TAMPERE POLYTECHNIC

BUSINESS SCHOOL

FINAL THESIS REPORT

PREVENTION OF TRANSPORTATION AND HANDLING DEFECTS AND DEVELOPMENT OF REEL PACKING FOR UPM BASE PAPERS TERVASAARI

Sannamaria Grip-Lahdenniemi

Degree Programme in International Business
May 2007
Supervisor: Dr. Anasse Bouhlal

TAMPERE 2007

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Author(s): Sannamaria Grip-Lahdenniemi

Degree Programme(s): Degree Programme in International Business

Title: Prevention of transportation and handling defects and development of reel packing for UPM Base Papers Tervasaari

Month and year: May 2007

Supervisor: Dr. Anasse Bouhlal **Pages:** 42

ABSTRACT

UPM Base Papers Tervasaari produces release base paper for customers all over the world. Release base paper is a specialty paper that has high value added and the customer requirements toughen all the time and still they must be met without losing company's profitability. This creates its challenges for the producer.

Transportation and handling related costs are constantly increasing for UPM Base Papers and it has an effect on both the profitability and the competitive advantage as it is a big factor on image. The main issues of transportation and handling defects are moisture, piping phenomenon and dents.

The aim for this thesis is to find out solutions to reduce the costs related to transportation and handling as well as to detect the ways to ensure the product quality and that the product reaches the customer at its best all the time. Reaching these goals involves finding out the optimal package materials, the possible points of improvement in the packing, warehousing and shipping processes as well as provide overall support to the product quality and constant product quality development.

The current complaint situation concerning the three main issues and package material information have been used as a source material for this thesis. The critical observation of current materials and ways of working has provided deeper knowledge and understanding. Also the existing knowledge has been gathered and analysed in order to find out new solutions.

Answers to the three main problems, moisture, piping phenomenon and dents, can be found mainly in the development of wrapping material and the packing process in addition to closer look at the warehouse operations. The cost effectiveness and actual savings can be reached by concentrating on the same issues. Still the personnel's input can not be stressed enough. The skilled and motivated people are the key to continuous development.

Keywords: release base paper, reel packing, piping phenomenon, moisture defects, transportation and handling defects

Preface

This thesis has been done for UPM-Kymmene Release Base Papers, Tervasaari. The aim has been to critically observe the current situation of reel packing and transportation and to find out cost effective solutions for occurring problems.

Writing this thesis has been inspiring and exciting as well as challenging and rewarding. It has been a memorable part of my life and the whole process has raised me as a person.

I want to thank UPM Base Papers' Technical Customer Service Manager and my instructor Mika Uusikartano who has shown me that existing knowledge is nothing compared to the genuine willingness to learn. I would also like to thank Logistics Manager Markku Myyrä and everyone in Tervasaari who have had the patience to answer to my questions during this process.

I am also very grateful to Dr. Anasse Bouhlal and Head of Degree Programme Janne Hopeela for guiding me through the steps of completing this thesis.

Pälkäne May 2007

Sannamaria Grip-Lahdenniemi

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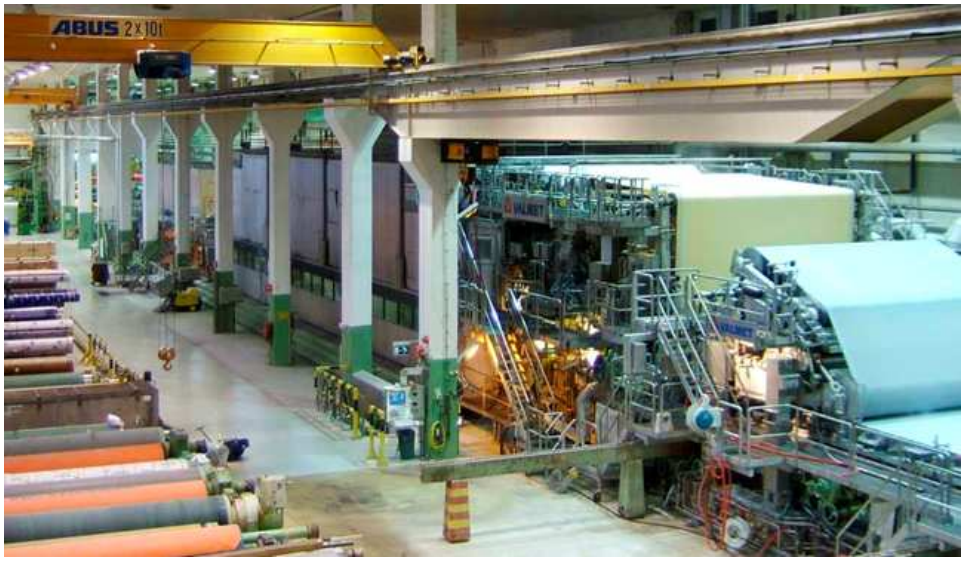
1 UPM Base Papers, Tervasaari

UPM-Kymmene Tervasaari is the biggest specialty paper producer in Europe. The papermaking in Tervasaari started as early as at the beginning of last century. Since the 1980's Tervasaari has focused on release paper and nowadays it is also Europe's biggest release paper producer.

Picture 1 UPM-Kymmene Tervasaari

UPM Base Papers at Tervasaari consists of two release base paper machines: Paper Machine 5 (PM5) and Paper Machine 8 (PM8). PM5 was built 1938 and it has been modified few times since. PM8 was built 1996 and rebuilt 2006. The production capacity of these two paper machines is annually 245 000 tonnes.

Picture 2 Paper Machine 8



Picture 3 Paper Machine 5

Release base paper is a valuable product that has high value added. The field of customers, mainly laminators and siliconizers, is very demanding since the product is so valuable. The producer's accuracy on every level is valued high among the customers and this sets the bar very high throughout the value chain and leaves little room for errors and emphasizes the importance of continuous improvement.

The customer service level is very high and the customer feedback and co-operation are vital in order to maintain the business' status. Since there are all the time more competitors the customer must have added value to the actual product in order to maintain current business relationship. Offering this added value is a challenge for every producer but especially for one that has to deliver the demanding and valuable product from northern Europe to as far as the Americas and Asia Pacific region.

The high standards, the demanding customers and the valuable product create problems and requirements for the packaging and transportation methods, which do not occur on other paper types. These problems will be discussed more deeply later on. Still the elimination of additional expenditure is essential. This equation with the needed quality and elimination of costs is a very tough one and requires constant development process that reaches every single stage of the value chain.

1.1 The goal of this thesis

In 2005 almost 40% of UPM Base Papers' claim costs were more or less transportation or handling related. Main problems on this area are moisture, piping phenomenon and dents. In 2006 this percentage was little bit less, but still too much, more than 21%. This eats away business' profitability and even more importantly this harms the image of a company that needs to function in a very competitive environment and provide added value to customers.

Since the customers' expectations and requirements have increased and have the tendency to do so in the future also the producer's ability to react to changes and occurring problems must be as high as possible. This ability, or the lack of it, either makes the producer a strong competitor or a weak player. Time is crucial nowadays and the solutions to problems must be found faster in order to maintain good business relationships.

UPM Base Papers Tervasaari has the ability as well as the willingness to fulfil customers' needs and the toughening requirements. This thesis is done on that basis. There is a problem that needs attention and has been noticed.

The main aim for this thesis is to reduce transportation and handling related costs for UPM-Kymmene Tervasaari Base Papers as well as to detect the ways to ensure that the product reaches the customer at its best every time. Reaching these goals includes finding the optimal packaging material in addition to handling and transportation method that reduce moisture defects, piping phenomenon and dents on the rolls. This creates cost efficiency throughout the process as well as additional value for both the producer and the customers.

The importance of this thesis is noteworthy, since the aim is not only find solutions for these transportation and handling related problems but to support the overall product quality development as a whole. Product quality development at UPM Base Papers Tervasaari is a constantly on-going process that maintains the product's competitiveness and helps to react on the changes of the continuously transforming paper industry.

UPM Base Papers Tervasaari may also use the findings of this thesis as the base for future material decisions, such as wrapping material, the amount of wrapping layers used and so on, as well as educational material.

