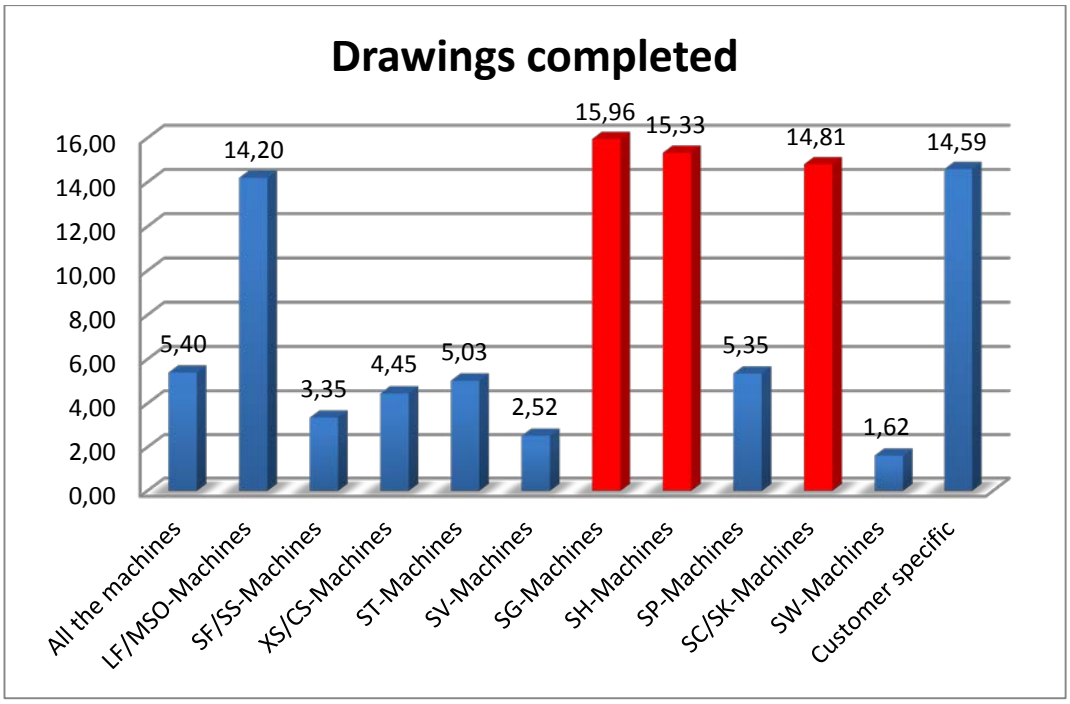


FIGURE 8. Drawings completed in product families

Figure 8 above describes which product family's drawings completing takes the most time. From this chart it is possible to conclude that SG-, SH- and SC/SK-products take the most time to complete the drawings, average of 15-16 days. SG- and SH-products big values are explained with their small sampling (see figure 1). SG-products have been ordered only 26 pieces and SH-products only nine pieces. SC-product family is a quite new product family and they still make continual changes for it so the drawings are not yet that constant. It also takes a lot of time to complete the drawings of LF/MSO-machine's orders.

This is explained by the fact that the big project which was started and planned went down after all. This happened because the customer insisted more specific material for the machine, which was not possible to fulfil.

6.3 Problems

PDC's work is going very well at the moment. Delays are caused by the missing information on OF and in this phase it is highlighted even more. The reason for that is that in this phase PDC has to ask the information from Hollola office and they have to ask from salesperson whom then needs to ask it from the customer. The long inquiry chains from person to person cause long delays. Hollola office also organizes some irregular meetings with PDC that helps with the functionality of work.

The most problems for drawings are caused by media specs and motors final information. Especially the customer specific orders are missing essential and important information concerning media and motors ambient temperature.

Should getting motor information be the first priority for PDC so that they can state it good and send the information ahead to AC?

6.4 Conclusions

According to Remeslo they are very satisfied for PDC's operation. Drawings come in time on agreed dates. Small mistakes occasionally happen, but those are handled well and efficiently with PDC. The repair ways should come from previous phases (See section 5.4.). PDC's actions work well and drawings arrive on time. The reason behind delays is mostly changes and missing information in the order form, except for the random happenings. Therefore PDC's making of the drawings is at good state and they work on time according to the lead time. If the lead time would shorten, other organization parts should aim to the point where PDC gets the order at correct form. This way PDC could make the drawings instantly like they should be.

SC-screen's model standardizing should be the first priority. This product family has caused lots of delays during the first and second phase so getting the SC-screens for the final shape would help to improve the lead time.

PDC has also tried to improve their methods all the time. Good example of this is that they have increased the using of TC where PDC attach their drawings. They should also add some kind of permissions for users so that the salespersons could use already finished drawings as an example for customers and use those for creating the order. This way salespersons could create new orders easily and plan to make the order in a right shape with the customer. Like this PDC wouldn't get incomplete orders and could make the right drawings for the order instantly.

PDC could release motor information for AC right away when they know it so that AC could order the motor in advance and the machine wouldn't stand idle in the factory when waiting for this. This would be extremely essential especially when the machine needs a specified motor.

After the discussions with the different people it looks like that the weakest thing in actions of PDC is creating the bolt kit. Bolt kit contains every fastening accessories used on the machine. It is made manually in PDC and that's why there have been some faults. This isn't that big problem in short sight but when this happens with the several orders it causes long delays in further sight. PDC should focus on this in the future so that right fastenings could be found from bolt kit. There should be logically every fastening accessory in the system categorized by its name, size or number. This way it would be easy to find the right fastening for the right machine.

For example:

Screw DIN 7982, model (stainless steel, zinc coated) 4.2x16 – number in system
Screw DIN 7982, model (stainless steel, zinc coated) 5.2x19 - number in system
etc.

If this information was in different columns in excel or enterprise resource planning system for example it would be easy to find the right fastening by searching and adding it to the bolt kit file. There have been also discussions that every AC should start to be responsible of making the bolt kit when assembling the machine, this would help that PDC could make right away correct spare parts manuals.

PDC works well with Hollola office but improvements should be made with the ACs. According to Remeslo the communication between PDC and AC has improved so far only recently. The reason for this might be that Remeslo is a fairly new manufacturing place for Sandvik but it still shows that communication should get better. At least focusing and improving the communication shows that the direction for improving is right.

7 MANUFACTURING OPERATIONS

7.1 Present situation

For discovering the S&F's manufacturing I used Sandviks' subcontractor company Remeslo which manufactures the machines in Slovakia.

When an order form comes to Hollola office Remeslo gets the information of a new order. They can then start to reserve resources for manufacturing the machine. Sandvik has reserved Remeslo's capacity for one week so that the Remeslo has to be able to manufacture two vibrating motor units (example SP, SW, SF), and two mechanism axis units (example LF, SS, SV, SG). After this they wait for drawings and BOM from PDC. After getting the drawings they will create a new order for their inner system and after that the info is sent forward to part ordering, factory and other necessary parts of organization.

A new timetable will be created for each manufactured machine so the AC can work along a schedule. This is how they know when the machine should leave the factory and that fulfilment will be followed. The Hollola office will be consulted for possible delays and unexpected circumstances.

Part ordering in Remeslo happens as following: Remeslo has two people who are responsible for the part ordering. One takes care of feeder's part and the other the screen's part ordering. Their actions are based on BOM-file which is got from PDC. That BOM-file includes every part that the manufactured machine needs. Most of the S&F's parts are ordered from different subcontractors. Because of this the parts have been separated for different categories. Categories have been listed for two classes "short term -parts" and "long term -parts" depending on how long is the dispatch time. (Josef Ziac, E-mail conversation, 16.6.2015)

If the order is a standard order the delivery time is about six weeks and then "long term" -parts should be ordered within two days. But this also depends on if the parts are available so it can easily reach to a week. Some "Long term" parts might take even six week to deliver but that depends a lot of the order.

Some specific orders dispatching might get even longer. Usually dispatching time of the parts is five weeks. There is an example in appendix 7 where all the needed parts which Remeslo needs to order for some machines except steel plates are listed. After that they will mark with colors which parts have been already ordered, which have arrived and which parts still needs to be ordered. They also mark the dispatch date when the parts are supposed to be arrived.

Certain parts are usually ordered from the same subcontractor. Below subcontractors are mostly used ones in Remeslo, but there are also several other smaller subcontractors if some parts have to be ordered somewhere else instead:

- Long term:
    - Motors – ABB
    - Bearings - FAG & SKF
    - Springs – Lesjofors

- Short term:
    - Steel plates, steel bars and laser cutting parts - three different subcontractor
    - Meshes - from Sandvik & Vomet
    - Small parts, like screws, nuts and other fastenings - one subcontractor

Remeslo's purpose is to get the parts from same subcontractor at the same time to keep the delivery costs as low as possible. But in some cases some of the parts have to be ordered in advance or some parts are not available at the time. (Josef Ziac, E-mail conversation, 16.6.2015)

When ordered parts are arrived to the warehouse part ordering handlers will get confirmation of it and it is marked to their inner system CITO Digital. This way part ordering responded persons can control all the parts and their usage.

When the parts have arrived to the warehouse manufacturing can be started in stages. The example below illustrates the stages. Values are approximate values usually taken to manufacture the machine.

However, some stages could be made simultaneously so the total manufacturing time is not possible to see from this demonstration. SC1863 screen is used as an example below.

Manufacturing the machine consists of the following stages:

1. Part ordering 14 days
2. Part dispatch and waiting time 35 days
3. Welding and machining 7 days
4. Assembling 7 days
5. Testing 2 days
6. Painting and finishing 2 days
7. Waiting for delivery 0-2 days

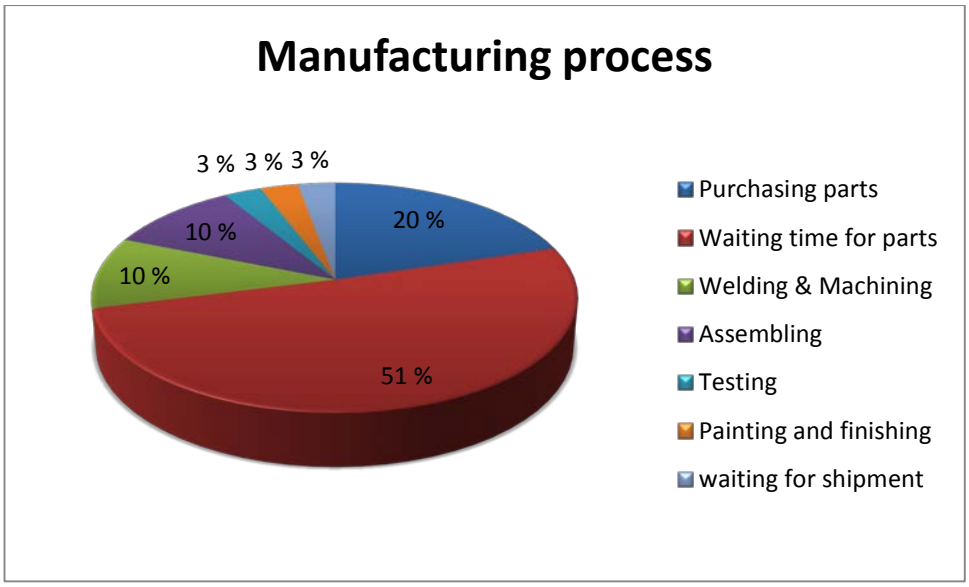


FIGURE 9. Whole manufacturing process in percents

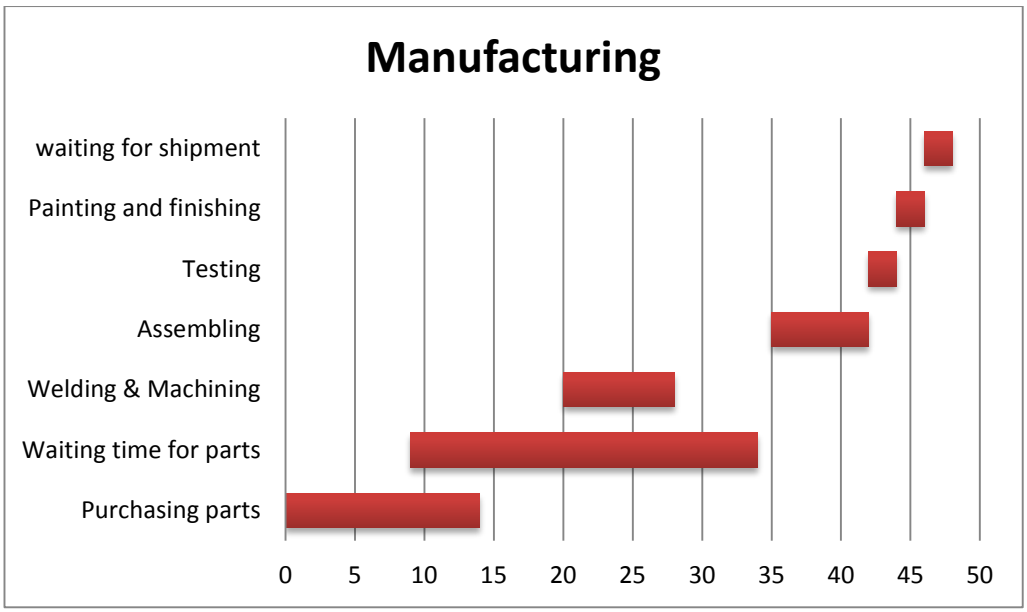


FIGURE 10. Realistic picture of manufacturing.