1.2 Proactive customer service

Since the customer needs are constantly more demanding and the competitors' field is broad, UPM Base Papers Tervasaari must meet these demands and give the needed added value with the help of a proactive customer service. The customer feedback and co-operation are key factors on everyday production and production planning and they work as guidelines when developing operations to meet customer demands.

The customer service team is wide; it mainly consists of market coordinators, productions planners, regional customer service managers and technical customer service managers. Technical customer service managers also work as product managers, so they each have their specific products as their specialty. This system gives deeper knowledge and understanding to the key persons and keeps them up-to-date all the time.

Technical customer service managers are also the bridge between the customers and the production management as well as the ground level production personnel. This is vital given that the production personnel needs to know the reasons for changes in production, packing, labelling and so on in order to fully understand the current situation and its requirements in production manners. Knowing the reasons behind the decisions also give an opportunity to the personnel to try to find out even better solutions and take the progress yet one step further. This creates better commitment to the ground level workers also.

Technical customer service is a big part of product quality and consists of for instance complaint handling. Many times the complaints and remarks from customers give the needed push to give emphasis to a certain problem or to otherwise boost product development. So customer demands and requirements are also a part of product quality and product quality development. This again creates added value to customer and gives them better service additional to the actual product.

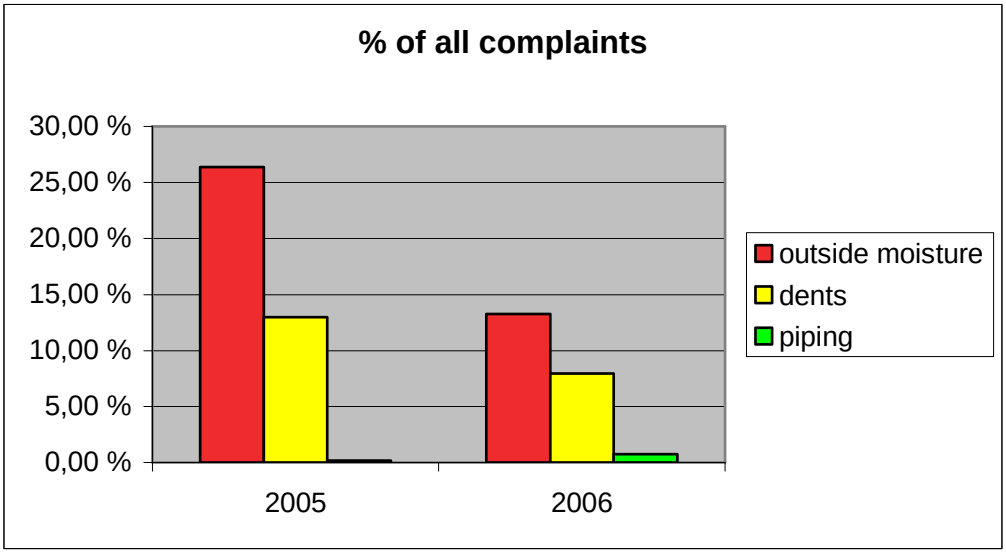
UPM Base Papers Tervasaari has the ISO 9000 certificate of continuous improvement which also requires steady improvement. Although the certificate and its requirements are not the driving force, they are also important when thinking about future development and perpetual progress. Progress is seen as an everyday business not as a long term goal that needs attention every now and then. Development occurs not only when customers' needs require it but every time the personnel of Base Papers sees the opportunity to somehow improve the product or the process.

1.3 The complaint situation

Since the complaints are an important trigger for development the amount of different complaints and remarks are being watched all the time. This gives a good knowledge for the customer service and production about the issues that need to be focused on.

As brought up earlier the amount of transportation and handling related complaint costs was significant in 2005 and 2006. The main problems when talking about Base Papers' transportation and handling related issues are moisture that comes outside of the package, reel end and body damages, e.g. dents, and the piping phenomenon. In 2005 these three causes counted for almost 40% of all complaints. In euros this was almost 500 000 euros in 2005 alone, so it is a major problem.

APPENDIX 2



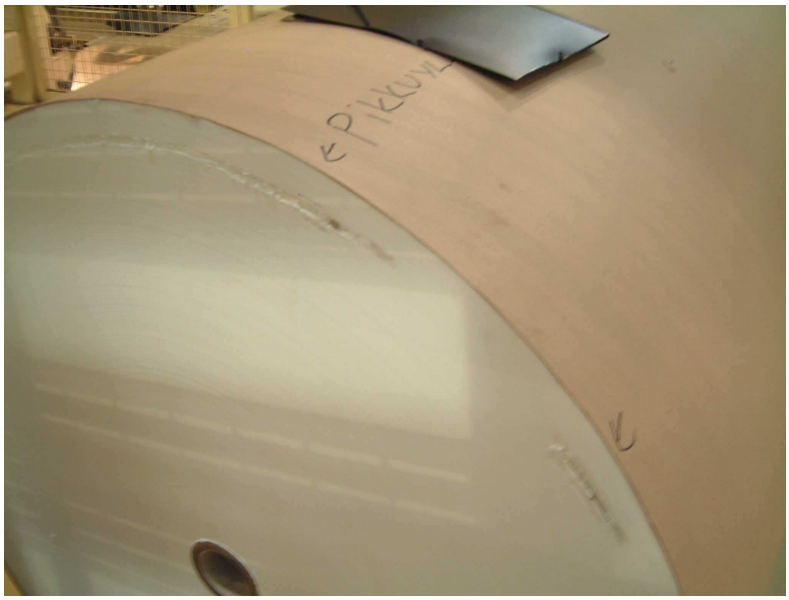
Picture 4 Complaints concerning outside moisture, dents and piping phenomenon in 2005 and 2006.

These three issues are not important only because they have deteriorating effect on the base paper itself but also because they are visible and therefore have a direct impact on the image as well. The image issue is important at the customers' end but also on the way, since there are a lot of people in between who encounter the reels and form their opinions about UPM Base Paper on the basis of what they see.

At the following, we'll look deeper into these three matters, their role, the reasons for them and what could be done in order to gain better profitability and competitive advance for the business.

1.3.1 Moisture

Moisture coming outside the package is the biggest issue concerning transportation and handling related costs. Moisture related complaint costs totalled more than 26% of all complaint costs in 2005 and more than 13% in 2006. In 2006 this meant, in average, more that 3 000 euros per moisture related complaint.



Picture 5 Moisture defect at the reel end

If the crimping is not sharp and firmly glued with the outer head on the reel ends the moisture may penetrate the package from the reel end. The body of the aluminium package does not let moisture through if it is not damaged but the standard wrapping used, that has polyethylene in it, may also let some moisture penetrate even if it is undamaged. So there is more than one way for the moisture get inside the package.

Usually the outside moisture comes from the floor of warehouse or container. This can be the case if for instance the container is situated on the deck of a ship and the waves reach the deck or if the container is in heavy rain. This of course does not happen if the container is in good shape and there are no holes for the water to get in. Reels travelling as break bulk are also more vulnerable than the ones in containers, since they do not have the container protecting them from the waves and rain.

It does not mean that from the floor the water automatically finds its way to the crimping and into the reel end, but if the water gets into the crimping and then the reel is lifted and turned there may be straight pathway inside the reel. So if a reel sits in a puddle of water it is more

likely that when the reel is moved the surrounding water makes its way into the package.

The best way to prevent outside moisture meeting the roll is to make the package as good as possible. If the crimping is first-class, the outer head placed well and the wrapping material is undamaged, the possibility of outside moisture getting inside the package is significantly smaller even though there might be holes on the container or puddle of water on the warehouse floor. However, even if the water does not get inside the package, it should be tried to be eliminated as well as possible because it still makes the appearance of the package worse and therefore has an effect on the image issue.

1.3.2 Piping

Piping is also a humidity related problem. Piping phenomenon occurs when humidity penetrates the package through the package body or the end. This penetrated humidity makes the surface layers expand and therefore they start to corrugate. This corrugation creates run ability and/or printability problems and is therefore very unwanted phenomenon.

Picture 6 Reel that has corrugation because of piping phenomenon

Piping is an issue especially at a tropical environment or when humidity is present otherwise. High air humidity is the case in for instance Lybec Harbour, Germany, where some reels spend a lot of time, sometimes even 3-4 months. Long warehousing times are not the only reason for humidity leading to piping; this is also the case on long transportation times by sea, to for instance Asia Pacific area.

Piping does not count for a large portion of complaints, but it is big issue since the moisture is the reels biggest enemy. On a shorter distances, when the transportation chain is quicker and/or the air humidity is less the piping phenomenon reaches only the 3-5 top layers of the reel, which will be taken off and thrown away by the customer in any case, so it really doesn't occur as a big problem. But when the phenomenon has expanded to for instance 100 top layers it becomes a huge problem. The reels can not be used as they are, since it will create pleats on the laminating machine, but cutting away such an amount of base paper is also very costly. Not to mention the image that suffers when the product looks bad and can not be used as it is.

Since the long transportation times can not be decreased the solution is in the wrapping material and the wellness of the package. When the barrier properties of the wrapping and the well made package are good the amount of penetrating humidity and therefore the amount of piping phenomenon plunge. Also if it is possible, the warehousing times should be reduced as much as possible in order to increasingly avoid this problem.

1.3.3 Dents

Dents on the reel counted for about 8% of all complaints in 2006. Dents are usually on the reel ends or there might be forklift marks on the body of the reel also. Each reel weights about 3 tonnes and it faces approximately 14 handling times before reaching the customer. So the possibilities for dents to occur are numerous. Biggest issue with dents is the image and especially the loss of it. When the package of the reel seems shabby, the whole product is supposed to be of bad quality. Many times this is not the case, since for instance the aluminium packaging material used for deliveries in the Asia Pacific area “remembers” every forklift impact and folds accordingly and does not “bounce back” to its original shape.

Dents are constantly increasing problem, since the logistics chain faces hurry when dealing with the reels and the amount of staff is being reduced all the time. This is the case in Tervasaari's own warehouses and especially at the ports around the world. The loading and unloading times are being reduced continuously and so the people just do not have the time to handle the reels with extra care and/or check every little detail.

The reel end damages are a real problem and could be reduced significantly with the right kind of training for forklift drivers, better monitoring and longer loading/unloading times, since the end

damages are usually due to a human error or impurities, for instance gravel or screw ends, on the warehouse or container floors.

Picture 7 Damaged reel

There already has been made one significant improvement concerning Tervasaari's warehouse conditions. Gravel is a problem especially in the winter since the forklifts need to be refilled with gas outside the warehouse and the warm tyres are like magnets to the cold gravel used to secure walkers' safety. The gravel has been changed to sand to limit this problem since especially these reel end damages usually cost a lot, since because of one impurity at the end of the reel the whole reel will be rejected at the customer. This is an example of needed improvements throughout the value chain; even a change that seems small may have immense impact.

2 Value chain

Value chain is a model of company's value addition process, developed by Michael Porter in 1985. Value chain is a term that refers to a process where a commodity gradually develops from raw material into finished product. Every single stage of the value chain, every individual process, adds value to the product. The stage can be for instance cotton being weaved into fabric or a certain brand being implemented on a product. The last stage of the value chain is distribution, for instance retail.

The producing company can, according to its corporate strategy, function in one or several stages of the value chain. This can be referred as narrowed or extended value chain. A company that concentrates on its core process usually functions in a narrowed value chain and all other stages of the refining chain are being handled by subcontractors. However, product's competitiveness is determined by the effectiveness of the whole value chain.

Porter's value chain's primary functions that form the actual material flow are inbound logistics, operations or production and outbound logistics. In addition to these sales, marketing and services or maintenance are primary functions. Although Porter emphasizes the significance of integration the model also includes functional boundaries. The stages in value chain are repetitive. The aim is to make it as simple as possible and all stages that do not produce added value to the customer should be removed.

Company's own value chain is a part of a wider value chain, a network that starts from the raw material and ends at the end user. The added value is produced largely in the whole network, before or after the actions done in one's own company. Value chain can therefore be determined as a chain formed by companies where the raw material is being processed into finished products for the end users.

Value chain can be represented on a four different levels:

1. Business' value chain: the whole company and its customer groups: how and with who to function
2. Company's value chain: different operations inside the company: how to function to stand out from the competitors and to obtain competitive advantage
3. Core process' value chain: different core process operations
4. Operation's value chain: small operation or entirety

Porter represents one company's value chain. The cooperation of multiple companies from the raw material sources to use and recycling is called value system. This point of view has since been named value chain in the common language. (Wikipedia 2007)

3 Roll wrapping and handling

Terms roll wrapping and handling refer to the processes and operations that take place after the paper has been wound into reels at a paper mill. The wrapping and handling systems at the mill focus on the required material handling and providing the reels with protective and finishing actions needed to prepare the reels for the mechanical and climatic rigors of transporting them to the end user and it equips the reels with end user defined labels and markings in order to ensure accurate logistics control during transportation.

Internal transportation system normally involves equipment for conveying, weighing, identification and labelling. The system usually includes sequences providing the reel with wrapping, strapping, sorting, grouping as well as upending and warehouse operations like storage management and shipping can also be connected to these operations.

The list of necessary finishing processes is determined by the produced paper grade and the strains associated with the chosen transportation method. For instance lighter weight paper usually receives a full wrap on the body and the reel ends and on the other hand some paper and board grades reels do not require wrapping.

Wrapping is the only process that provides protection to the reel that is completely under the mill's control. Labelling and marking differentiate various customer orders and grades at the mill, during transportation and at the end user's premises. The reel handling system is effective when it takes into account the paper grade and prevents damages and other unfavourable conditions.

In the majority of paper mills the reels are stored in the warehouse before shipping. The amount of reels stored can be thousands. The process management system must be able to establish the inventory and location of every reel. In the warehouse the reels are handled by forklifts or clamp trucks. There can be for instance a wireless radio terminal on board each truck that shows for the driver the database of the reels in addition to handling functions.

Easy reel identification is achieved with the help of wireless barcode reading equipment. Usually the bar-coded reel identification is printed on the shipping label or directly on the reel's bilge. Each reel must be identified when moved in the warehouse or taken from there. These are transactions that are also recorded in the warehouse database. (Jokio, 1999: 239-240, 276-277)

4 Transportation chain

4.1 Transportation at Tervasaari mill

The rolls are handled inside the mill by own employees and conveyors. The human factor comes into account after wrapping when the reels arrive at the warehouse. Reels are either stored at the warehouse for later loading or loaded immediately into trains or containers. Both storing and loading are done by forklifts.

Picture 8 Reels stored in Tervasaari warehouse

4.2 Transportation from the mill to the customer

If the reel is loaded into a container straight from the conveyor and the container is unloaded at the customer, the amount of forklift contacts is minimal, possibly only two. It is the best case scenario, but unfortunately it is rarely the case. Normally the amount of forklift contacts is about 14 times per each reel, and this is due to the different ways of transportation and amount of storing.

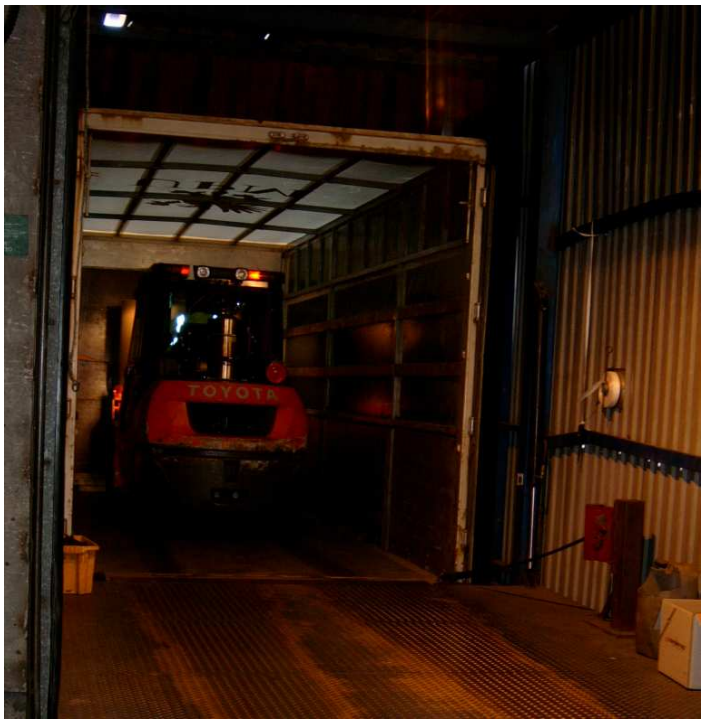
Picture 9 Reels being moved by forklift

Myyrä has informed that approximately 80% of Tervasaari Base Papers' reels is put into containers at Tervasaari and then unloaded at the destination warehouse. That is the optimum working way since it reduces the handling times and is cost effective. This is also the best time to monitor and correct the quality of packing and the container conditions.