As we can see from the figure 9 and 10 above the waiting time of parts takes the most time of manufacturing process. From figure 10 we can see that purchasing parts, waiting time for parts and welding and machining are happening simultaneously in the process.

When manufacturing the machine, the workers at Remeslo work in two shifts; in a morning shift and an evening shift. When the parts are ready the machine will be assembled, tested, painted and finished. The manufacturing is controlled by Remeslo's own quality control group. After this Hollola office orders the delivery and required papers are made for it. Remeslo has tend to order the delivery at the time when the machine is ready, usually one day before the machine should leave the factory. After this the machine is delivered to the customer.

7.2 Results

7.2.1 Manufacturing time of S&F

Manufacturing the S&F indicator describes how long it takes to AC to manufacture the machine. It is counted from the date when they get the request until that date when it is ready for shipping. With this indicator AC knows how long it takes to manufacture the machine with all the waiting time including waiting time of drawings. I got the result of counting the difference between ready for shipment and AC request dates (see appendix 2).

TABLE 6. The time for whole process of manufacturing.

d=days	Whole manufacturing process time		
	All the machines (d)	**Standard machines (d)**	**Customer specific (d)**
Average	85	84	136
Standard deviation	52	51	58

From the table 6 it is possible to conclude that standard S&F's manufacturing takes an average of 12 weeks and customer specific's as much as 19 weeks. Customer specific S&F's long manufacturing time can be explained with the long waiting time of parts. Customer specific S&F require more specified parts and their dispatching takes more time. Customer need must be taken into consideration at order manufacturing. Large project deliveries which take up to 14 % from all of the orders (see table 1) requires more time for manufacturing than standard deliveries. This has an effect for the average for about five days.

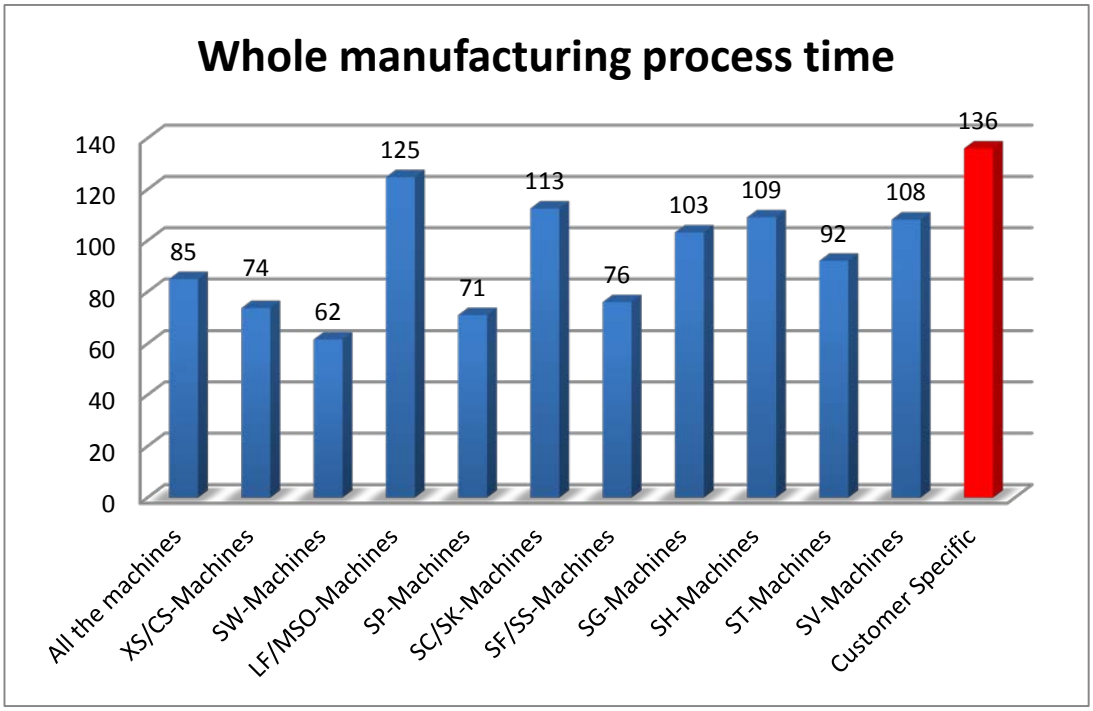


FIGURE 11. Product families' whole manufacturing process time.

Figure 11 shows that expectedly customer specific's manufacturing takes the most time. This is because these are more complicated machines than standard S&F and that is why they require much more time especially for waiting of parts and drawings.

7.2.2 Manufacturing the S&F when drawings completed

The machine's manufacturing after drawings are ready measures how much time it takes to manufacture the machine from AC. It is counted from the date when AC gets the completed drawings to the date when the machine is ready for shipping. The results are based on counting the difference between a ready for shipment and drawing complete date (see appendix 2).This is very important gauge for Remeslo considering the machine's manufacturing.

TABLE 7. Time for manufacturing the S&F when drawings are ready.

d=days	Manufacturing the S&F when drawings are ready		
	All the machines (d)	**Standard machines (d)**	**Customer specific (d)**
Average	81	80	127
Standard deviation	50	49	61

From the table 7 it can be seen that standard S&F's manufacturing takes on average a little over 11 weeks and customer specific's manufacturing takes 18 weeks.

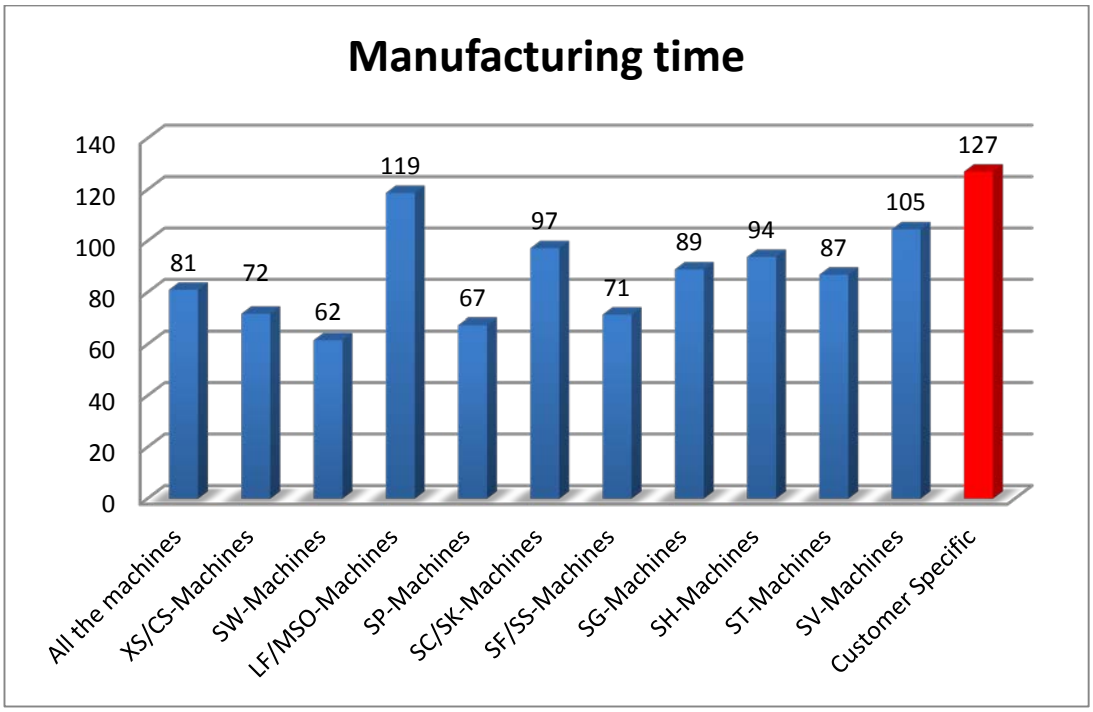


FIGURE 12. The manufacturing time of product families after the drawings are ready.

Figure 12 indicates that the longest time for manufacturing the machine takes customer specific S&F. Also LF/MSO machine's manufacturing takes much more time than any other product family.

7.3 Problems

By comparing the tables 6 and 7 above we can realize that after an order arrives to Hollola office, Remeslo has four days for standard S&F and nine days with customer specifics until the drawings are fully completed. Within this time Remeslo plans the order's manufacturing and arranges the order book. This helps a lot to complete the machine on time. At this time it could also be possible to order some casual standard parts or even a motor if the information would have got from PDC in advance. This would be a good way to reduce the waiting time of parts.

Remeslo also tries to order all parts at same time so that they get the parts at same time from the same subcontractor. This might also cause that the parts of which manufacturing takes more time get delayed. Because of this reason prioritizing the parts order would be quite essential. The question is: when some of the drawings have arrived, could Remeslo already start buying some of the parts? From manufacturing process figures 9 and 10 we can see that the longest part of manufacturing process is the waiting time of parts. That is why some of the parts should be gotten in advance so the manufacturing of the machines could be started earlier.

Remeslo works in two shifts already but doesn't tell how many workers they have.

7.4 Conclusions

The biggest problem is within the part ordering. Remeslo states that they order the same parts at the same time so they arrive to the warehouse at the same time, as a way of reducing the delivery costs. Therefore they do not use predictions of part necessity. Thus they make the part orders always just for the one machine at a time when they get the drawings from PDC to see what parts are needed. This causes big delays for starting the manufacturing the machine. If some parts have been ordered in advance and "long term" parts in different purchase order than "short term" parts, would save much time. This requires Remeslo to pay several freight charges.

However if the machine has been manufactured faster, Sandvik would be able to get the payment of the machine faster. Also that way they would pay also for Remeslo faster. This would benefit both sides.

Remeslo has a warehouse for parts in which they store some small materials and fastening accessories needed for every machine. They also store some “long term” parts like bearings and springs. However from appendix 7 we can see that mostly Remeslo orders the parts after they receive the order and drawings. This helps to administrate the parts but slows the start of manufacturing the machine. It would be essential to keep enough parts ordered, especially from Finland, in the warehouse because the shipping of these to Slovakia takes a long time - up to six weeks. This would consider mostly the “long term” parts. Bearings and springs standard parts should be always stocked up in the warehouse for new machines. When the supplies get fewer they should be instantly stocked up. Also some steel plates, which are standard for almost every machine, should be immediately available. Some of steel plates are machined in their subcontractors but some of the materials are made by themselves. This way they don’t have to wait for their delivery and Remeslo would save a lot of time. This would also enable them to start manufacturing the machine instantly after the order is received. Thus it would be important to decrease the parts waiting time. Steel plates can be easily stored and working those is easy to start right away when order is received. Steel plates are always needed instantly at first phases of manufacturing the machine. So if they would be ready at the warehouse, manufacturing the machine could be started and they would save much time. Even though the order would get changes it would not be a problem because these parts are used commonly almost in every machine and also could be used in other orders later on. This is where Remeslo should pay attention. They should list the parts needed most often and keep them stocked up all the time in order to reduce the waiting time of parts.

The motors are always ordered after the order of the machine has been received. But if we take consideration the machine’s manufacturing time and motor’s delivery time there shouldn’t be any delays of the machine, if the motor is gotten in early enough for testing. Especially when the ambient temperature of the motor rises or lowers it is important to take in consideration that motor is ordered instantly when the manufacturers get the information of this. From appendix 8 it is possible to see the motors that are used in Sandvik’s screens and feeders with their delivery times.

If PDC would send the motor information in advance when they are sure of the motor, the AC could order the motor instantly. This should happen especially when the order needs more specified motor requiring higher or lower ambient temperature. This way it would be easy to avoid the delays that motors can cause in the manufacturing process.

The work with the PDC and AC should be improved regarding the customer specifics orders. These machines require more specified parts, which AC might not have made even a request for tenders for subcontractors. This might cause some delays for starting the manufacturing. If AC would get the information that some specified parts are needed immediately and the PDC has verified which specified parts are used, AC could order them right away and the waiting time of specified parts would decrease.

Based on discussions with Remeslo they have the possibility to store more parts but the problem is in funding this. This could be a good opportunity for Remeslo; if they prioritize the part ordering and store more parts, they would have to pay more dispatching costs but they would manufacture the machines faster and Sandvik could be more favorable to compensate the decreased lead time by paying more for manufacturing. Also this way Remeslo would be able to increase the capacity of units and make more profits. There would be an opportunity to increase the current capacity with one smaller unit at least. The final result would be that Remeslo increased their income in a long term and Sandvik decreased their lead time.

For the phases of manufacturing the machine itself or its testing it is hard to get involved in because I was not able to get to Remeslo, Slovakia, to report how it is done. Nevertheless, based on discussions with Remeslo they have plans to start making shaft ends, bearing housings and also some other machining parts in advance and starting to store them. This way they could save some time from manufacturing. Remeslo is working in two shifts at the moment and in urgent orders they are able to work over time, in three shifts or even during the weekends. This shows that they have the possibilities for working in a fast pace but that is not a goal of theirs. Working all the time in three shifts may not lower the manufacturing time of the machine significantly, because the welding and machining phases are the only parts which the third shift would get faster. But if Remeslo were to work all the time in three shifts, they would be able to increase their capacity of units and increase the work and profit in long sight.

8 DELIVERY PREPARATIONS

8.1 Present situation

The delivery of the machine is the last phase which has an effect for the lead time. Delivering the machine happens as following: AC gives a confirmed date when the machine is ready and ready for shipment. This date is given when the AC starts the manufacturing. The AC aims to manufacture the machine according to the given date. When the AC reports that the machine is ready for shipment, the delivery is ordered. Hollola office makes the necessary papers for the delivery. The goal is to get the machine delivered instantly after it is manufactured so that it would not stand idle in the factory.

However, some transport companies insist certain safety time for arranging the delivery when in question is a special delivery. The machine size and the amount of machines are required information, needed so that the Hollola office can get necessary licenses and right amount of shipping containers for the delivery. Trucks needs two days safety time for normal delivery but wider machine's delivery should be ordered two weeks before the delivery date. Transport companies needs 1-2 weeks of safety time to arrange the ship delivery.

After the notification the truck collects the machine from the factory and takes it forward to the customer according to agreed terms of delivery.

8.2 Results

8.2.1 Product's waiting time

Table 8 describes how many days the machines stand for nothing in the factories. The results are gotten by calculating the difference between delivery date and ready for shipment (see appendix 2).

TABLE 8. Product's waiting time in the factory

d=days	Product's waiting time		
	All the machines (d)	**Standard machines (d)**	**Customer specific (d)**
Average	10	10	14
Standard deviation	24	24	27
Maximum	228	228	94

According to table 8 standard S&F stands on factory an average of as much as 10 days and customer specifics as much as 13 days.

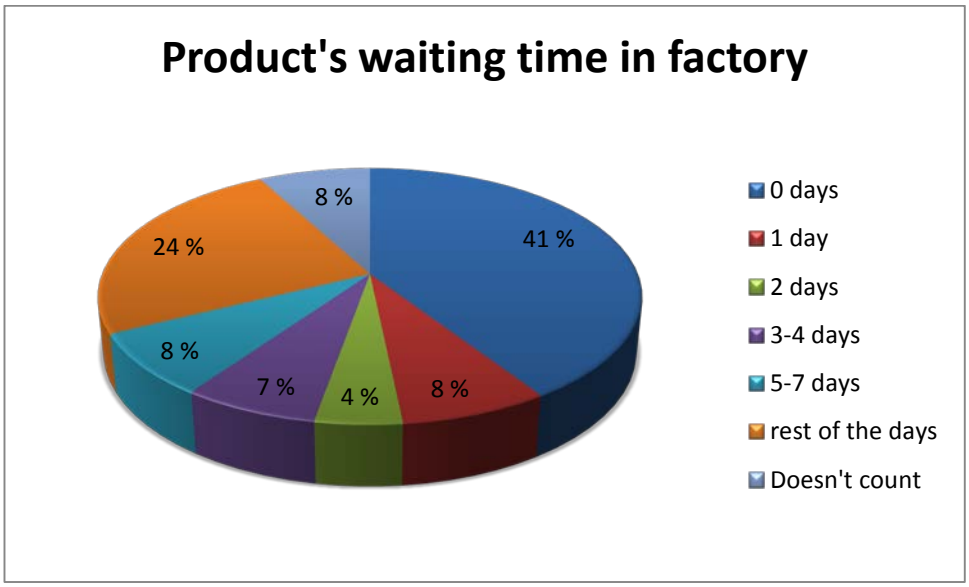


FIGURE 13. Product's waiting time in factory in days.

From the figure 13 we can see that only 49 percent of the orders are delivered during the same or next day. This is only a half amount of the all the orders, because it shows that 43 % stands in the factory two or more days. 8 % of the orders were not being able to take into account because of the missing dates. As much as 24 % of the orders stand in the factory over seven days waiting for shipment. The figure does not take into account possible weekends.

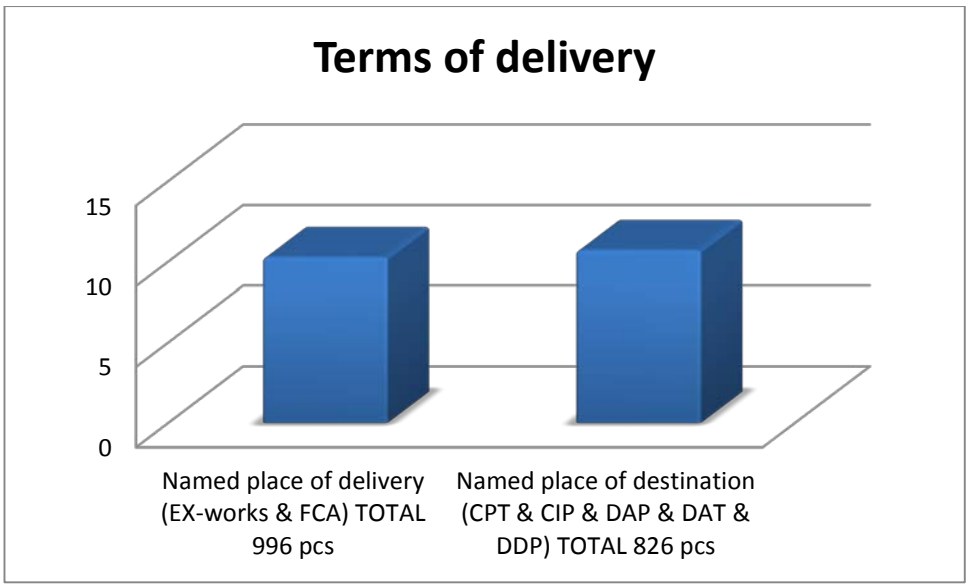


FIGURE 14. Terms of delivery effect for waiting time.

As figure 14 shows that terms of delivery doesn't affect for machine's waiting time in factory.

8.2.2 Variance of delivery time

Table 9 indicates how much the real AC's confirmed delivery date differs from originally agreed delivery date. The results were got by calculating the difference between confirmed delivery date and ready for shipment (see appendix 2).

TABLE 9. Variance of delivery time

d=days	Variance of delivery time		
	All the machines (d)	**Standard machines (d)**	**Customer specific (d)**
Average	7	7	2
Standard deviation	15	15	4
Maximum	186	186	15

Positive values indicate that AC's reliability of delivery is very good. Standard machines are an average ready seven days earlier than what AC has promised and customer specifics an average of two days in advance.

This shows that AC's stick well to the agreed schedule and gives even a little bit of freedom of action for manufacturing the machines.

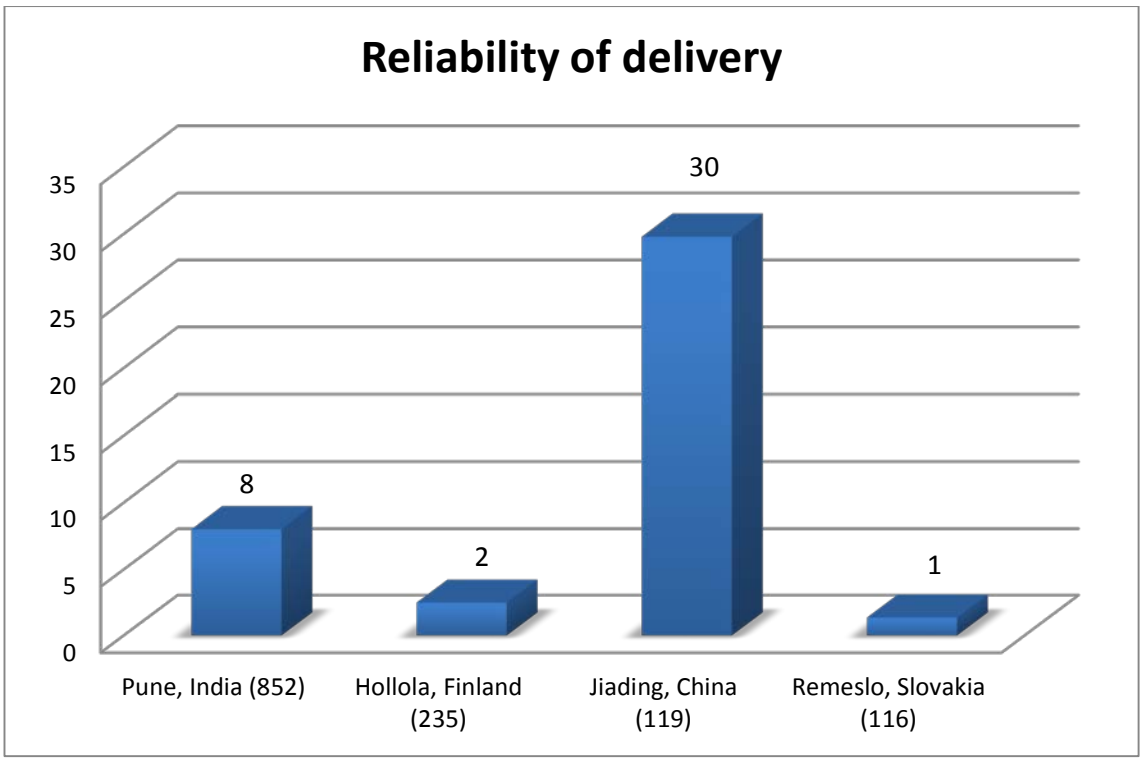


FIGURE 15. Reliability of delivery in assembly centers

The figure 15 above describes the reliability of delivery of four of the used assembly centers. Values in parenthesis are the amounts of orders. Hollola and Remeslo have very good values and this shows that the predictions of delivery date are made carefully and this makes it also easy to trust on the date when machine is ready for shipment so it is also easy to order the shipment. Jiading, China's high number is caused because there has been many orders which they have started to manufacture earlier. They have made project deliveries and started them as early as possible. Even though it is good value it makes it hard to order the shipment cause the predictions are not that good.