Picture 10 Reels loaded into train at Tervasaari warehouse

According to Myyrä less than 2% of the reels are transported to the Port of Rauma as break bulk by the train or by car and stored and later loaded into containers there. If Tervasaari's resources would allow, these reels would also be loaded into containers at Tervasaari, but since it is not possible this is the second best option.

The Port of Rauma has its own repacking station, where damaged packing can be fixed or taken off and the reel can be repacked totally. This is important since accidents happen both between Tervasaari and the Port of Rauma and at the port. This is one last chance to have an impact on how the reel looks like and more importantly, how the valuable paper is protected.



Picture 11 Reels being loaded into a car

As said by Myyrä about 18% of the reels go as break bulk all the way from Tervasaari to the customer. The amount of forklift contacts is significantly bigger by using this method of transportation. But still this method of transportation is necessary when delivering to the US because the costs and transportation possibilities in the US require break bulk.

APPENDIX 3

5 Packing

5.1 Reasons for roll packing

Niskanen (1992: 3) has pointed out that the majority of reel defects are due to the forklift truck handling. The statistics show, that 75% of all damage is done while moving and/or lifting. The most vulnerable part is the reel end.

The package must give protection against mechanical strains as well as protect from moisture during handling, transportation and warehousing. Nylund (2006) has mentioned that paper on the wrapping material provides the defence against mechanical damages and dirt and polyethylene, e.g. PE, provide the protection against moisture. So both components are needed.

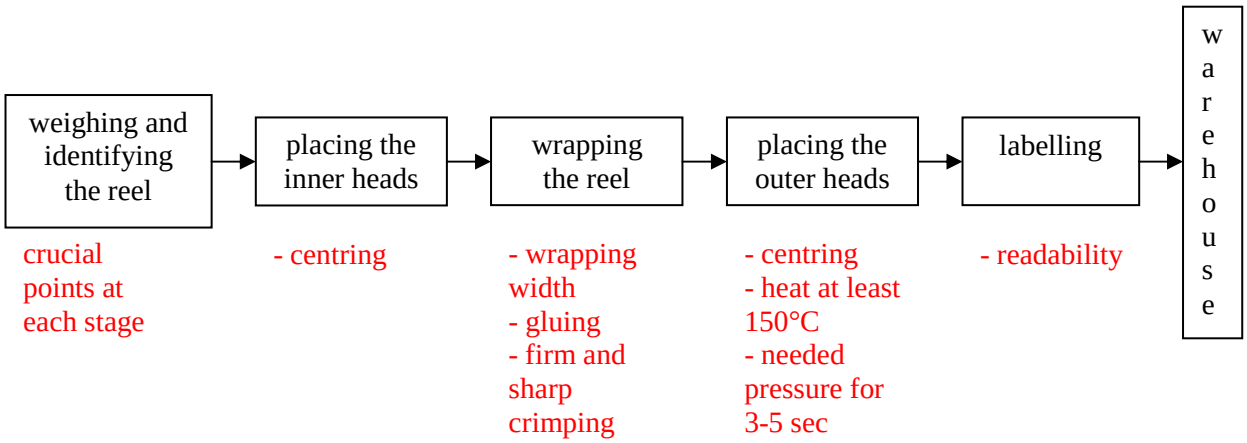
Nylund (2006) has also pointed out that protection against moisture is needed for three reasons: to protect the paper against water in short periods in transportation and handling, to ensure paper's original moisture profile, therefore run ability problems can be minimized and to prevent piping phenomenon, since absorbing moisture may lead to extra waste because of bad run ability or bad printability.

Release base paper as a speciality paper has many requirements that other paper grades do not have. Because release base paper is such an expensive product the customers order it at a specified length. This requires that the package protects the reel so that there are no defects on even the surface layers so that as little as possible of the material goes to waste.

Release base paper also has a high density. Because of this high density even a smaller roll is heavy witch requires better strength properties from the package.

Paper chemistry of release base paper also creates it challenges. Uusikartano has stated that the most important one is that if the reel gets moist during the transportation, as it dries the chemicals on the paper turn into glue and the reel layers stick to each other making unwinding impossible. Uusikartano has also informed that moisture can also make the surface layers expand, creating pleats. So there are many factors that set the bar high for release base paper reel package.

5.2 Packing process in short



At first the reel is weighed and identified. This is very important stage since not all reels are packed the same way; some need different packing material, some need extra marking and so on.

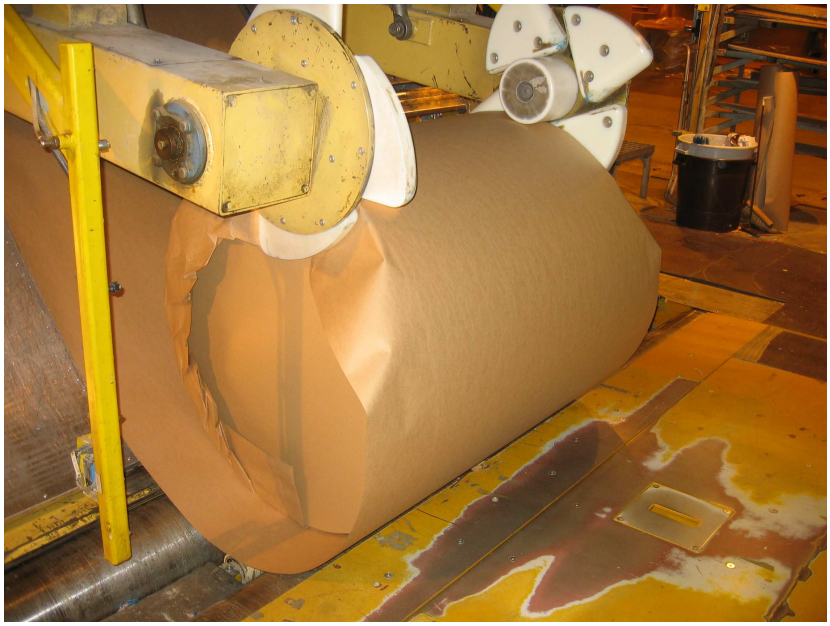
After identifying the reels the inner heads are placed to protect the reel ends from wrapping glue and other impurities, moisture and impacts to the reel end. This is done by people on both PM5 and PM8 packing stations. It is crucial that the inner heads are placed as centre as possible and that the size of the heads is correct. Otherwise they do not provide needed protection.

Picture 12 Placing of inner heads at PM5

After placing the inner heads the wrapping is rolled around the package. On PM5 the reels of wrapping material lie on top of the wrapping station, there are 10 stands for all the wrappings needed.

Picture 13 Wrapping material reels at PM5

The wrapping is glued to the reel at the beginning and then glued to itself at the end. The wrapping material must be 15-25cm wider than the reel on each side. The “extra” of the wrapping material forms the crimping as it is folded to both ends of the reel. When the crimping is sharp and firm, it protects the reel end well. If the wrapping material width is more than the mentioned 15-25cm per side, the crimping is not sharp and firm enough and if it is less the crimping coverage is not enough.