8.3 Problems

The calculations above show that AC's stay well in the schedule and they even have few days for freedom for actions if they don't get the machine ready on the promised date. But this also tells that it is possible to get on the better lead time. The predictions for the date when the machine is ready could be given seven days better than ACs gives at the moment.

Machines stand idle in the factories in some situations even though they are ready for delivery.

This problem is highlighted especially with the wider machines that need up to two weeks of safety time for arranging the delivery with the transport company. With wider machines the transport order handlers do not know the real measures of the transports so there is lack of communication between the AC and the transport handlers also.

When ordering the ship transport there is a problem that the machine might be ready on Friday but the ships only transports during certain days, for example on Wednesdays. That is why some machines are idle in the factories. Also multiple machine transports should be reported early enough so that the transport handlers can get all the necessary licenses.

8.4 Conclusions

For an ideal lead time it is important to consider also the sizes of the machines. Wider and larger machines should be announced early enough for transport handler, so that the possible transport can be ordered on time when the machine is ready so it wouldn't stand idle in the factory. That is why the communication between Remeslo and Hollola office has to be improved. Remeslo announces that the machine is ready after a day of its actual finishing date. This is a wrong way because it affects the ordering the transport, especially if the transport needed should be larger or even so. That is why it is crucial to announce early enough when the machine is ready and have to stay on schedule.

In addition to the date when a machine is ready for delivery it should also be taken in consideration whether the order demands ship transport. Order should be prioritized so that the machine will be ready for a day that it could get instantly for the ship transport.

The machine's manufacturing doesn't end up when it is finished. AC should pay attention for that the machine's delivery is also a big part of the process. That is why AC should announce early enough the machine's real size, including the package for the transport handler. The information should be informed instantly to Hollola's office when AC knows the real package size. This is how they could confirm the date when the machine is ready and so the transport for the machine could be order for the exact date. For this it is important to pay attention for the communication between AC and transport handler.
The transport handler should inform AC if the machine is transported with ship, so then AC can prioritize that the machine is ready on certain date. Also AC should inform

transport handlers if the transport needs wider or bigger transport. This is how the transport handler can get the necessary licenses for wider transport early enough. The possible delays have to be informed also right away. The communication between AC and transport handlers should be wide enough so that they can minimize the machine doesn't stand idle in the factories. AC's should communicate with transport handlers when they start the final stages of the manufacturing, thus enabling the Hollola office to know in which stage the AC is going and when the transport should to be ordered.

Another distinct improving subject is the presuming the real date when the machine is ready for delivery. At the moment AC stays in schedule very well and reliability of delivery is at good shape, because AC can manufacture the machine faster than they promise to Sandvik. Yet there is still a problem of finished machines stand idle in the factories. More precise prediction of the date when a machine is ready for delivery would make it easier to order the transport for the right date. So even that AC gives some prediction for it, it should be specified at some point of manufacturing if it changes, get delayed or is finished in advance. This could happen with easy communication between AC and Hollola office. When the estimate would be more precise, also the date for ordering the transport would be easier to execute.

9 PREDICTION CONTROLLING

Sandvik has to give some prediction for the customer of the date when machine is ready and of the date when they promise that it is ready for action.

Table 10 describes how much Sandvik's delivery times differ from those the customer wishes for them to be. The results were gotten by calculating the difference between original confirmed delivery date and customer wish date (see appendix 2). According to this Sandvik adds an average of 10 days for customer wish date, after they have taken consideration manufacturing time, possible capacity etc. This gives some freedom of action for the delivery.

TABLE 10. Analysis of prediction

d=days	Analysis of prediction		
	All the machines (d)	**Standard machines (d)**	**Customer specific (d)**
Average	10	10	4
Standard deviation	39	39	41

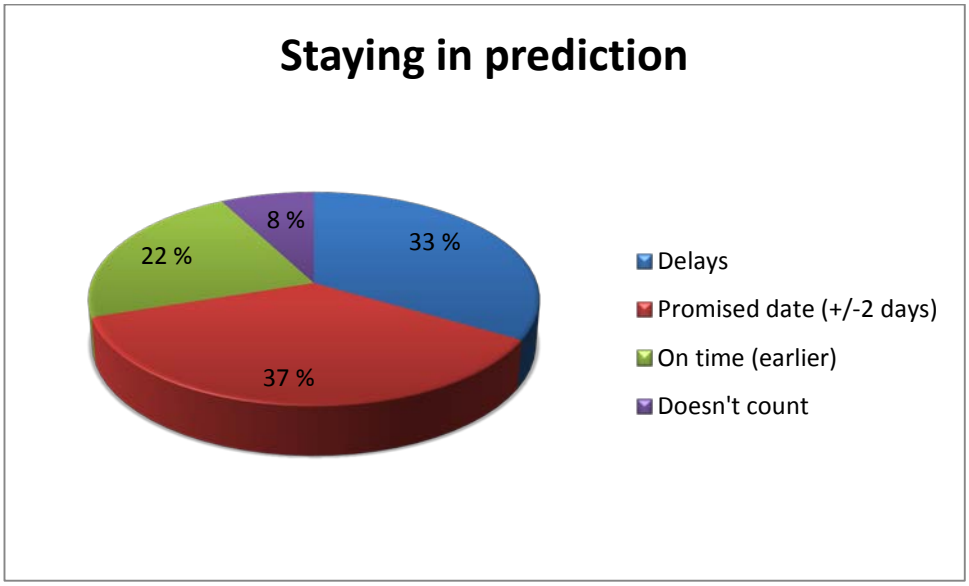


FIGURE 16. Staying in prediction

Figure 16 describes how much Sandvik differs from originally promised delivery date. Only 36 % of the orders match with the promised delivery date but a total of 59 % all of the orders are delivered on time. Anyhow 33 % of the orders are delayed.

Negative values describe the delays, 0-values are that they match with the promised date and positive values describes that the machine is manufactured faster than they have promised (see appendix 2).

10 SUMMARY

The customer needs affect Sandviks' S&F lead time a lot. It is much easier to work with the standard deliveries because their delivery planning is in larger role than other deliveries. At the same time it is easy to prepare for the large project deliveries because controlling these takes anyway much more time, so the sudden changes do not cause big problems. One aspect that affects a lot for Sandviks' lead time are the emergency deliveries. For reacting these is much harder and they require instant reaction. This is why especially storing the parts is playing a big role, because then reacting for these in slow sight is much easier.

According to above conclusions Hollola office could improve their lead time by a few days even with the small actions. The delays of the machines should be able to minimize. At the moment Sandvik promises the standard delivery for the customer within 14 weeks, which is very realistic for them at the moment, but there are possibilities to improve it with the actions suggested earlier. One of the biggest investments should be in improving the communication. On some phases there is way too little communication and some phases there is some unnecessary communication that could be made much easier. This is a good thing to pay attention to and try to improve. The profitability of the actions for improving the lead time stays out of thesis' topic. Better communication also helps for that the order form would be more encompassing when it arrives to SalesTools

PDC is working well at the moment. The reason behind delays is mostly changes and missing information in the order form. Therefore PDC's making of the drawings is at good state and they work on time according to the lead time. They have also improved their methods lately increasing the using of TC and communication between PDC and AC.

It was hard to examine S&F manufacturing without getting on the place to observe the manufacturing. The main point which affects for the lead time is the manufacturing. That is why it is important to improve AC's actions, especially Remeslo's actions, it being the AC I examined. It should be also a priority when improving the lead time. The conclusions could help to shorten the lead time of ACs but it is necessary to observe the manufacturing on the AC for making the improvements. Main improving sector in

manufacturing is part ordering. However Remeslo has plans to start making shaft ends, bearing housings and also some other machining parts in advance and starting to store them. This could be a good way to shorten the lead time.

For delivery preparations it is also important to improve the communication. Wider and larger machines should be announced early enough for transport handler. Also prioritizing the manufacturing for exact date when delivery is handled by ship. These are good ways to improve delivery preparations.

In general view studying the company operations, the parts of it and factors that affect the lead time was interesting. Whilst studying it I did encounter a lot of difficulties, as in order to assess and make solutions I needed to get as realistic picture as possible to improve the company's operation.

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APPENDICES

Appendix 1. Sandviks' Screen & Feeders

Linear motion screen (LF)

"Linear motion screens (LF) are designed for accurate secondary screening and final sizing, as well as scalping ahead of crushers in mining applications. LF screens are an ideal choice in conditions where the height is limited by surrounding facilities, for screening small and short fractions, and when heavy material is loaded on the screen.

Advantages:

- Linear stroke improves screening and increases productivity
- Mechanism installation on top of screen body ensures easy maintenance
- Compact design and horizontal or low slope angle allows installation in height-limited locations"

(Sandvik, Mining, Products, Screen, LF-motion screen)

Circular motion screen (MSO)

"Circular motion screens (MSO) are specially designed for extra heavy-duty medium and fine screening applications. It is a high-capacity machine that has been engineered to increase material speed at the feed end and decrease it at the discharge end, resulting in far more accurate screening.

Advantages:

- Mechanism installation on top of screen body offers easy maintenance
- Robust construction enables screening of high-bulk density materials
- Elliptic stroke with high material speed on feed end and low material speed on discharge end offers maximum capacity and screening"

(Sandvik, Mining, Products, Screen, MSO circular motion screen)

PICTURE Circular motion screen (MSO)

Circular motion screen (SK and SC -family)

“Circular motion screens (SK and SC) are specially designed for extra heavy-duty medium and fine screening applications. This flexible inclined screen is ideal for use screening after primary and secondary crushing, as a splitter screen to divide flows within a plant, and for final screening of a finished fraction.

Advantages:

- Modular deck design offers maximum flexibility with minimum downtime
- Acceleration rate of up to 4.5 G results in increased performance
- Drive assembly designed for easy service and maintenance
- Optional dust encapsulation prevents the environment from dusting”

(Sandvik, Mining, Products, Screen, SC circular motion screen)

PICTURE Circular motion screen (SC)

Grizzly screen (SG)

“Grizzly screens (SG) are robust, linear-motion screens designed for heavy-duty scalping, and the removal of fines from the feed before primary crushing. These screens are ideal for tough primary screening of blasted rock, ripped rock and gravel with a high fines content.

Advantages:

- Double shaft mechanism generates a linear stroke that results in better feeding
- Versatile adjustment possibilities ensure optimum screening performance
- High acceleration keeps the grizzly section clean”

(Sandvik, Mining, Products, Screen, SG grizzly screen)

PICTURE Grizzly screen (SG)

Free-fall screen (SS and SF -family)

“Free-fall screens (SS and SF) are compact and high-capacity screens designed to handle large loads of material despite their modest size. These screens are have steeply inclined decks and a linear throw, and are often used instead of a slot sizer to remove natural fines before crushers.

Advantages:

- Compact size allows for light support structure and easy installation
- Economical due to low power consumption

- Free-fall principle ensures high capacity and quick removal of large amounts of fines”

(Sandvik, Mining, Products, Screen, SS and SF free-fall screen)

PICTURE Free-fall screen (SS)

Roller screen (SR)

“Roller screens (SR) are compact, non-vibrating roller grizzlies and screens ideal for use with non-abrasive materials like coal and limestone, as well as wet and sticky materials. They are high-capacity equipment that are easy to encapsulate against noise and dust.

Advantages:

- No vibration results in lighter supporting structure requirements
- Screens wet and sticky materials without binding, offering increased screening efficiency with difficult materials
- Easy to encapsulate, minimizing dust and noise emissions
- Reliable and efficient screening action minimizes screening area.”

(Sandvik, Mining, Products, Screen, SR roller screen)

Reciprocating plate feeder (SH)

“Reciprocating plate feeders (SH) are hydraulically operated machines ideal for primary and secondary applications with large volumes, high drop heights, or where large dump trucks are used.

This range of rugged, reliable and vibration-free feeders can be subjected to high head loads without affecting the feed rate, and can easily handle sticky material.

Advantages:

- Easily adjustable feed rate offers tailored performance
- Starts and stops as often as needed, resulting in more uptime
- Low operating speed results in lower power consumption and lower maintenance costs
- Powerful hydraulic system can be easily connected to existing or new control system”

(Sandvik, Mining, Products, feeder, SH reciprocating plate feeder)

Pan feeder (SP)

”Pan feeders (SP) are built for high-capacity feeding, with a simple interface and options to facilitate installation. This reliable range of feeders offers a wide variety of sizes, as well as large drive units and proper feed chutes that make high feed rates possible even for course materials.

Advantages:

- Fully engineered feed chutes guarantee proper installation and reliable operation
- Simple dust encapsulation ensures low dust emissions
- Adjustable inclination from 0-12 degrees adapts to different materials, capacities and installation requirements”

(Sandvik, Mining, Products, feeder, SP Pan feeder)

PICTURE Pan Feeder (SP)

Grizzly feeder (SV)

“Grizzly feeders (SV) are designed for high capacities (from 170 to 2,040 tons per hour) in primary and secondary feeding applications. They come in three main types and many sizes to balance demands for capacity, impact resistance, weight and installation dimensions. They have a standard hopper volume of 30 to 200 m3 with a max feed size up to 1,500 millimeters.

Advantages:

- Low profile ensures cost-effective installation
- Easily adjustable features offer tailored performance
- Double shaft mechanism in an oil bath offers extended service intervals
- Easily dismounted mechanism ensures easy servicing”

(Sandvik, Mining, Products, feeder, SV Grizzly feeder)

PICTURE Grizzly feeder (SV)

Combination feeder (ST)

“Sandvik ST-unit is a combination of a separate pan feeder and a separate double-deck vibrating screen. ST-unit has good fines removal which means better crusher performances. The features of ST-unit are powerful drive with variable capacity, compact installation, efficient scalping and minimum operating costs”.

(Sandvik, Mining, Products, feeder, ST Combination feeder)

PICTURE ST Combination unit

Pre-tensioned rubber panel (WK6000)

“The Pre-tensioned Rubber Panel, with punched holes, is designed primarily for fine- to medium-coarse screening in dry applications. It is suitable for cambered screen decks equipped with support bars as well as for trommel screens.
Advantages:

- Flat bar frame and a pre-tensioned fabric, gives stability and eliminates costly adjustments
- Made-to-measure lengths, widths and thicknesses, and hole sizes, makes it easy to get the best choice
- Reduced noise level of rubber provides a comfortable, safer work place”

(Sandvik, Mining, Products, screening media, Pre-tensioned rubber panel WK6000)

PICTURE Pre-tensioned rubber panel (WK6000)

Special PU screening media (WF9000)

“Special Polyurethane (PU) Screening Media with punched holes is designed primarily for fine screening in heavy-duty conditions. Panels are available in a variety of widths, lengths and thicknesses to accommodate most specialty applications.

Advantages:

- For best performance and easy install, panels are made flat with mounting holes or profiled for using special wedges
- Panels extend up the sides preventing material escapes, ensuring quality results
- Polyurethane panels are cost effective due to minimal maintenance requirements.”

(Sandvik, Mining, Products, screening media, Special PU WF9000)

PICTURE Special PU screening media (WF9000)

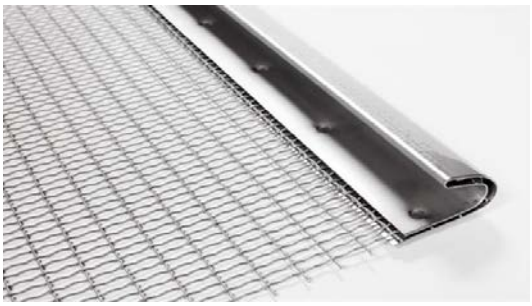
Wire mesh (WX1000)

“A tensioned wire mesh screening media for fine- to medium-coarse screening in dry applications. WX1000 Wire Mesh Screening Media is intended for installation in screens with cambered decks complete with support bars.

Advantages:

- Various widths, lengths and steel wire thicknesses for easy use, no matter where
- Quick and easy to change, making it ideal where separation size changes frequently
- WX1000 is low initial cost, making it affordable for start-ups or expansion”

(Sandvik, Mining, Products, screening media, Wire mesh WX1000)



PICTURE Wire mesh (WX1000)

Appendix 2. GPP-data

Below is part of used GPP-data. This shows what information the data contains.

Serial Number	Production Plan Week	Assembly Location	Product Model	LEAN ERP	Sales Country
H12001	201216	FIN	SG1231	L0702	MX
H12002	201216	FIN	SH1035	L0703	MX
P12001	201209	IND	GF1246 BgH-60		IN
P12002	201213	IND	SV1262		IN
P12003	201205	IND	PF12.5/20-45		IN
V12001	201211	BRA	SV1262	Lean	AR

Destination	Segment	Confirmed Delivery Date	Original Confirmed Delivery Date	TOD	Orderform Recieved
MX	UGM	20.4.2012	13.4.2012	CIF	2.1.2012
MX	UGM	20.4.2012	13.4.2012	CIF	2.1.2012
IN	MOB	29.2.2012	29.2.2012	EXW	2.1.2012
IN	CNS	30.3.2012	30.3.2012	EXW	2.1.2012
IN	CNS	18.1.2012	18.1.2012	EXW	2.1.2012
AR	CNS	16.3.2012	16.3.2012	CIP	2.1.2012

Ready For Shipment	Delivery Date	Customer Wish Date	Orderform Complete	Orderconfsent	AC Request Date
16-huhti-12	19.4.2012	20.1.2012	3.1.2012	16.1.2012	3.1.2012
18-huhti-12	19.4.2012	20.1.2012	3.1.2012	16.1.2012	3.1.2012
22-helmi-12	22.2.2012	29.2.2012	3.1.2012	19.1.2012	3.1.2012
22-maalis-12	23.3.2012	30.3.2012	3.1.2012	19.1.2012	3.1.2012
18-tammi-12	18.1.2012	30.1.2012	3.1.2012	10.1.2012	3.1.2012
05-maalis-12	22.3.2012	5.3.2012	5.1.2012	14.2.2012	5.1.2012

Drawing Start Date	Drawing Request Date Original	Drawing Request Date	Drawing Expected Date	Drawing Complete Date	AC Reply Date
	3.1.2012	3.1.2012		9.2.2012	16.1.2012
	3.1.2012	3.1.2012		20.1.2012	16.1.2012
5.1.2012	3.1.2012	3.1.2012	5.1.2012	5.1.2012	19.1.2012
4.1.2012	3.1.2012	3.1.2012	4.1.2012	4.1.2012	19.1.2012
5.1.2012	3.1.2012	3.1.2012	5.1.2012	5.1.2012	10.1.2012
6.1.2012	5.1.2012	5.1.2012	6.1.2012	6.1.2012	14.2.2012

Appendix 3. Checklist for order registration

SANDVIK

CHECKLIST FOR ORDER REGISTRATION IN ST FCCD
PL Screens and Feeders
20.7.2015

THE CASE

Requested customer delivery date to customer site (see image 1):

☐ This is essential information to have equipment delivered as agreed with the customer !

Delivery/Invoicing information for order (see image 2):
(Note that this information will be transferred to the order so you do not have to write it twice)

☐ **Buyer/Invoicing Address** (Must always be filled in, even if it should be invoiced to a Sandvik Sales Company)

☐ **Delivery/Shipping Address** (Must always be filled in – if same as buyer/invoicing address, write "same as buyer/invoicing address" Add contact person and phone number if else than order Contact Person)

☐ **Consignee** (Must be filled in for all shipments by sea - if same as buyer/invoicing address, write "same as buyer/invoicing address")

☐ **End User** (Must be filled in)

Won/lost info (see image 3):

☐ **End user price** (should be the sales price for equipment and parts to your end customer)

Equipment (see image 4):

☐ **Update the pricing sheet** (should be updated the same day as you create the order)

Equipment specification, cost and price calculation for factory delivery (see image 5):

☐ **Prices**
Adjust customer price to be correct.
If transfer price has been agreed, that needs to be updated also, otherwise ST prices will be used.

☐ **Site information**
Select as much Site Options as possible (Mandatory options must be filled in at least)

☐ **Options** (if screening media, AR400 liners, etc is needed.
Note also, that if you select site info, you may need to select option as well, example low or high ambient temperature)

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Fax +358 205 44 180
www.sandvik.com

Business ID/Y-tunnus 0211600-7
Location/Kotipaikka Tampere, Finland
VAT No. FI 02116007

CHECKLIST FOR ORDER
REGISTRATION IN ST FCCD
PL Screens and Feeders
20.7.2015

THE ORDER

Commercial details (see image 6):

- ☐ **Order type** (normally Inter Company order. Use of External order have to be agreed with GOSD beforehand.)
- ☐ **Order no** (your PO number)
- ☐ **Delivery time from factory** (your requested delivery time from factory) (Note that this information is not transferred from the case)
- ☐ **Delivery term** (on DAP/CIF add final destination or port of destination.)
- ☐ **Additional info** (Any additional information that is not transferred from the case)

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SANDVIK

CHECKLIST FOR ORDER REGISTRATION IN ST FCCD
PL Screens and Feeders
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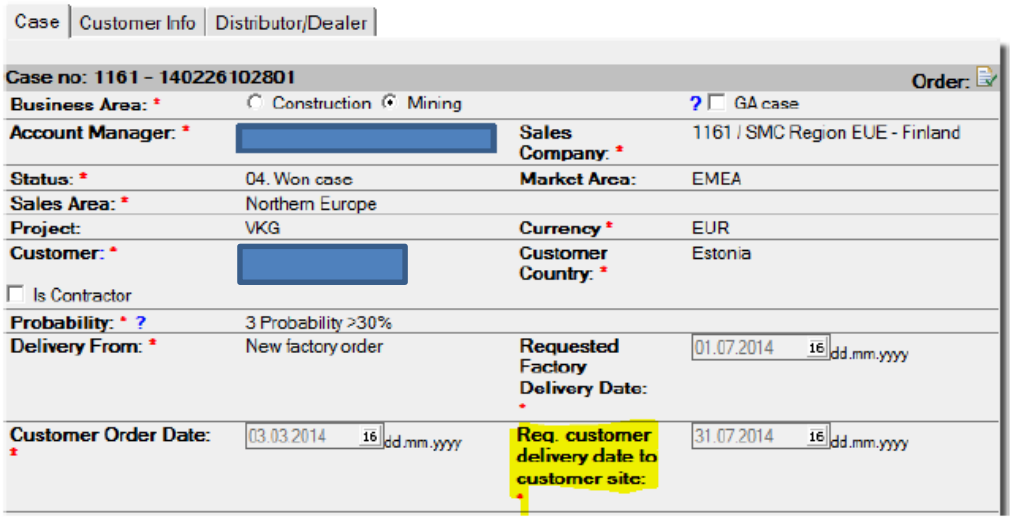