Picture 14 Wrapping the reel at PM5

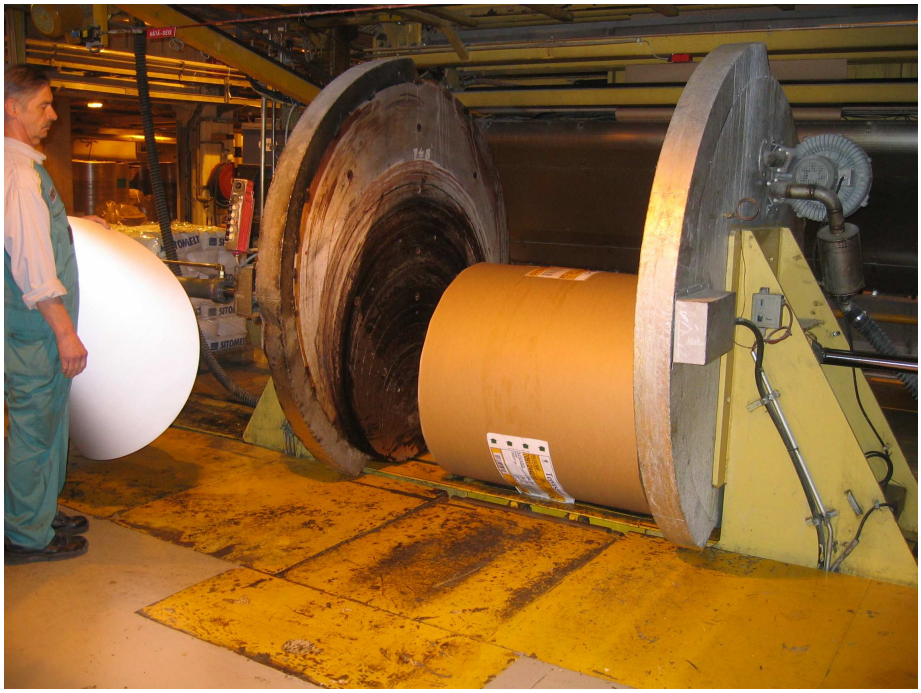
The outer heads are placed next. At PM5 this is done by people but at PM8 the robot does this. As with inner heads, the size and placement of the head is as important with the outer heads.

The outer heads are glued with hot (at least 150°C) plates that melt the glue of the head and press them into the crimping and the inner head at a certain pressure, minimum of 3-5 seconds. The outer head glues the crimping firmly and therefore prevents moisture penetration through the folds.

Picture 15 Outer heads placed at the hot plates at PM5

Finally the reel is labelled and otherwise marked if necessary. The other markings could be for instance different coloured stripes or tapes to indicate for instance certain jumbo reel position. This helps the customer when they are starting to use the reels at their premises. The placing of the label should be done carefully so that the visibility would be optimal. Usually there are two labels that are being attached at the other end of the reel and on the body. Sometimes there are two labels on the body also to improve their visibility.

The label contains important information about the reel: customer name, order number, the jumbo reel info, size, grade and so on. Some of the tracking info is also on a bar code. The label can also contain info that each customer defines themselves. After the labelling and other marking the reel is ready to move on to the conveyors and to the warehouse for storing and shipping.



Picture 16 Outer heads and labels have been attached to the reel at PM5

Picture 17 Reel ready to be transferred to the warehouse at PM5

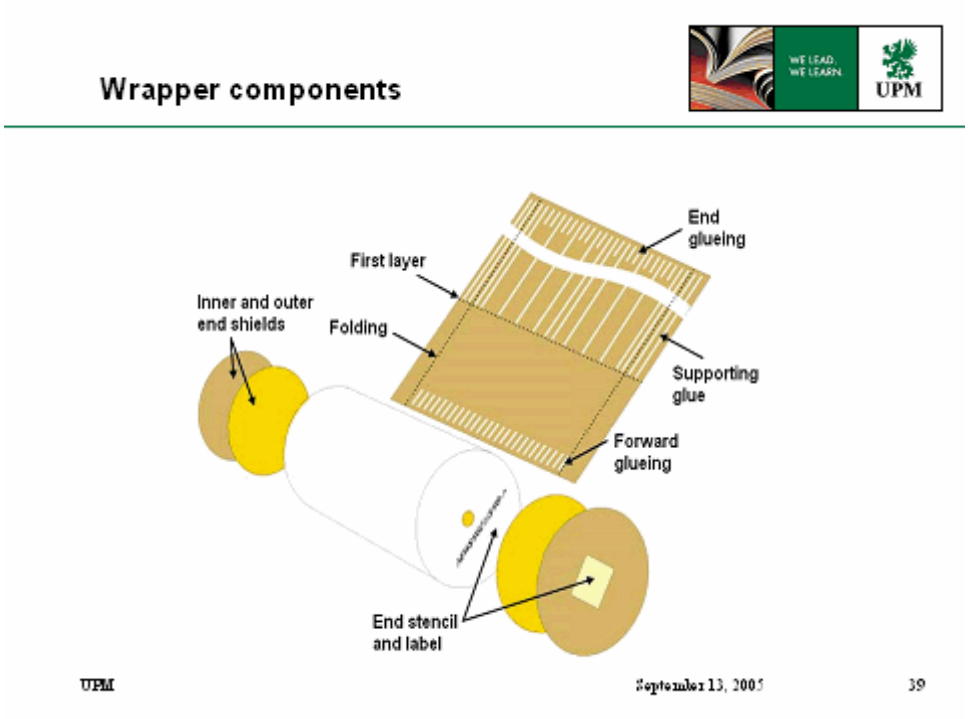
5.3 The optimum package

The optimum package would include breathable, durable but cheap wrapping material, perfect material (wrap and inner and outer heads) width, witch will lead to good, sharp crimping as well as coverage.

Durability would allow handling mistakes and still protect the roll perfectly. Durability is also the number one factor for inner and outer heads since the ends of the roll will have to absorb most of the impacts. The end damages are also very costly, so they must be prevented as well as possible.

Breathable material would prevent the piping phenomenon and other moisture related problems. Material should be such that it would let possible moisture go out the package but wouldn't let any outside moisture get inside. As mentioned earlier the moisture is harmful for release base paper because of the paper chemistry and the fact that moisture creates pleats on especially the surface layers.

The wrapping material must roll around the reel smoothly and firmly, with no wrinkles, but still create firm, sharp crimping on both reel ends. The moisture penetration must be as minimal as possible and handling durability must be as good as it can be. This is not an easy combination especially if reasonable price is also required but this is still the aim all the time.



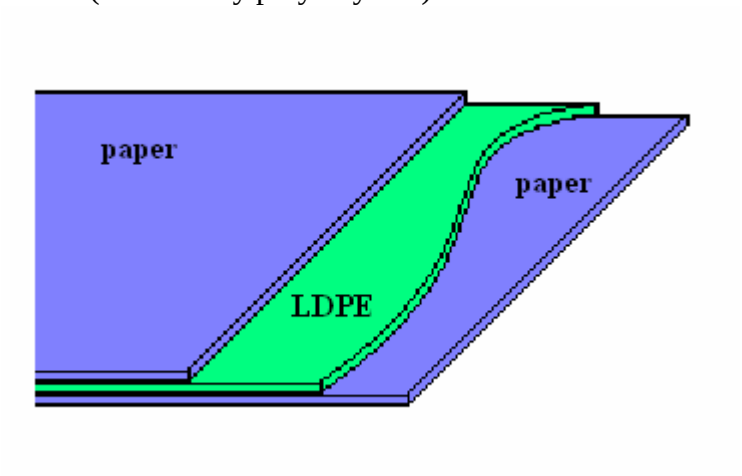
Picture 18 UPM Packing standard

5.4 Packaging materials

5.4.1 Wrapping

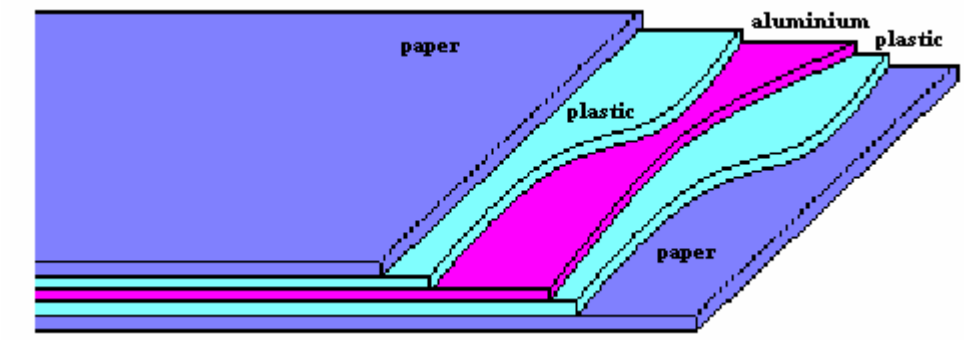
Critical issue with the standard wide wrappings is that they are sometimes too wide. The wrapping should be 30-50cm wider than the reel, the extra 15-25cm on both sides form the folding on the ends, crimping. If the extra part that forms the crimping is too wide the crimping is not as sharp and firm as it should be.

Currently at PM5 and PM8 there are two types of wrappings used. The reels are wrapped into either “standard” wrapping that is of 200g/m^2 and consists of 90g/m^2 papers on each side and 20g/m^2 of LDPE (low density polyethylene) in the middle.



Picture 19 Standard LDPE wrapping

On some occasions the standard wrapping is not seen protective enough, and then aluminium wrapping is used. This is the case when delivering to Asia Pacific area. The aluminium wrapping is of 260g/m^2 and has 20g/m^2 of aluminium in the middle, 20g/m^2 of LDPE on each side and then 100g/m^2 of paper on the other side of the plastic.



Picture 20 Aluminium wrapping

The aluminium wrapping provides better moisture blocking than the standard wrapping since the barrier properties are on very high level, humidity can not penetrate through the wrapping material but only from the wrapping folds, crimping, on the edge of the reel.

Although aluminium wrapping protects the release base paper from moisture and humidity, it also has its problems. First of all it is more difficult and costly to recycle. This is because the recycling requirements become stricter and the recycling of multilayer wrapping is even more difficult. Extra costs of such nature are never welcome, and some customers are even reluctant to accept such wrapping that create this extra effort and cost to them.

The aluminium wrapping also does not “bounce back” after handling. So if a forklift at some point puts a dent on the wrapping, it stays there and the reel looks damaged although it might just be on the wrapping, not on the actual paper. This rigidity of the material also creates problems during the actual packing process at the mill as aluminium wrapping folds more poorly because of the multilayered structure and the higher mass per square meter.

5.4.2 Inner and outer heads

There are two different inner heads used; the standard corrugated board inner head (CB), and corrugated board inner head that also has a layer of plastic on it (CB+plastic). The latter one is used with deliveries to the US.

One important issue with the inner and outer heads is their size. There are standard sizes, the difference in diameter being 5cm. The head should not be too big, so sometimes one needs to choose a little bit too small head. This can make the process sometimes more difficult than it needs to be and the package more vulnerable than it should be.

The reason inner heads are used is to protect the reel from impacts to the reel end. It also protects the reel from occasional wrapping mishaps. Such could be for instance if the wrapping comes on the reel on a wrong angle and touches the end and wrapping glue gets on the end.

There are also two kinds of outer heads used. Normally the outer head is a standard one side PE-coated outer head (PEC1S). It has a layer of paper on the outside and a film of polyethylene on the inner side. The other version of the outer head that is used with the aluminium wrapping also has a thin layer of aluminium on it. The outer head is glued to the reel end minimum of 3-5 seconds at a 150°C on a certain pressure. Outer head glues the crimping firmly, and by that it blocs the outside moisture.

5.5 Costs

The costs of the reel wrapping vary on reel to reel. But if we look at the average reel, we can calculate quite accurately the cost of packaging material per reel.

The average reel is 180cm wide and has the diameter of 120cm. The wrapping has to be from 30 to 50cm wider than the reel to ensure good crimping so the wrapping used is 220cm wide. The used amount of wrapping per reel is 4 layers. So per one average reel 15m of 2,2m wrapping is needed. This adds up to $33m^2$ of wrapping per average reel. As mentioned earlier the reel ends are protected with inner and outer heads, two pieces of each.

We can now calculate the costs for all of the three different package alternatives:

5.5.1 Standard wrapping, CB inner heads, PEC1S outer heads

$33m^2$ of standard wrapping costs $33m^2$ x 0,170index/m^2 = 5,60index.
2 times CB inner heads (0,44index each) and 2 times PEC1S outer heads (0,418index each) cost 0,88index + 0,84index = 1,72index.
This gives us the total of 7,32index for this packaging material combination.

5.5.2 Standard wrapping, CB + plastic inner heads, PEC1S outer heads

$33m^2$ of standard wrapping costs the mentioned 5,60index.
2 times CB + plastic inner heads (1,25index each) and 2 times PEC1S outer heads cost 2,5index + 0,84index = 3,34index.
This gives us the total of 8,94index for this second packaging material combination.

5.5.3 Aluminium wrapping, CB inner heads, aluminium outer heads

$33m^2$ of aluminium wrapping costs $33m^2$ x 0,533index/m^2 = 17,58index. 2 times CB inner heads and 2 times aluminium outer heads (0,754index each) cost 0,88index + 1,51index = 2,39index.
This gives us the total of 19,97index for this packaging material combination.

From these calculations we can verify that the aluminium package is not only hard and costly to recycle and has its difficulties with handling (inflexibility of the material) but it is also costs more than twice as much compared to the other packaging materials.

5.6 Investigations for better packaging material

So far two alternate wrapping materials have been tested. The main thought with these trial wrappings is to find a solution for moisture and handling problems but at the same time reach cost savings. Although these both wrappings are more expensive per m^2 than the standard wrapping, the cost effectiveness lies on the performance of these better wrappings. These wrappings provide better moisture blockage and handling durability and therefore they will reduce the complaint costs.

5.6.1 The 40g/m^2 LDPE wrapping trial

The first trial was conducted with a customer from Germany. In this test the standard PE-wrapping (100g/m^2 papers on both sides and 20g/m^2 LDPE in the middle) was replaced with a PE-wrapping that had 40g/m^2 of LDPE instead of the 20g/m^2. The amount of wrapping was also 4 layers.

4 layers, e.g. 33m^2 of this LDPE trial wrapping costs 33m^2 x 0,247index/m^2 = 8,15index.
The inner heads used were CB and they cost 0,88index and the outer heads used are PEC1S and they cost 0,84index.
The total cost for this LDPE trial package is 9,87index.

If we compare this price to the 3 packaging combinations used today, we find out that it is more expensive than the packages made with standard wrapping but it only costs about 50% of the package made with the aluminium wrapping and outer heads.

The feedback of this trial was purely positive. The amount of occurring piping was very small or none at all. Still, this trial wrapping has its downsides also, as the amount of LDPE is so high the mass of the wrapping material increases. There are limits for the amount of LDPE because of this increasing mass.

The solution for this problem can be reached by reducing the amount of PE and at the same time changing the density of it. This lead to the next trial with the HDPE.

5.6.2 The 25g/m^2 HDPE wrapping trial

Another trial on a modified wrapping material is on-going right now. This is done with the cooperation of two customers: the customer from Germany that the first trial was conducted with and another one from India. This time the 20g/m^2 LDPE in the wrapping was replaced

with 25g/m^2 of HDPE (high density polyethylene). In this trial also, the amount of wrapping was 4 layers.

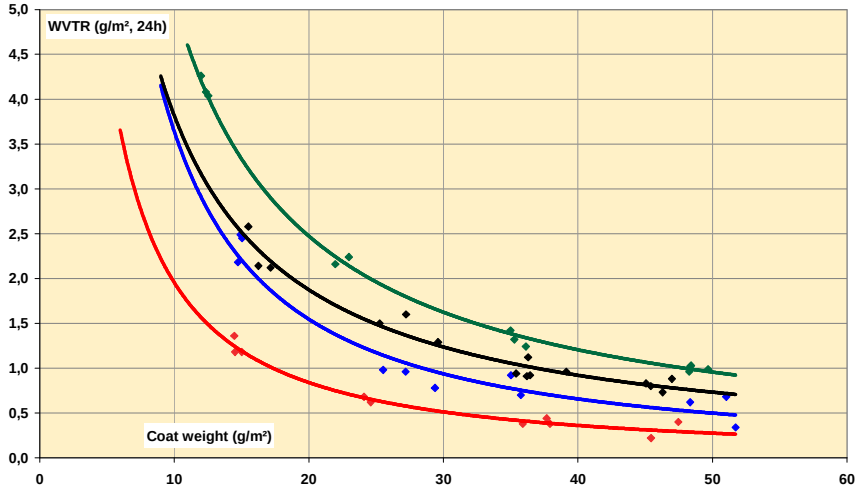
4 layers, e.g. 33m^2 of this HDPE 25g trial wrapping costs 33m^2 x 0,244index/m^2 = 8,05index.
The inner heads used were standard CB and they cost 0,88index and the outer heads used are also standard PEC1S and they cost 0,84index. The total cost for this HDPE trial package is 9,77index.