Image 1

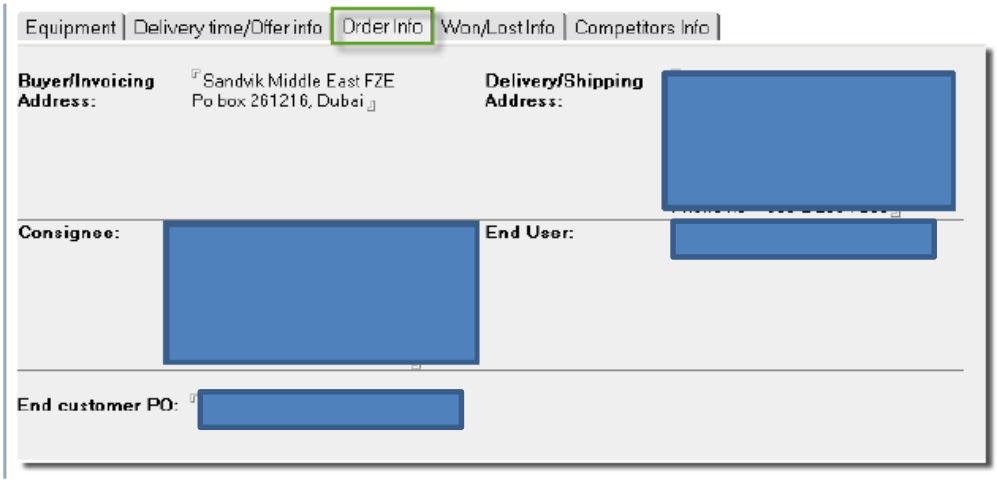

Image 2

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CHECKLIST FOR ORDER REGISTRATION IN ST FCCD
PL Screens and Feeders
20.7.2015

Image 3

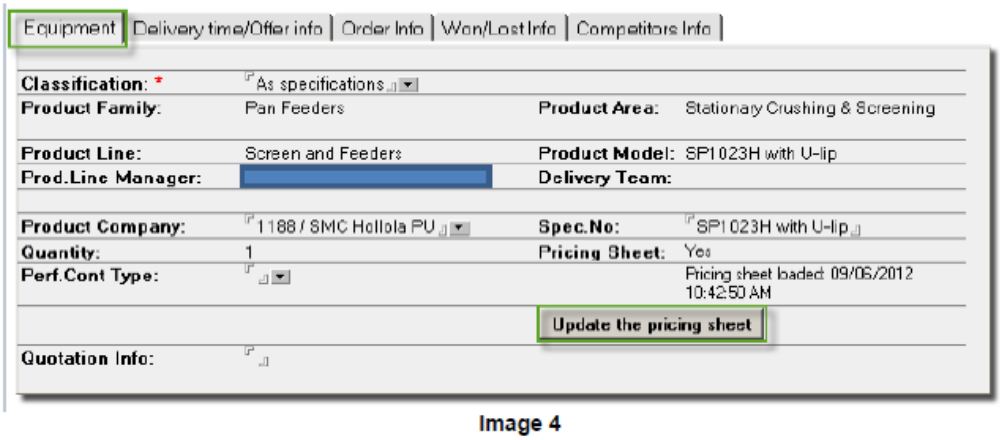

Image 4

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20.7.2015

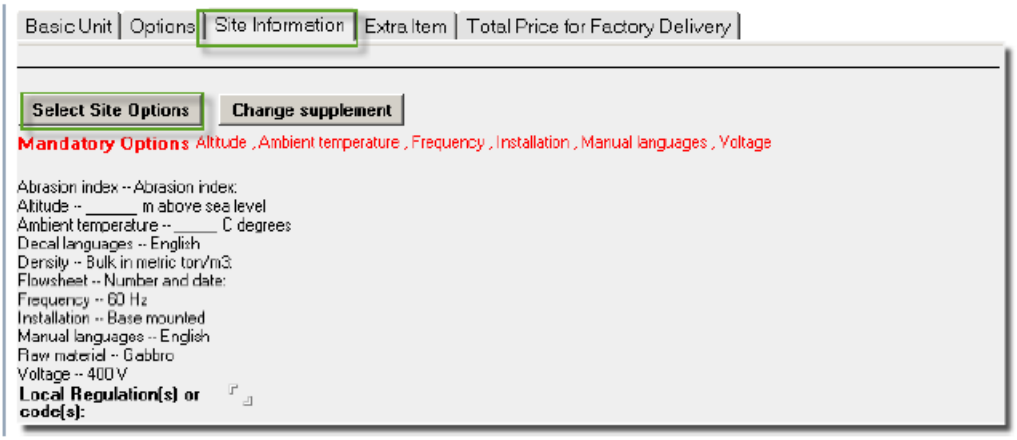

Image 5

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SANDVIK

CHECKLIST FOR ORDER REGISTRATION IN ST FCCD
PL Screens and Feeders
20.7.2015

Inter Company Order 1/2

Case nr: 3488 - 130301112855

Business Area: Construction		
Sales Company: 3488 / Sandvik Mining and Construction Europe GmbH	**Product Company:** 1188 / SMC Hollola PU	**Order Status:** 20. Received
ST Order No: S.13.326.01	**ST Order Date:** 01.03.2013	**Order Type:** Customer Order
Contact Person: [redacted]	**Ref:**	**Serial Number:** 1188B13040
Market Area / Sales Area: EMEA / Norway	**Country:** Norway	
Buyer/Invoicing Address: Sandvik SMC Europe GmbH	**Consignee (if not buyer):**	
Delivery/Shipping Address: (if not any of above) [redacted] This need to be filled in, detailed, exact address.	**End User:** NCC Roads Skien	
Delivery time from Factory 31.03.2013	**Delivery terms:** DAP Skien	
Transportation: ○ Air ○ Ship ○ Train ● Truck ○ Other	**Payment Terms:** Standard term	
Manuals:	**Manuals / Delivery address:**	
Service Technician Info:	**Start-up from product company is required:** ○ Yes ● No	
Liquidated Damage & Penalties: ○ Yes ● No	**Deposit recieved:** ○ Yes ● No	

	Price / EUR
Basic Unit: SS1633H	
Options:	
Extra Items:	
Transfer Price Discount:	
Other Product Company Costs:	
Other Costs:	
Total Price	

Additional Info:
Middle deck end tensioned rubber media

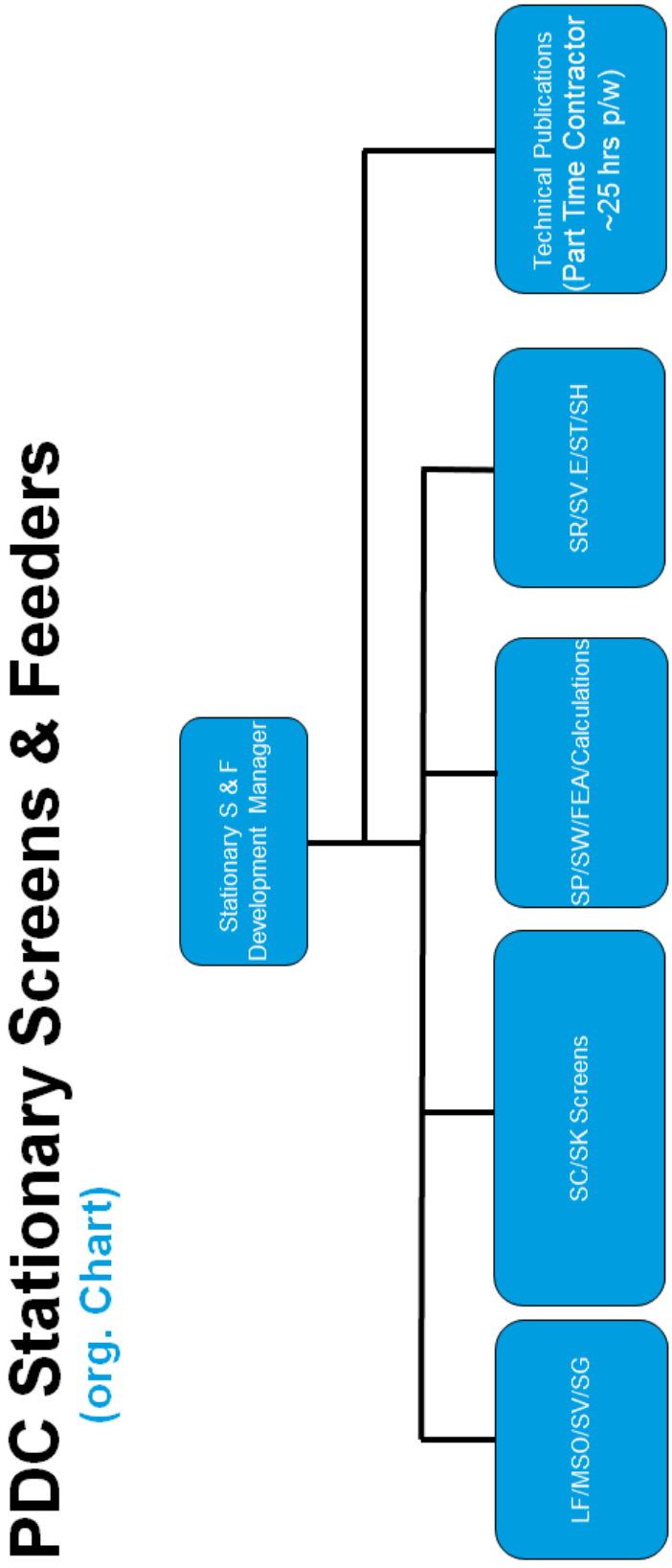
Image 6

Sandvik Mining and Construction Oy
Keskikankaantie 19
FI-15860 Hollola, Finland

Tel. +358 205 44 181
Fax +358 205 44 180
www.sandvik.com

Business ID/Y-tunnus 0211600-7
Location/Kotipaikka Tampere, Finland
VAT No. FI 02116007

Appendix 4. PDC stationary S&F



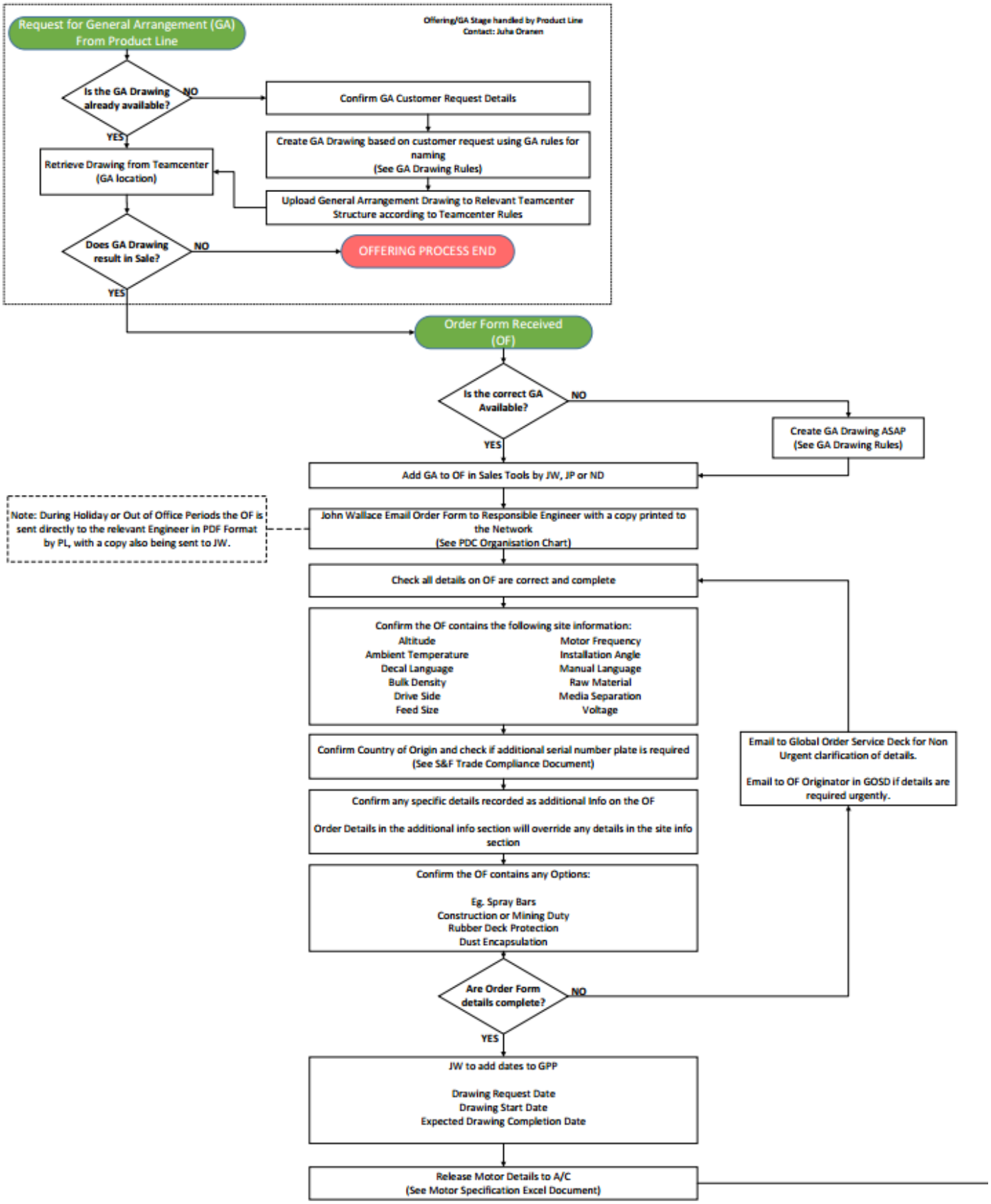
Appendix 5. Bill of materials (BOM)

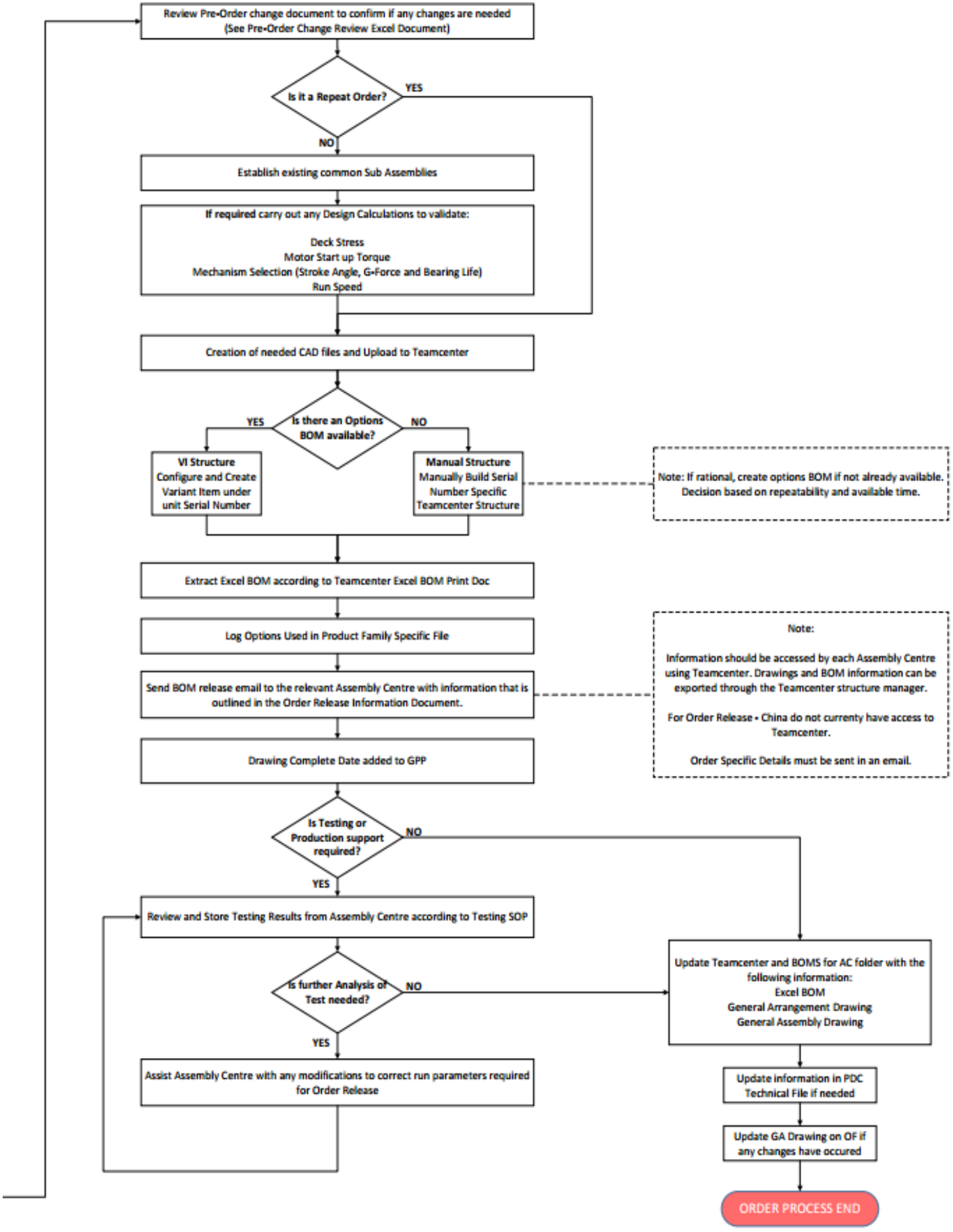
Part of BOM - SC1863:

Level	Item Id	Rev.	Item Name	Rev Description	Material	Weight	Qty	Σ Weight
	1188E14003A	A	SC1863 SIDE TENSION			9427,060	1	9427,060
1	BG00174273	B	SC1863 STM SCREEN BODY			6528,900	1	6528,900
2	BG00174274	A	SC1863 STM SIDE PLT ASSY (R)			1611,100	1	1611,100
3	BG00174277	A	SC1863 STM REINFORCEMENT PLT (R)	6MM_PLT	S355J2	107,000	1	107,000
3	BG00112135	A	SPRING SUPPORT ASY. (3)			54,700	2	109,400
4	726.3107-001		SPRING SUPPORT - UPPER CLAMP	60MM_PLT	S275JR	9,400	2	18,800
4	BG00112130	A	SPRING SUPPORT (3) - LOWER BASE ASY.			44,000	2	88,000
5	724.0190-001	1	TUBE	85x9_CHS	S275JR	0,900	6	5,400
5	BG00112129	A	Spring support (3) - Lower support plate	80MM_PLT	S275JR	27,900	2	55,800
5	726.3054-001		SPRING SUPPORT (3) - LOWER BASE PLATE	200x15_FLT	S275JR	13,700	2	27,400
3	724.0206-001	2	LIFTING PLATE - S355	30MM_PLT	S355J2	13,000	2	26,000
3	BG00112096	A	MOUNTING PLATE ASY. (R)			62,000	2	124,000
4	726.3043-001		CAPPING PLATE (SUITS 114.3 X 10 HFS)	5MM_PLT	S275JR	0,300	2	0,600
4	726.3042-001		SPRING SUPPORT TUBE (114.3 X 10 HFS)	114,3x10_CHS	S355J2	6,300	2	12,600
4	BG00112092	A	Mounting plate (R)	10MM_PLT	S355J2	52,000	2	104,000
4	726.3044-001		SPRING SUPPORT GUSSET	15MM_PLT	S355J2	0,900	8	7,200
3	726.1865-001	1	ANGLE BAR	8MM_PLT	S355J2	57,000	1	57,000
3	BG00174276	A	SC1863 STM SIDE PLT	10MM_PLT	S355J2	1173,000	1	1173,000

Appendix 6. Process map of PDC

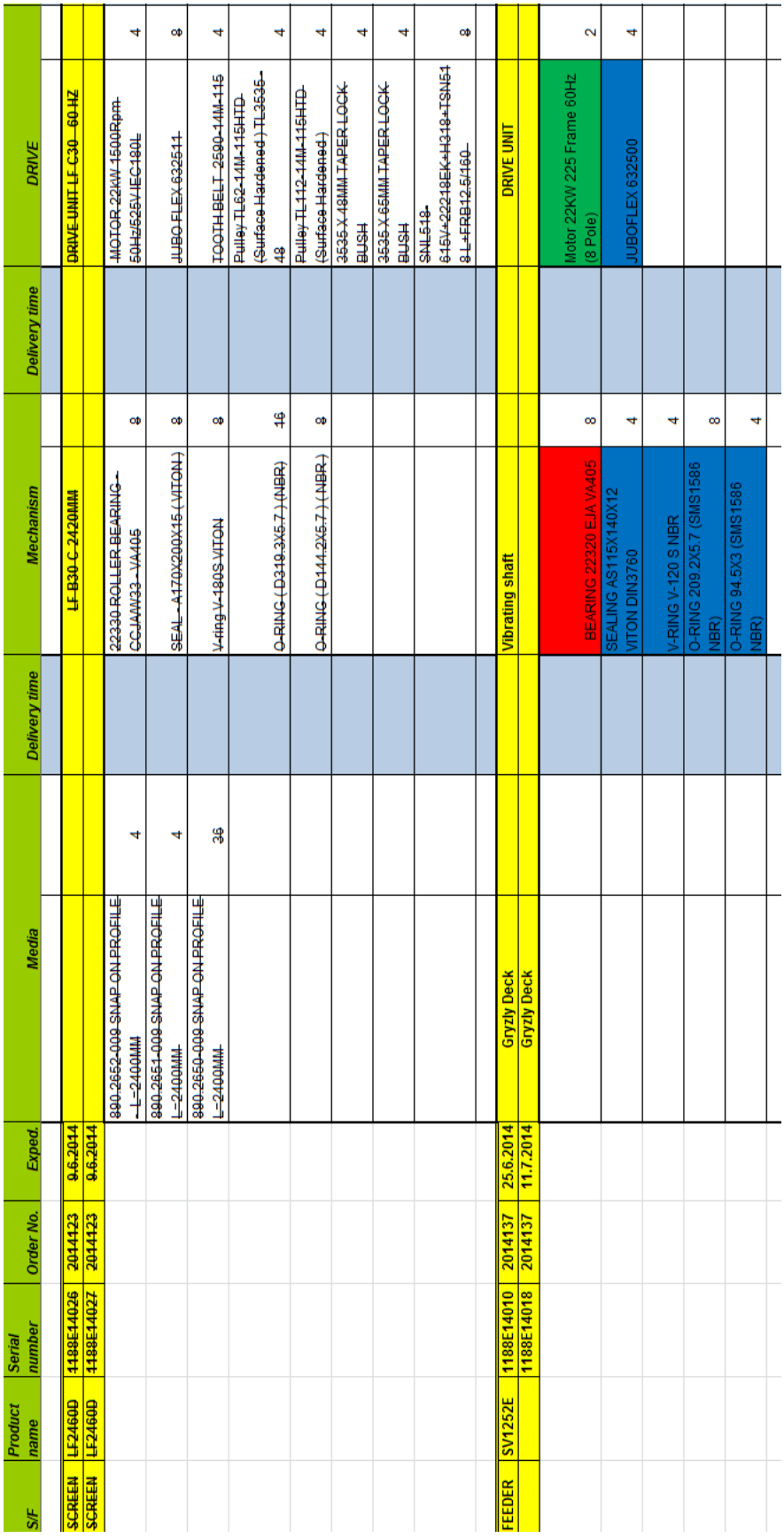
Screens & Feeders PDC Order Process Map




Review Pre-Order change document to confirm if any changes are needed (See Pre-Order Change Review Excel Document)
Is it a Repeat Order?
YES
NO
Establish existing common Sub Assemblies
If required carry out any Design Calculations to validate:
Deck Stress
Motor Start up Torque
Mechanism Selection (Stroke Angle, G-Force and Bearing Life)
Run Speed
Creation of needed CAD files and Upload to Teamcenter
Is there an Options BOM available?
YES
NO
VI Structure Configure and Create Variant Item under unit Serial Number
Manual Structure Manually Build Serial Number Specific Teamcenter Structure
Note: If rational, create options BOM if not already available. Decision based on repeatability and available time.
Extract Excel BOM according to Teamcenter Excel BOM Print Doc
Log Options Used in Product Family Specific File
Send BOM release email to the relevant Assembly Centre with information that is outlined in the Order Release Information Document.
Note:
Information should be accessed by each Assembly Centre using Teamcenter. Drawings and BOM information can be exported through the Teamcenter structure manager.
For Order Release - China do not currenty have access to Teamcenter.
Order Specific Details must be sent in an email.
Drawing Complete Date added to GPP
Is Testing or Production support required?
NO
YES
Review and Store Testing Results from Assembly Centre according to Testing SOP
Is further Analysis of Test needed?
NO
YES
Assist Assembly Centre with any modifications to correct run parameters required for Order Release
Update Teamcenter and BOMS for AC folder with the following information:
Excel BOM
General Arrangement Drawing
General Assembly Drawing
Update information in PDC Technical File if needed
Update GA Drawing on OF if any changes have occured
ORDER PROCESS END