When comparing this HDPE trial to the 3 used combinations and the LDPE trial, the result is that it costs about 33% more than the package made with the standard wrapping material. Again, package made with this trial material is 50% cheaper than the one made with aluminium packaging materials.

5.7 The differences between the HDPE and the LDPE

The amount of plastic on the wrapping can be maximum of 40g/m^2 and it is still usable. However, the bigger the amount of plastic the heavier is the package and therefore more expensive to transport. So instead of increasing the amount of LDPE it can be changed to HDPE and still similar or even better barrier properties can be achieved.

We can make some estimation on this HDPE trial's outcome by studying the picture 21 below. From this graph we can see the water vapour transmission rate (WVTR) figures of different plastics that can be used on the wrappings. The WVTR-figure indicates the amount of water penetration through the plastic at specific conditions and time.



Picture 21 WVTR-figures at 23°C and 50% RH
Source: SEWALPAP

We are interested in the green and the blue line, green being the LDPE and blue being the HDPE.

From the green line, we can see that in these conditions (23°C and 50% relative humidity), the WVTR figure of 20g/m^2 LDPE is 2,5g/m^2, 24h. If the amount is 40g/m^2, as it was on the first trial, the figure decreased to approximately 1,2g/m^2, 24h.

When looking at the blue line, we find out that the same WVTR figure (1,2g/m^2, 24h) can be reached with 24-26g/m^2 of HDPE. So probably the outcome of this trial is just as victorious or even better, than with the 40g/m^2 of LDPE –trial.

The point being that the less we need the plastic per m^2 on the wrapping, the lighter it is and therefore cheaper to transport and more importantly easier to handle and packages are of better quality.

On the picture 21 there are also two other lines red, being the cyclo-olefin-copolymer (COC) and black, being polypropylene (PP). They are not being examined here since they are not as easy to attach to paper as PE is and therefore not as usable.

6 Findings

6.1 Warehousing and transportation improvements

The transportation situation comes down to two main issues: quality and costs.

The problems that occur when dealing with tight schedules have a major effect on the quality of the transportation as a service and on the quality of the packages. Because the time is so limited these days even the warehouse personnel at Tervasaari does not always have the time to inspect the reels, loading equipment and containers individually or even if they do, they do not always have the possibility to for instance demand for another container since the reels have a ship to catch.

The time situation is even worse when thinking about the employees at some destination port on the other side of the world; they do not need to worry about the image of UPM or Tervasaari, their main concern is whether they can perform their job at the short time given.

Unfortunately we can not create more hours on the day and because time is money, we can not extend the times used for loading so the focus should be on the performance and the maintenance and quality of the equipment used. Or even if the amount of particles/impurities on the warehouse and container floors could be reduced, it would mean better results since every particle that penetrates through the package into the reel end means almost certainly a wasted reel and hence extra costs and an unhappy customer.

The monitoring of the packaging quality could also be done quickly with the help of mirrors on the warehouse walls. This system is in use on some warehouses and could probably be implemented into Tervasaari warehouses quite easily. When damaged or otherwise faulty package is spotted quickly, it can easily be sent back for repacking. This quick way of working would not delay loading much or even at all and therefore possible extra costs would be minimal but still a bigger problem could be prevented.

As most of the reels are loaded into containers at Tervasaari premises, the employees are a key factor. They have the best knowledge on the product and they have the highest motivation to correct things that are not right, since it makes their own job performance easier. The key is to provide them with easy to use tools and the right attitude –they really can make the difference and they should feel proud of it!

6.2 Improvements in the packing process

The packing station at PM5 will be remodelled in the near future. The aim is to create similar station as it is on PM8, one person and a robot. This is a very good time to critically look at the present system and the plans for the new PM5 packing station.

Key factor on the quality of the package is the end of the reel. The end has the most critical parts: inner and outer heads and the crimping that is formed from the folded part of the reel's body wrapping. Focus is on the size of these 3 factors. If the inner and outer head are too small or too big the coverage and protection is not optimal and if the wrapping is too wide or too narrow the crimping is not well enough.

The possibilities with the actual wrapping are unfortunately quite limited: because the wrappings are of standard width it is impossible to always have the best width since the size of the reels may occasionally vary a lot. And if there are rolls of wrapping material that are used very seldom, the quality of the wrapping deteriorates over time. So the aim is that most of the reels could be packed in a material that has the optimal width.

Even though right now there are standard width wrappings used, sometimes they wait for long time between batches that are of that size. As mentioned, the wrapping deteriorates over time, for instance the moisture profile may change, and therefore it is harder to use. In order to maintain the wrapping quality for wrappings that are used seldom they need to be re-moisturised. This has been an issue at PM5 packing station for a quite long time. Now when the whole station is facing a change this issue should be emphasized also.

The main focus could be on the heads, both inner and outer. Now the situation is that there are standard diameters, 5cm apart of each other, and sometimes too small heads need to be used in order to avoid too big ones. But instead of the standard sized heads there could be the raw material and a laser, or similar, cutter that would provide customized heads for each reel. This could be done quickly after the first part of packing process, the identifying, weighing and measuring the reel, so the time of packing would not increase significantly. This would reduce the need for storage for different sized heads and most importantly this would improve the quality of the package and therefore the valuable reel would travel safer. This on-the-spot cutting would of course create some waste material but even now the heads are being cut from a reeled material so the waste is an issue on the previous stage in the chain.

6.3 Future trials on the wrapping material

APPENDIX 4

The costs could be reduced even more if the amount of wrapping layers would be decreased into 3 layers. This HDPE 25g trial wrapping material has the potential to perform better than the standard wrapping with only 3 layers as well.

3 layers of wrapping would mean 25m^2 of wrapping, in this case it would be 25m^2 x 0,244index/m^2 = 6,10index.
The inner heads used would be standard CB and they'll cost 0,88index and the outer heads used would also be standard PEC1S and they'll cost 0,84index. The total cost for this 3 layered HDPE 25g/m^2 trial package would be 7,82index.

The 4 layered package of the standard wrapping material costs 7,32index so the difference in price is only 0,50index per package. And if the wanted result, the improvement, could be reached with such a small increase in unit price it makes practically no difference in total costs in the long run. Actually, if this trial material could prevent even one complaint that costs for instance 2 000 euros it would mean that packing 3 999 reels in this trial material would be cheaper.

Cost savings can be reached on another level also. The reduction of packing material per reel would be, as mentioned, about 8m^2. If the used wrapping weights 205g/m^2, the reduction in weight per reel would be approximately 1600g. From this, we can calculate that if dealt with 80 000 reels per year and they each are 1,6kg lighter, the total reduction in weight is about 130 000kg. This means 130 tonnes less waste material to recycle or otherwise take care of and especially 130 tonnes less "useless" material to transport with the actual release base paper. This gives the savings in transportation costs of roughly 10 500 euros per year, since the average cost for every tonne transported is about 80 euros.

So this trial material, 25g/m^2 of HDPE, is definitely worth further testing. The cost savings can be reached so easily. Not to mention the advantages in the packing process. When less material per reel is used, it means shorter packing time per reel and therefore better packing capacity, it increases the time between packing material change at the packing machine, yet another time and money saving improvement, and the crimping quality would improve, thus the whole package would be even more reliable.

There have been some requests from customers for packing trials in order to prevent piping phenomenon. This would be optimal time to test this 3 layer system. If it turned out to be not such a success the

amount of wrapping could always be increased back to 4 layers. But if the trials would originally be conducted with 4 layers of HDPE material and the results would be successful it is always harder then to try the 3 layers since the customer would obviously be afraid that the quality of the package would suffer.

7 Conclusions and recommendations

The goal of this thesis was to find out solutions for transportation and handling related problems with the most cost effective way. This was done because of all the time toughening customer requirements as well as the fact that constant product development is important in order to maintain competitive advantage.

The main issues turned out to be the selection of the best wrapping material, the improvement of packing process and the concentration in some warehouse operations.

The hunt for the best possible wrapping material is still on-going but the needed direction has been found. The aim is to reduce both direct material and transportation costs in addition to reducing the consequential complaint costs. Further material trials with the HDPE wrapping can be continued with the customers from Germany and India along with starting trials with other customers also. The final outcomes are yet to be discovered but the expectations are promising.

The trial of HDPE wrapping with less wrapping layers per reel also provides the needed improvement in the packing process by reducing the packing time and therefore by increasing the capacity of the packing stations, by increasing the time between material change at the packing machine, and finally by improving the package's quality along with the reliability when the crimping firmness improves.

Also the possibility of the on-the-spot creation of custom made inner and outer heads for the reels should be considered as it significantly improves the quality of the reel end packing and therefore the reliability of the package increases drastically.

Furthermore a good look at the warehouse operations should be taken. The importance of actions that seem to be minor but have a huge effect on the quality of the reels leaving the Tervasaari premises should not be overlooked by anyone. Just by looking at the improvements already gained by changing the gravel, used to secure walkers' safety during the winter, into sand that does not such harm to reel ends, we realize that the focus should be on even the littlest things when considering major effects.

A small input on the overall cleanliness and maintenance of the warehouse and the containers might help to prevent costly complaints. Also by installing mirrors into the warehouse a small action would help the forklift drivers' task of monitoring the packing quality and therefore improving the condition of the shipped reels.

All in all the focus should be on the importance of attitude on all levels throughout the process, starting from the second the incoming order is received by the market coordinator to the moment the reels reach the customer. The difference the attitude can make is huge, bigger than any new machine or material can create, since the aim is to constantly improve the performance and to maintain the ability to react on occurring issues quickly.

Personnel is still UPM Base Papers' biggest strength and most valuable asset and it should be acknowledged. The skilled and motivated people are the key to continuous improvement and the wide range of professionals on the customer service team as well as on the ground level workers provide the tools for product quality and product quality development.

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Pictures 1-3
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Pictures 4, 8-17, 19-20
Grip-Lahdenniemi, Sannamaria 2007.

Pictures 5-7
Customer complaints

Picture 18
Uusikartano, Mika 2006. Kuljetus- ja käsittelyvaurioiden ehkäisy sekä rullapakkauksen kehitys, kustannustehokkuuden parantamiseksi. Presentation. Meeting, UPM Tervasaari 13.9.2006. Valkeakoski

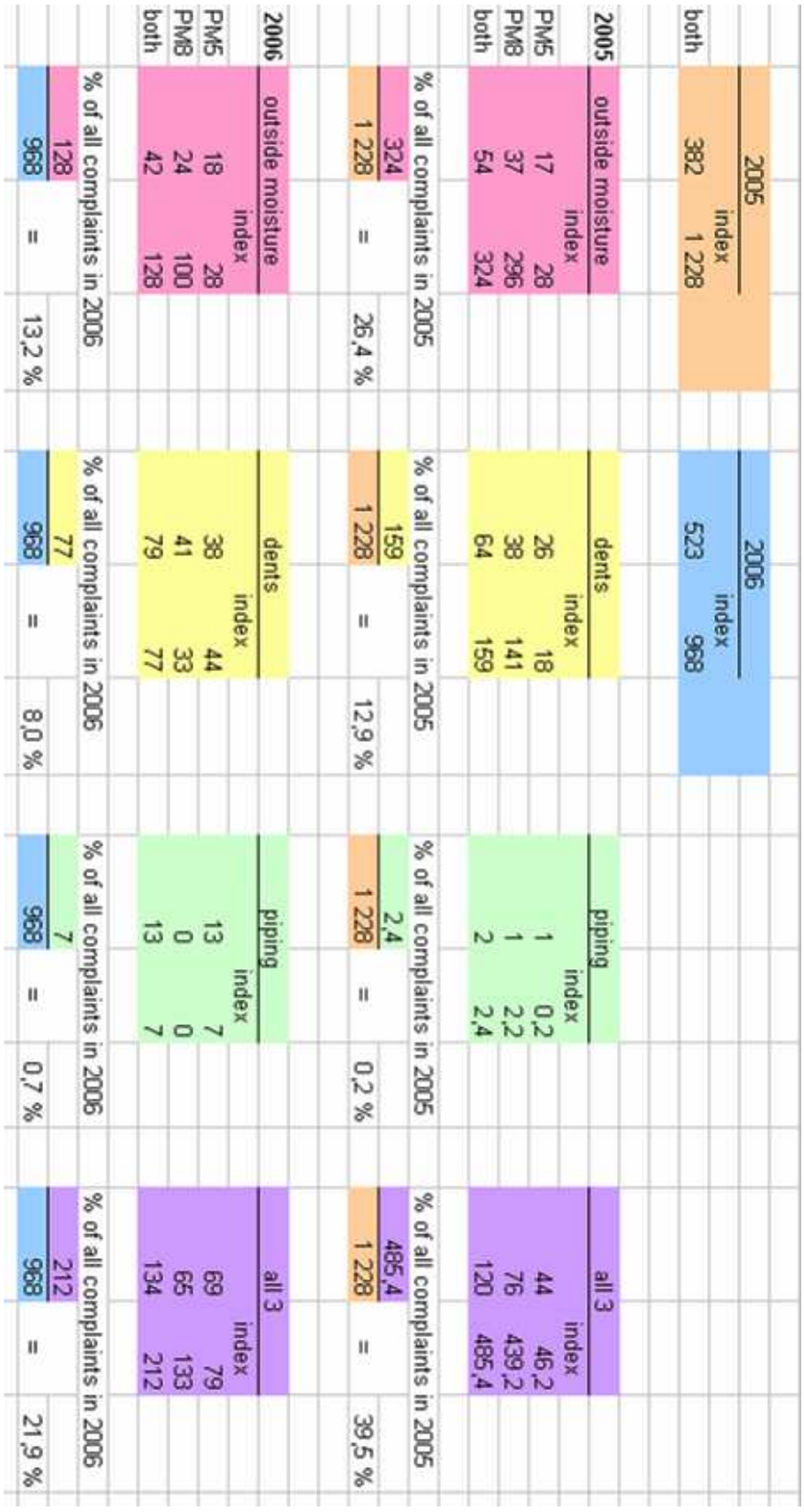
Picture 21
Nylund, Kenneth 2006. Rullakääreet ja Kosteussuoja. Presentation. Meeting, UPM Tervasaari 19.12.2006. Valkeakoski.

Appendixes

Appendix 1: Abbreviations

PM	Paper machine
LDPE	Low density polyethylene
CB	corrugated board
PE	Polyethylene
PEC1S	One side polyethylene coated
HDPE	High density polyethylene
WVTR	Water vapour transmission rate

Appendix 2: The transportation and handling related complaints



2005	
	index
both	382
	1 228

2006	
	index
	523
	968

2005	outside moisture	
		index
PM5	17	28
PM8	37	296
both	54	324
% of all complaints in 2005		
	324	
	1 228	=
		26,4 %

	dents	
		index
	26	18
	38	141
	64	159
% of all complaints in 2005		
	159	
	1 228	=
		12,9 %

	piping	
		index
	1	0,2
	1	2,2
	2	2,4
% of all complaints in 2005		
	2,4	
	1 228	=
		0,2 %

	all 3	
		index
	44	46,2
	76	439,2
	120	485,4
% of all complaints in 2005		
	485,4	
	1 228	=
		39,5 %

2006	outside moisture	
		index
PM5	18	28
PM8	24	100
both	42	128
% of all complaints in 2006		
	128	
	968	=
		13,2 %

	dents	
		index
	38	44
	41	33
	79	77
% of all complaints in 2006		
	77	
	968	=
		8,0 %

	piping	
		index
	13	7
	0	0
	13	7
% of all complaints in 2006		
	7	
	968	=
		0,7 %

	all 3	
		index
	69	79
	65	133
	134	212
% of all complaints in 2006		
	212	
	968	=
		21,9 %

Appendix 3: The transportation chain