Appendix 7. Remeslo's components buying list

Part of Remeslo's component buying list data



S/F	Product name	Serial number	Order No.	Exped.	Media		Delivery time	Mechanism		Delivery time	DRIVE	
~~SCREEN~~	~~LF2460D~~	~~1188E14026~~	~~2014123~~	~~9.6.2014~~				~~LF 830 C 2420MM~~			~~DRIVE UNIT LF C30 60 HZ~~	
~~SCREEN~~	~~LF2460D~~	~~1188E14027~~	~~2014123~~	~~9.6.2014~~								
					~~890.2652-009 SNAP ON PROFILE L=2400MM~~	~~4~~		~~22330 ROLLER BEARING CCJAW33 VA405~~	~~8~~		~~MOTOR 22KW 1500Rpm 50Hz525V IEC180L~~	~~4~~
					~~890.2651-009 SNAP ON PROFILE L=2400MM~~	~~4~~		~~SEAL A170X200X16 (VITON)~~	~~8~~		~~JUBO FLEX 632511~~	~~8~~
					~~890.2650-009 SNAP ON PROFILE L=2400MM~~	~~36~~		~~V-ring V-180S VITON~~	~~8~~		~~TOOTH BELT 2590-14M-115~~	~~4~~
								~~O-RING (D319.3X5.7) (NBR)~~	~~16~~		~~Pulley TL62-14M-115HTD (Surface Hardened) TL3535-48~~	~~4~~
								~~O-RING (D144.2X5.7) (NBR)~~	~~8~~		~~Pulley TL112-14M-115HTD (Surface Hardened)~~	~~4~~
											~~3535 X 48MM TAPER LOCK BUSH~~	~~4~~
											~~3535 X 65MM TAPER LOCK BUSH~~	~~4~~
											~~SNL518-615+22218EK+H318+TSN518 L+FRB12.5/160~~	~~8~~
FEEDER	SV1252E	1188E14010	2014137	25.6.2014	Gryzly Deck			Vibrating shaft			DRIVE UNIT	
		1188E14018	2014137	11.7.2014	Gryzly Deck							
								BEARING 22320 EJA VA405	8		Motor 22KW 225 Frame 60Hz (8 Pole)	2
								SEALING AS115X140X12 VITON DIN3760	4		JUBOFLEX 632500	4
								V-RING V-120 S NBR	4			
								O-RING 209.2X5.7 (SMS1586 NBR)	8			
								O-RING 94.5X3 (SMS1586 NBR)	4			

Appendix 8. S&F motor list

DAP delivery times Vaasa: 10 Västerås: 7

SANDVIK [redacted]ND FEEDERS

MOTOR PRICE LIST

Max. Ambient temperature	+40 °C
Min. Ambient temperature	-20 °C
Altitude from sea level	<1000m (for higher altitudes, please consult ABB for derating motor rated output power)
Atmosphere aggressivity	Very dusty and moist conditions
Electrical system	400/690V, 3 phase, 50 Hz. For other voltage/frequency pairs, please contact ABB, +002 required
Duty type	S1 for direct-on-line duty
Motor rpm	1500 rpm / 4-poles

- Efficiency class IE2 and IE3
- Insulation class F
- Temperature rise class B
- Cast iron enclosure IP55
- Regreasable bearings, for motor frame sizes below 160 +041 variant required for regreasable bearings
- Bearing seals suitable for hard conditions
- Foot mounted motor B3 (IEC)
- Surface treatment according to category C3
- Motor connection box shall be with rubber gaskets and complete with internal line terminals and earthning lugs
- Winding protection 3 PTC Thermistors

FOR NETWORK VOLTAGES EXCEEDING 500V, PLEASE CHECK NOTIONS FOR OPTIONS REQUIRED IN MOTORS AND VARIABLE FREQUENCY DRIVES

Prices with bold letters and dark red color indicate made-to-order configuration. Current approximate made-to-order production lead time 8-10 weeks.

Motor nominal output power [kW]	*Motor type / product code*	*Efficiency class*	*Motor nominal speed [rpm]*	*Motor weight [kg]*	*Del time (hidden)*	*Motor price [€]*	*Notes*
5,5	M3BP 132 SMB 4 / 3GBP132322-ADB	IE2	1500	70	2	#VIITTAUS!	for ambient temperature down to -20°C
7,5	M3BP 132 SMC 4 / 3GBP132323-ADB	IE2	1500	73	2	#VIITTAUS!	for ambient temperature down to -20°C
11,0	M3BP 160 MLA 4 / 3GBP162031-ADG	IE2	1500	135	2	#VIITTAUS!	
15,0	M3BP 160 MLB 4 / 3GBP162032-ADG	IE2	1500	165	2	#VIITTAUS!	
18,5	M3BP 180 MLA 4 / 3GBP182031-ADG	IE2	1500	205	2	#VIITTAUS!	
22,0	M3BP 180 MLB 4 / 3GBP182032-ADG	IE2	1500	222	2	#VIITTAUS!	
30,0	M3BP 200 MLA 4 / 3GBP202031-ADG	IE2	1500	291	2	#VIITTAUS!	
37,0	M3BP 225 SMA 4 / 3GBP222031-ADG	IE2	1500	324	2	#VIITTAUS!	
45,0	M3BP 225 SMB 4 / 3GBP222032-ADG	IE2	1500	356	2	#VIITTAUS!	
55,0	M3BP 250 SMA 4 / 3GBP252031-ADG	IE2	1500	414	2	#VIITTAUS!	
5,5	M3BP 132 SMF 6 / 3GBP133324-ADB	IE2	1000	86	2	#VIITTAUS!	for ambient temperature down to -20°C
7,5	M3BP 160 MLA 6 / 3GBP163031-ADG	IE2	1000	134	2	#VIITTAUS!	
11,0	M3BP 160 MLB 6 / 3GBP163032-ADG	IE2	1000	172	2	#VIITTAUS!	
15,0	M3BP 180 MLA 6 / 3GBP183033-ADG	IE2	1000	221	2	#VIITTAUS!	
18,5	M3BP 200 MLA 6 / 3GBP203031-ADG	IE2	1000	269	2	#VIITTAUS!	
22,0	M3BP 200 MLB 6 / 3GBP203032-ADG	IE2	1000	291	2	#VIITTAUS!	
30,0	M3BP 225 SMA 6 / 3GBP223031-ADG	IE2	1000	349	2	#VIITTAUS!	
37,0	M3BP 250 SMA 6 / 3GBP253031-ADG	IE2	1000	395	2	#VIITTAUS!	
45,0	M3BP 280 SMA 6 / 3GBP283210-ADG	IE2	1000	605	2	#VIITTAUS!	
55,0	M3BP 280 SMB 6 / 3GBP283220-ADG	IE2	1000	645	2	#VIITTAUS!	

5,5	M3BP 132 SMF 4 / 3GBP132260-ADK	IE3	1500	70	10	#VIITTAUS!	for ambient temperature down to -20°C
7,5	M3BP 132 SMG 4 / 3GBP132270-ADK	IE3	1500	73	10	#VIITTAUS!	for ambient temperature down to -20°C
11,0	M3BP 160 MLA 4 / 3GBP162051-ADK	IE3	1500	135	2	#VIITTAUS!	
15,0	M3BP 160 MLB 4 / 3GBP162052-ADK	IE3	1500	165	2	#VIITTAUS!	
18,5	M3BP 180 MLA 4 / 3GBP182051-ADK	IE3	1500	205	2	#VIITTAUS!	
22,0	M3BP 180 MLB 4 / 3GBP182052-ADK	IE3	1500	222	2	#VIITTAUS!	
30,0	M3BP 200 MLA 4 / 3GBP202051-ADK	IE3	1500	291	2	#VIITTAUS!	
37,0	M3BP 225 SMA 4 / 3GBP222051-ADK	IE3	1500	324	2	#VIITTAUS!	
45,0	M3BP 225 SMB 4 / 3GBP222052-ADK	IE3	1500	356	2	#VIITTAUS!	
55,0	M3BP 250 SMA 4 / 3GBP252051-ADK	IE3	1500	414	2	#VIITTAUS!	
5,5	N/A	IE3	1000				
7,5	M3BP 160 MLA 6 / 3GBP163051-ADK	IE3	1000	172	2	#VIITTAUS!	
11,0	M3BP 160 MLB 6 / 3GBP163052-ADK	IE3	1000	185	2	#VIITTAUS!	
15,0	M3BP 180 MLA 6 / 3GBP183051-ADK	IE3	1000	234	2	#VIITTAUS!	
18,5	M3BP 200 MLA 6 / 3GBP203051-ADK	IE3	1000	291	2	#VIITTAUS!	
22,0	M3BP 200 MLB 6 / 3GBP203052-ADK	IE3	1000	318	2	#VIITTAUS!	
30,0	M3BP 225 SMA 6 / 3GBP223051-ADK	IE3	1000	392	2	#VIITTAUS!	
37,0	M3BP 250 SMA 6 / 3GBP253051-ADK	IE3	1000	467	2	#VIITTAUS!	
45,0	M3BP 280 SMB 6 / 3GBP283220-ADK	IE3	1000	680	2	#VIITTAUS!	
55,0	M3BP 280 SMC 6 / 3GBP283230-ADK	IE3	1000	725	2	#VIITTAUS!	

Notions:
+095 is option code for intermittent duty
+041 is option code for regreasable bearings
+451 is option code for heating element 200-240V
+396 is option code for -20...-40°C ambient temperature design
+704 is option code for EMC cable gland

3xPTC 150°C in stator winding included as standard
C3 surface treatment is standard treatment for M3BP
Regresable bearings included as standard from frame size 160

* With variable frequency drive, reinforced insulation is required in stator winding, when network voltage equals or exceeds 600V. Extends delivery time.
** If nominal rating is desired for the frequency converter, please go one size smaller (e.g. ACS880-01-025A-3 --> ACS880-01-017A-3)
*** For supply network voltages exceeding 500V, the frequency converter motor output must be equipped with a du/dt filter or alternatively with reinforced insulation
**** Heating elements (+451) required for -20...-40°C ambient temperature design (+396) from size 160
***** IP65 or IP56 protection classes are NOT available with D-end roller bearings

Nominal supply voltage U_N of the converter	Winding insulation and filters required
$U_N \leq 500$ V	ABB Standard insulation
$U_N \leq 600$ V	ABB Standard insulation + dU/dt filters OR ABB Special insulation (variant code 405)
$U_N \leq 690$ V	ABB Special insulation (variant code 405) AND dU/dt-filters at converter output
$U_N \leq 690$ V AND cable length > 150 m	ABB Special insulation (variant code 405)